Belg. J. Zool., 136 (1) : 107-111 January 2006

Relative efficiency of three types of small mammal traps in an African rainforest

V. Nicolas[1] and M. Colyn[2]

[1] **Museum National d'Histoire Naturelle, Département de Systématique et Evolution, UMR 5202 du CNRS / USM 601, Laboratoire Mammifères et Oiseaux, 55 rue Buffon, 75005 Paris, France. Tel : (33) 1 40 79 35 05; Fax : (33) 1 40 79 30 63; E-mail : vnicolas@mnhn.fr**

[2] **UMR CNRS 6553, Université de Rennes 1, Station Biologique, 35380 Paimpont, France**

ABSTRACT. Numerous studies have compared the efficiency of different types of traps for the survey of small mammals in temperate countries, but such comparative studies are strikingly fewer in tropical habitats. We compared the efficiency of three types of traps for sampling small mammals in an African rainforest : one type of interception trap (pitfall traps with drift fences) and two types of baited traps (Sherman live trap and metal snap trap). We captured 1884 individuals belonging to 9 shrew and 11 murid rodent species. Pitfall traps were more efficient (higher number of species trapped and higher trap success) than baited traps for capturing shrews. In contrast, they were less efficient for capturing rodents, even if some rare species were captured in pitfall traps only. Sherman and snap traps have complementary qualities for the capture of rodents. Sherman traps are more effective for trapping smaller rodent species, while snap traps tend to be more effective for trapping larger ones. Moreover, light individuals of the largest species are better captured than heavy ones in Sherman, while no significant difference was observed for small species. No sex ratio difference was detected between populations sampled by each of the three types of traps. The three types of traps used in this study have complementary effects onto the capture of small mammals in African rainforest. An assortment of traps should always be employed in studies of small mammal communities in African rainforest in order to obtain a wider range of taxa, and thus a better representation of the community.

KEY WORDS : Sherman; snap trap; pitfall; rodent; shrew

INTRODUCTION

Most studies of small mammal communities rely on sampling methods involving trapping. The quality of the data collected is thus dependent on the efficiency of the trapping techniques employed. Traps can be categorized into those catching small mammals randomly (interception or passive traps such as pitfall traps) and those attracting and eliciting orientation behaviour (active traps such as baited traps; SOUTHWOOD, 1978). Additionally, two main types of baited traps can be used to capture small mammals : live traps (such as Sherman traps) and snap traps.

In temperate countries, numerous studies compared the success of different trapping techniques for the survey of small mammals, and adequate techniques for sampling each group have been established (e.g. COKRUM, 1947; SEALANDER & JAMES, 1958; BEER, 1964; PATRIC, 1970; WIENER & SMITH, 1972; DALBY & STRANEY, 1976; ROSE et al., 1977). In contrast, such comparisons are fewer in tropical habitats (LAURANCE, 1992; WOODMAN et al., 1996; LYRA-JORGE & PIVELLO, 2001), particularly for the African rainforest ecosystem. Recent awareness of the rapid disappearance of tropical rainforests has increased interest in understanding and conserving biodiversity (WILSON, 1988, 1992). To this aim, defining appropriate trapping techniques is essential.

The aim of this study was to compare the efficiency of three types of traps for sampling small mammals (murid rodents and shrews) in an African rainforest : one type of interception trap (pitfall traps with drift fences) and two types of baited traps (Sherman live trap and metal snap trap).

Study site

Our study was conducted in the eastern part of the “Aire d'Exploitation Rationnelle de Faune (AERF) des Monts Doudou”, south-western Gabon (02°09'S, 10°30'E), in undisturbed lowland forest (110 m A.S.L.). The forest canopy, which is approximately 35-45 m high, is dominated by Caesalpiniaceae and Mimosaceae. The understorey is open and *Dichostemma glaucescens, Meiocarpidium lepidotum* and a large variety of *Diospyros* species are frequently encountered (SOSSEF et al., 2004). The average annual rainfall recorded near this area is about 2300 mm (SAINT-AUBIN, 1963), with a short rainy season from March to May and a long one from October to December. The long dry season occurs from June to September and the short one in January-February. Temperature is more or less uniform along the year, with mean monthly minima between 19° and 23°, and maxima between 24° and 29°C.

