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Impact of removal pitfall trapping on the community of shrews (Mammalia : Soricidae) in two African tropical forest sites.

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SUMMARY

Removal trapping is still used for the study of tropical African shrews biodiversity and ecology, because shrew species identification requires cranio-dental analyses due to the existence of sibling species. Pitfall trapping has been found to be the most effective protocol to collect shrews. However, the impact of removal pitfall-trapping on density and diversity of shrew species is still unknown. In this paper, we test this impact on two African tropical forest shrew communities, by comparing the results of two trapping sessions conducted in two consecutive years. Our results support the view that removal trapping, with conditions described in this paper, does not adversely affect local population numbers and shrew species richness.

KEY WORDS

shrews,
density,
diversity,
removal,
pitfall-trapping,
Africa.

RÉSUMÉ

L'identification de la plupart des espèces de musaraignes tropicales africaines ne peut se faire qu'après analyses crânio-dentaires, en raison de l'existence

d'espèces jumelles. C'est pourquoi, l'euthanasie de ces micro-mammifères reste nécessaire à l'étude de leur biodiversité et de leur écologie. Le piégeage « pitfall » est reconnu comme la méthode la plus adaptée à la collecte des musaraignes ; cependant, l'impact de ce type de piégeage, avec euthanasie des spécimens, sur la densité et la diversité des musaraignes reste méconnu. Nous testons ici cet impact sur deux communautés de musaraignes de forêt tropicale africaine, en comparant les résultats obtenus lors de deux sessions de piégeage effectuées, à la même place, deux années consécutives. Nos résultats montrent que le piégeage, dans les conditions décrites dans ce papier, n'affecte pas la densité ou la diversité des musaraignes.

INTRODUCTION

Shrews (Insectivora : Soricidae) constitute a species-rich and ecologically diverse taxon, with 335 described species, which 150 are found in Africa (Wolsan and Hutterer 1998). African lowland tropical forests, an area of high diversity for this group, harbour up to 18 shrew species on a 10.4 Km² forest plot (Barrière and Nicolas 2000). Shrew species are difficult to identify, particularly due to their small size and the existence of sibling species. Thus, identification of most species requires cranio-dental analyses. Similarly, the study of their diets implies stomach contents analyses (Churchfield and Sheftel 1994), thus requiring the killing of the animals. The same is true for epidemiological surveys (Breman *et al.* 1999 ; Leirs *et al.* 1999 ; Morvan *et al.* 1999).

Pitfall-trapping is the most effective protocol to collect shrews (Williams and Braun 1983, Kalko and Handley 1992, Maddock 1992, Kirkland and Sheppard 1994). When used in transect lines with drift fences, this method yields information on the diversity and relative abundance of shrew species (Handley and Kalko 1993). In tropical Africa, this last method has only been used since the middle of the nineties (e.g. Cornélis *et al.* 1995, Colyn *et al.* 1996, Stanley *et al.* 1996). In this part of the world, the ecology (Churchfield 1990, Hutterer 1997, Haberl

2001), life histories (Innes 1994) and social structure (Rychlik 1998) of shrews are still poorly known.

The impact of removal pitfall-trapping on the shrew population density and species richness is still unknown. Therefore, we decided to test this impact on two shrew communities in African tropical forests by comparing the results of two trapping sessions conducted in two consecutive years.

MATERIALS AND METHODS

Study sites and sampling method

Sampling was performed in two African lowland rain-forest localities : Batouri, located in the Ngotto forest (03°54N-17°02E), in Central African Republic (C.A.R.), and Moueva, located in Monts Doudou (02°09S-10°30E), in Gabon. Pitfall lines consisted of 10-litre plastic buckets (26 cm deep, 26 cm top internal diameter, 20 cm bottom internal diameter), positioned at 5 m intervals, along a plastic drift fence bisecting all of the buckets, and extending 2.5 m beyond the first and last buckets (Fig. 1). The plastic array was inserted into the ground to prevent burrowing through litter beneath the fence, and held