MATERIAL AND METHODS

Trapping methods

Small mammals were trapped monthly, from April 2000 to March 2001, in two 875 x 1000 m study sites, standing 2500 m apart, which were localised at the same altitude and subject to similar climatic conditions. Each month, the trapping schedule was as follows :

(i) three traplines (each 1 km long) of 200 traps baited with manioc. Each trapline contained 100 Sherman live traps (7.5 X 9 X 23 cm) and 100 metal snap traps (10 X 15 cm) spaced at 5 m interval (one Sherman and one snap trap alternatively). Traplines were set 25 m apart;

(ii) one pitfall line with drift fences (150 m long) comprising 30 10-litre plastic buckets (26 cm deep, 26 cm top internal diameter, 20 cm bottom internal diameter) placed at 5 m interval (NICOLAS et al., 2003). Small holes (3-5 mm) were burned through the bottom of the buckets to allow water drainage in case of rain and thus prevent the drowning of trapped animals until the bucket was checked. Each month, the distance between the pitfall line and traplines was at least of 300 m. All traps (Sherman, snap traps and pitfall traps) were set for seven days and checked daily.

Due to the existence of sibling species, all animals captured had to be euthanized by cervical dislocation for species identification. As all animals were therefore removed from the study area, traplines were moved in space from one month to another, at a distance of 25 m from neighbouring traplines and 300 m for neighbouring pitfall lines.

Sex and weight of all the animals captured were checked and measured and muscle-tissue samples taken from killed animals were placed in surgical alcohol for molecular analysis. Skulls were extracted and cleaned for use in species determination, and bodies were preserved in 10% formalin.

Species identification

Species identification was based on external morphology and cranio-dental characteristics, and confirmed for several specimens by molecular analysis (16S rRNA sequencing). Identification was based on the most recent advances in the knowledge of shrew and rodent taxonomy, but several complexes of species are still in need of revision (NICOLAS, 2003; QUÉROUIL et al., 2006). Thus, in the text and tables, the designation "cf." (as in *Praomys* cf. *petteri*) suggests that specimens best fit within the morphological variation described for the named species, but could, under further examination, represent a different species.

Methods of analysis

At each study site, 87% of the land surface was covered by mainland forest and 13% was covered by flooded forest. Because the community structure and proportion of traps set in each habitat varied between these habitats (NICOLAS, 2003), our results take into account mainland forest only.

A trap in use for a 24-hour period is referred to as a trap-night (TN, dawn to dawn). Trap success (T) is defined as the number of individuals caught per 100 TN, i.e. $T = (N_m/N_{tn})x100$, where N_m is the number of individuals trapped and N_{tn} the number of trap-nights.

For each type of trap (pitfall, Sherman and snap trap) we compared the number and identity of species caught, and their trap success. Chi-square tests were used for trap success comparisons and a probability of $P \leq 0.05$ was considered significant. We also tested if body weight or sex of individuals had an effect on their capture by different types of traps. Chi-square tests were used for sex ratio comparisons between trap types and Mann-Whitney tests were used for body weight comparisons.

RESULTS

We captured a total amount of 1884 individuals belonging to nine shrew and 11 murid rodent species (Table 1).

Number of species and species composition

More shrew species were captured in Pitfall traps (nine) than in Sherman (six) or snap traps (two), and nearly the same number of rodent species was captured with the three types of traps (seven, nine and eight species respectively).

Species composition varied according to the type of trap used (Table 1) :

- several species of shrews (*Crocidura dolichura*, *Suncus remyi*) and rodents (*Hylomyscus parvus*) were captured in pitfall traps only;
- several rodent species were never captured in pitfall traps (*Deomys ferrugineus*, *Hybomys univittatus*, *Praomys* cf *misonnei*, *Praomys* cf *petteri)*;
- most species of shrews (*Crocidura crenata*, *Crocidura goliath*, *Crocidura grassei*, *Crocidura batesi* and *Sylvisorex ollula*) and the rodent species *Hylomyscus* cf *aeta* and *Lophuromys nudicaudus* were never captured in snap traps. The shrew species *Sylvisorex johnstoni* and the rodent species *Thamnomys rutilans* were never captured in Sherman traps.

Several shrew (*Paracrocidura schoutedeni)* and rodent (*Heimyscus fumosus*, *Hylomyscus stella*, *Malacomys longipes*) species were captured in the three types of traps.

Trap success

Trap success of shrews was significantly greater in pitfall traps than in Sherman or snap traps ($X^2 = 2462.007$ and 2815.180 respectively, $P < 0.001$), while the opposite was true for rodents ($X^2 = 43.279$ and 17.398 respectively, $P < 0.001$; Tab. 1). Trap success of shrew species was significantly greater in pitfall traps than in Sherman or snap traps ($63.358 < X^2 < 1492.965$, $P < 0,001$), except *C. goliath* evenly captured in pitfall and Sherman traps ($X^2 = 3.176$, $P < 0,075$). Trap success of most rodent species was greater in Sherman or snap traps than in pitfall traps, but several rare species (*H. parvus*, *L. nudicaudus*, *T. rutilans*, *H.* cf *aeta*) were mainly captured in pitfall traps.

Trap success of shrews vas greater in Sherman traps than in snap traps ($X^2 = 35.268$, $P < 0.001$); the same result was obtained for rodents ($X^2 = 53.880$, $P < 0,001$; Tab. 1). Trap success of *D. ferrugineus*, *H. fumosus*, *H.*

TABLE 1

Mean weight of species (in g); number of captures (N) and trap success (T) for each type of trap. E is the trapping effort.

	Mean weight	Pitfall traps (E=4865)		Sherman traps (E=44065)		Snap traps (E=43967)	
		N	T	N	T	N	T
Shrews							
Crocidura batesi Dollman, 1915	12	31	0,64	13	0,03	0	0,00
Crocidura crenata Brosset et al., 1965	8	30	0,62	1	0,00	0	0,00
Crocidura dolichura Peters, 1876	7	13	0,27	0	0,00	0	0,00
Crocidura goliath Thomas, 1906	44	5	0,10	19	0,04	0	0,00
Crocidura grassei Brosset et al., 1965	12	9	0,18	2	0,00	0	0,00
Paracrocidura schoutedeni Heim de Balsac, 1956	8	38	0,78	2	0,00	1	0,00
Suncus remyi Brosset et al., 1965	2	3	0,06	0	0,00	0	0,00
Sylvisorex johnstoni Dobson, 1888	3	170	3,49	0	0,00	1	0,00
Sylvisorex ollula Thomas, 1913	15	34	0,70	5	0,01	0	0,00
Total		333	6,84	42	0,10	2	0,00
Rodents							
Deomys ferrugineus Thomas, 1888	47	0	0,00	30	0,07	8	0,02
Heimyscus fumosus Brosset et al., 1965	18	6	0,12	119	0,27	30	0,07
Hybomys univittatus Peters, 1876	49	0	0,00	131	0,30	237	0,54
Hylomyscus cf *aeta* Thomas, 1911	24	3	0,06	4	0,01	0	0,00
Hylomyscus parvus Brosset et al., 1965	10	3	0,06	0	0,00	0	0,00
Hylomyscus stella Thomas, 1911	16	10	0,21	329	0,75	161	0,37
Lophuromys nudicaudus Heller, 1911	22	6	0,12	3	0,04	0	0,00
Malacomys longipes Milne-Edwards, 1877	65	2	0,04	20	0,05	24	0,05
Praomys cf *misonnei* Van der Straeten & Dieterlen, 1987	29	0	0,00	162	0,37	78	0,18
Praomys cf *petteri* Van der Straeten et al., 2003	29	0	0,00	46	0,10	28	0,06
Praomys sp		0	0,00	37	0,08	28	0,06
Thamnomys rutilans Peters, 1876	34	1	0,02	0	0,00	1	0,00
Total		31	0,64	881	2,00	595	1,35