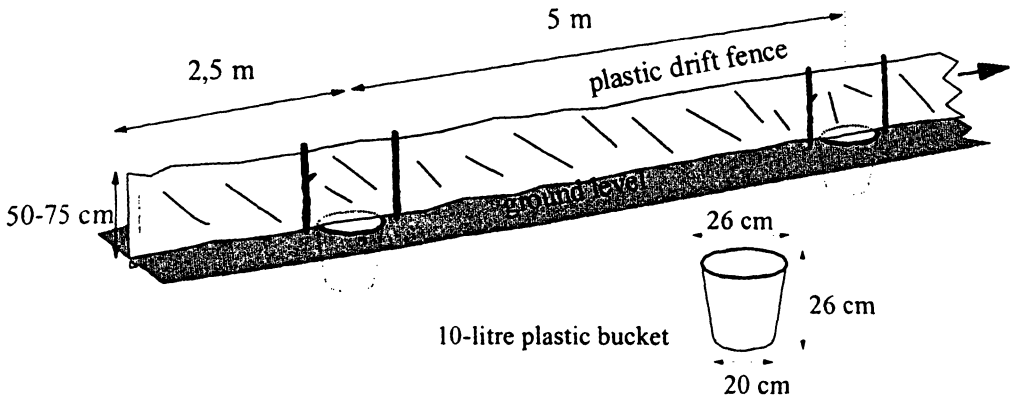


Fig. 1. – Schematic representation of an extremity of the pitfall sampling device used by our team since 1994, with 10-litre plastic buckets and a plastic drift fence, 50-75 cm high above the ground level.

upright by sticks cut from the forest. Buckets were sunk to a depth where the rim was even with the ground level. Small holes (3-5 mm) were burned in the bottom of the buckets to allow water drainage. As shown by Table 1, the number of buckets per line varied from 20 (100 m long line) to 40 (200 m). At Batouri, six pitfall lines (B1 to B6), separated at least by 100 m from each other, were set perpendicularly to the Batouri River, with three lines on either side of the river (more details *in* Barrière and Nicolas 2000). At Moueva, one pitfall line (M1) was set in *terra firme* forest (i.e. forest ground never flooded). All lines were set for 21 days once in one year, and then again once in the following year. At each locality, pitfall lines were set exactly at the same place for the two consecutive years.

Rainfall is known to increase activity of shrews and therefore their trappability (Kirkland and Sheppard 1994), depending on their capacity to enter torpor or not (Churchfield 1990). Therefore, we compared results obtained in seasons with comparable rainfall (July 1999 and 2000 at Batouri; March 2000 and 2001 at Moueva). Daily rainfall was measured during the 21 consecutive days of each trapping session.

Data analysis

A bucket-night is defined as one bucket in use for a 24-hour period (dawn to dawn), and the trapping effort (E) as the number of bucket-

nights. The trap success (T) is defined as the number of shrews caught per 100 bucket-nights; i.e. $T = (N/E) \times 100$, where N is the number of shrews trapped. We used Chi-square tests (χ^2) for trap success comparisons; a probability of $P \leq 0.05$ was considered as significant. The regression coefficient (r^2) of the cumulative number of individuals trapped as a function of time was calculated for each line and each trapping session.

Specific identification was performed at the laboratory by P.B. and Rainer Hutterer for the specimens from Batouri, and by P.B. for those from Moueva. The number of species known to occur at Batouri and Moueva is 18 (Barrière and Nicolas 2000) and nine (Nicolas and Barrière 2001) respectively. While all the specimens collected during both trapping sessions at Moueva were identified, those collected during the second trapping session at Batouri could not be identified. Thus, in order to test the impact of removal trapping on the community structure, we only compared the results obtained at Moueva in March 2000 and March 2001. Species relative abundance (p_i) is defined as the number of individuals of the species i caught per 100 individuals of all species, i.e. $p_i = (n_i/N) \times 100$, where n_i is the number of shrews of the species i , and N the total number of shrews. Spearman rank correlation of species abundance between 2000 and 2001 was calculated in order to compare the overall shrew community structure between years.

All statistical analyses were performed by MINITAB 12.2.

RESULTS

Rainfall

At Batouri, the number of rainy days in July 1999 and 2000 were 11 and six respectively, and cumulative rainfalls for the 21 days of survey were 136 and 141mm. At Moueva, 10 and 13 rainy days occurred in March 2000 and 2001 respectively, with an amount of 101 and 194 mm of rain.

Trap success

At Batouri, 142 shrews were collected during the first trapping session, and 154 during the second one; which represents a total trapping success of 4.23 % and 4.58 % respectively (Table

1). These differences, in term of trapping success, are not significant ($\chi^2 = 0.360$, d.f. = 1, $P = 0.549$). Between the first and the second trapping session, the trap success significantly increased for the line B4 and decreased for B5 ($\chi^2 = 4.635$, and 5.934 respectively, d.f. = 1, $P < 0.05$), but did not vary significantly for the four other lines ($P > 0.05$). Whatever the line, and the trapping session, the cumulative number of shrews trapped did not decline as a function of time ($0.86 < r^2 < 0.99$, $P < 0.001$), as shown in Table 1. In 1999, the trap success varied significantly among lines ($\chi^2 = 29.249$, d.f. = 5, $P < 0.001$), but this difference was only due to the greater number of captures on line B5. Thus, no significant difference was observed when this line was excluded from the analysis ($\chi^2 = 5.748$, d.f. = 4, $P = 0.219$). In 2000, no significant variation was observed among lines ($\chi^2 = 7.635$, d.f. = 5, $P = 0.718$).