stella, *P.* cf *misonnei* and *P.* cf *petteri* was greater in Sherman traps than in snap traps ($4.335 < X^2 < 53.051$, P < 0,001). This was not true for the two heaviest rodent species : *M. longipes* was evenly captured with the two types of traps ($X^2 = 0.372$, P = 0.542) and more *H. univittatus* were captured in snap traps than in Sherman traps ($X^2 = 30.641$, P < 0.001).

Effect of body weight

Mean weight of individuals of *H. stella* and *H. fumosus* captured in pitfall traps (6 and 13 g respectively) was smaller (P < 0.05) than those captured in Sherman (16 and 19 g) or snap traps (17 and 10 g). In contrast, no significant difference (P > 0.05) was observed between mean weight of *C. batesi*, *C. goliath* and *S. ollula* individuals captured in pitfall and Sherman traps (13 and 12 g, 49 and 43 g and 15 and 16 g respectively). Number of captures of other species was too low to conclude.

Mean weight of individuals of *D. ferrugineus*, *H. univittatus* and *P.* cf *misonnei* captured in Sherman traps (45, 43 and 30 g respectively) was smaller (P < 0.05) than those captured in snap traps (58, 53 and 31 g). In contrast, the difference was not significant (P > 0.05) for *H. fumosus* (19 and 19 g), *H. stella* (16 and 17 g) and *P.* cf *petteri* (25 and 33 g).

Sex

When possible, we tested for possible significant difference in sex ratio between populations sampled by different types of traps. There was no significant difference in sex of *H. fumosus* or *H. stella* sampled by the three types of traps (P > 0.05). Similarly, we did not observed any significant difference in sex of *C. goliath* or *C. batesi* sampled by Sherman and Pitfall traps, or in sex of *H. univittatus*, *M. longipes*, *P.* cf *petteri* or *P.* cf *misonnei* sampled by snap traps and Sherman traps. No significant difference in body weight between sexes was recorded in these eight species (P > 0.05).

DISCUSSION

Comparison between pitfall traps and baited traps

In agreement with numerous studies (BROSSET, 1966, 1988; MADDOCK, 1992; KIRKLAND & SHEPPARD, 1994; DICKMAN, 1995; STANLEY et al., 1996; GOODMAN et al., 2001) we found that pitfall traps were more efficient (higher number of species and higher trap success) than Sherman or snap traps for capturing shrews. In contrast, pitfall traps were generally less efficient than Sherman or snap traps for capturing rodents, even if some rare species (e.g. *H. parvus*) were captured in pitfall traps only. In other parts of tropical Africa, COLYN et al., (unpublished data) also found several rare rodent species to be only captured in pitfall traps (e.g. *Prionomys batesi*, *Dendromus sp*).

At least four traits could influence capture rates for different species :

(1) body size and ability to jump : mean weight of rodents individuals captured in pitfall traps was smaller than those of the same species captured in Sherman or snap traps. Few individuals of large rodent species (Table 1) were captured in pitfall traps and all of them were captured during rainy nights. This is in agreement with the observation of HANDLEY & VARN (1994) and SILVA et al., (2000) according to which wet pitfall traps are more effi-

cient than dry ones because animals cannot escape by jumping. Contrary to rodents, large shrew species (eg *C. goliath*) would not be able to jump out from dry pitfalls;

(2) trigger sensitivity and weight of animals : animals of low weight (< 10 g) rarely trigger the mechanism of the trap;

(3) shrews, in contrast to rodents, are not attracted by the bait used (Brosset, 1966);

(4) some crocidurine shrews would be reluctant to explore new objects and therefore would not enter in Sherman or snap traps (Dickman, 1995).

Comparison between Sherman traps and snap traps

Sherman and snap traps are only efficient to capture rodents and have complementary effects onto their capture : Sherman traps (7.5 X 9 X 23 cm) are more effective for trapping smaller species, while snap traps (10 X 15 cm) tend to be more effective for trapping larger ones. Moreover, light individuals of the largest species (e.g. *D. ferrugineus*, *H. univittatus* and *P.* cf *misonnei*) are better captured than heavy ones in Sherman, while no significant difference was observed for small species (e.g. *H. fumosus* and *H. stella*). The tendency of the two types of traps to catch rodents of different sizes may reflect trigger sensitivity in traps, or be due to the fact that larger rodents are reluctant to, or cannot, enter the confined space of the Sherman trap, as suggested by Pizzimenti (1979).

CONCLUSION

The three types of traps used in this study have complementary effects onto the capture of small mammals in African rainforest. Thus, as concluded from studies in other tropical rainforests (Woodman et al., 1996; Lyra-Jorge & Pivello, 2001), we suggest that an assortment of traps should always be employed in studies of small mammal communities in African rainforest in order to obtain a wider range of taxa, and thus a better representation of the community.

Additional studies are needed to compare the efficiency of others types of traps, such as Tomahawk traps or different sizes of Sherman and snap traps. Moreover, a comparison of the efficiency of different types of bait would be interesting. Also, to define an appropriate sampling methodology for the study of small mammal communities in African rainforest, we must also pay attention to the cost of the traps and their convenience for carriage and installation in the field. For example, Sherman traps are more costly than snap traps or pitfall traps. A limitation for using pitfall traps is that their carrying and placement in the field demands a great physical effort, and their installation may become unfeasible in rocky or swampy soils.

ACKNOWLEDGMENTS

Field studies were supported by the World Wildlife Fund (W.W.F.) Gabon – Programme Régional de L'Information Environnementale. V. Nicolas received a fellowship from the Ministère de l'Education Nationale, de l'Enseignement Supérieur et de la Recherche (France). We are particularly grateful to MM. O. Lengrand, A. Kandem and P. Obame Ondo (W.W.F.) for logistic support in the field and to the local team of Monts Doudou (particularly S. Guimondou, J.N. Assoume Ondo and A. Essono Bigang). We thank Mr Manfoumbi Kombila from the “Direction de la Faune et de la Chasse” in Libreville, and Mrs Koumba from Moukalaba Reserve. We are grateful to P. Barrière (University of Rennes 1) for the identification of shrew species.

REFERENCES

Beer, J.R. (1964). Bait preferences of some small mammals. *Journal of Mammalogy,* 45 : 632-634.

Brosset, A. (1966). Recherches sur la composition qualitative et quantitative des populations de vertébrés dans la forêt primaire du Gabon. *Biologica Gabonica,* 2 : 163-177.

Brosset, A. (1988). Le peuplement de mammifères insectivores des forêts du nord-est du Gabon. *Revue d' Ecologie Terre et Vie,* 43 : 23-46.

Cockrum, E.L. (1947). Effectiveness of live traps versus snap traps. *Journal of Mammalogy,* 28 : 186.

Dalby, P. & D. Straney (1976). The relative efficiency of two size of Sherman live trap. *Acta theriologican,* 21 : 311-313.

Dickman, C.R. (1995). Diets and habitat preferences of three species of crocidurine shrews in arid southern Africa. *Journal of Zoology of Lond*on, 237 : 499-514.