TABLE 1. – Sampling characteristics (number of buckets, sampling period, trapping effort E (in bucket-nights)), number of captures (N) and trap success (T, %) obtained on the seven pitfall lines. Pitfall lines B1 to B6 were set in Batouri (C.A.R.), and M1 in Moueva (Gabon). P is the probability that trap success differs according to years of trapping (P associated with Chi-square values) and r^2 is the regression coefficient of cumulative number of individuals trapped as a function of time.

Pitfall lines	Nb of buckets	sampling periods			N		T (%)		P	r^2	
		year 1	year 2	E	year 1	year 2	year 1	year 2		year 1	year 2
B1	40	15-07 to 04-08-99	06-07 to 26-07-00	840	39	43	4,64	5,12	0,666	0,98	0,98
B2	40	16-07 to 05-08-99	07-07 to 27-07-00	840	28	43	3,33	5,12	0,081	0,98	0,94
B3	20	15-07 to 04-08-99	06-07 to 26-07-00	420	16	20	3,81	4,76	0,514	0,99	0,96
B4	20	16-07 to 05-08-99	07-07 to 27-07-00	420	9	21	2,14	5,00	0,031	0,96	0,90
B5	20	15-07 to 04-08-99	06-07 to 26-07-00	420	38	19	9,05	4,52	0,015	0,96	0,97
B6	20	16-07 to 05-08-99	07-07 to 27-07-00	420	12	8	2,86	1,90	0,377	0,97	0,86
Overall				3360	142	154	4,23	4,58	0,549		
M1	30	24-02 to 16-03-00	09-03 to 29-03-01	630	72	72	11,43	11,43	1,000	0,99	0,97

At Moueva, 72 shrews were captured both years, representing a trap success of 11.43 % (Table 1), significantly higher than that of Batouri ($\chi^2 = 39.794$ and 46.552 for the first and the second trapping session respectively, d.f. = 1, $P < 0.001$). Both in March 2000 and March 2001, the cumulative number of shrews trapped on M1 did not decline as a function of time ($r^2 = 0.97$ and 0.99 respectively, $P < 0.001$).

Species richness and community structure

At Moueva, seven species out of the nine known to occur were captured in March 2000, after 19 days of trapping (Table 2). In March 2001, the nine species of the community were caught after 14 days. The two additional species (*Crociodura goliath* and *C. grassei*) had a low trap success (0.63 and 1.11 % respectively).

TABLE 2. – Number of individuals of each shrew species captured on line M1 (Gabon) in March 2000 and 2001.

Species	March 2000	March 2001
<i>Crociodura batesi</i>	5	8
<i>Crociodura crenata</i>	6	8
<i>Crociodura dolichura</i>	2	2
<i>Crociodura goliath</i>	0	4
<i>Crociodura grassei</i>	0	7
<i>Paracrociodura schoutedeni</i>	21	14
<i>Suncus remyi</i>	2	1
<i>Sylvisorex johnstoni</i>	35	23
<i>Sylvisorex ollula</i>	1	5
Total	72	72

There was a significant positive relation between abundance per species in 2000 and 2001 ($r = 0.70$, $P < 0.05$), indicating that the overall shrew community structure was similar in both years. *Sylvisorex johnstoni* was the most abundant species both years (49 % and 32 % of the total captures in March 2000 and 2001 respectively), *Paracrociodura schoutedeni* was abundant (29 % and 19 %) and the other species were rare (< 10 % each).

DISCUSSION

At both study sites, the overall trap success did not vary significantly between two trapping sessions, and on six lines out of seven, the trap success did not decrease significantly. In addition, whatever the line and the trapping session, the cumulative number of shrews trapped did not decline as a function of time. At Moueva, the trap success obtained on line M1 in the second trapping session (11.43 %) was even greater than that obtained on two other neighbouring lines, where no trapping occurred during the first trapping session (8.57 % and 5.71 %, unpublished data). All these results suggest that removal trapping, with conditions described in this paper, does not induce a significant decrease in the density of shrew populations.

Though our data on the impact of removal trapping on community structure are limited to the Moueva study site, our results also support the view that the removal trapping method has no significant effect on species diversity. Indeed, two additional rare species were observed at

Moueva, on line M1, during the second trapping session, and the species richness obtained on this line (nine species) was higher than on the two neighbouring lines where no previous trapping occurred (six and eight species). Then, rare species are known to require an increased trapping effort to be captured. As an example, at Batouri, 41020 bucket-nights were needed to capture the first specimen of *Crociodura hildegardeae* (Barrière and Nicolas 2000).

Crociodurine populations have a rapid turnover (Churchfield 1990) and the study sites, where trapping were carried out, occupied a minuscule area of an extensive and unfragmented tropical forest. Removal trapping, with such conditions, would not have significant consequence on density and diversity of shrew species, even the rarest ones, and therefore on their conservation.

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