Goodman, S.M., R. Hutterer & P.R. Ngnegueu (2001). A report on the community of shrews (Mammalia : Soricidae) occurring in the Minkébé Forest, northeastern Gabon. *Mammalian Biology,* 66 : 22-34.

Handley, C.O. & M. Varn (1994). *The trapline concept applied to pitfall arrays*. In : Merritt, Kirkland & Rose. (eds), *Advances in the biology of shrews.* Carnegie Museum of Natural History, special publication n° 18, Pittsburgh : 285-286.

Kirkland, G.L. & P. Sheppard (1994). *Proposed standard protocol for sampling small mammal communities*. In 'Advances in the biology of shrews'. In : Merritt, Kirkland & Rose. (eds), *Advances in the biology of shrews.* Carnegie Museum of Natural History, special publication n° 18, Pittsburgh : 277-283.

Laurance, W.F. (1992). Abundance estimates of small mammals in Australian tropical rainforest : a comparison of four trapping methods. *Wildlife Research,* 19 : 651-655.

Lyra-Jorge, M.C. & V.R. Pivello (2001). Combining live trap and pitfall to survey terrestrial small mammals in savanna and forest habitats, in Brazil. *Mammalia,* 65 : 524-530.

Maddock, A.H. (1992). Comparison of two methods for trapping rodents and shrews. *Israel Journal of Zoology,* 38 : 333-340.

Nicolas, V. (2003). *Systématique et écologie des communautés afrotropicales de muridés (Mammalia : Rodentia) et de soricidés (Mammalia : Insectivora).* PhD Thesis, Rennes 1 University, France.

Nicolas, V., P. Barrière & M. Colyn (2003). Impact of removal pitfall trapping on the community of shrews (Mammalia : Soricidae) in two African tropical forest sites. *Mammalia,* 67 : 133-138.

Patric, E.F. (1970). Bait preferences of small mammals. *Journal of Mammalogy,* 51 : 179-182.

Pizzimenti, J. (1979). The relative effectiveness of three types of traps for small mammals in some Peruvian rodent communities. *Acta theriologica,* 24 : 351-361.

Quérouil, S., P. Barrière, M. Colyn, R. Hutterer, A. Dudu, M. Dillen & E. Verheyen (2006). Phylogenetic relationships between African soricids of the genus *Crocidura* inferred from mitochondrial DNA sequences. In : Merritt, Churchfield, Hutterer & Sheftel (eds), *Biology of the*

Soricidae. Carnegie Museum of Natural History, special publication, Pittsburgh.

ROSE, R., N. SLADE & J. HONASKI (1977). Live trap preference among grassland mammals. *Acta theriologica,* 22 : 297-307.

SAINT-AUBIN, G. (1963). *La forêt du Gabon.* CIRAD - Forêt, Département forestier du CIRAD : Montpellier.

SEALANDER, J.A. & D. JAMES (1958). Relative efficiency of different small mammal traps. *Journal of Mammalogy,* 39 : 215-233

SILVA, M., J. CAMERON & C. PUDDISTER (2000). Small mammal abundance and community composition in Prince Edwards Island National Park. *Canadian Field Naturalist,* 114 : 26-33.

SOSSEF, M.S.M., Y.ISSEMBE, H.P. BOUROBOU & W.J.M. KOOPMAN (2004). *Botanical diversity of the Pleistocene forest refuge, Mts Doudou (Gabon).* In : FISHER (ed), *A floral and faunal inventory of Monts Doudou, Gabon : with reference to elevational variation*, Proceedings of the California Academy of Sciences, San Francisco : 17-92.

SOUTHWOOD, T.R.E. (1978). *Ecological methods with particular reference to the study of insect populations*. Chapman and Hall, London.

STANLEY, W.T., S.M GOODMAN & R. HUTTERER (1996). Notes on the insectivores and elephant shrews of the Chome Forest, South Pare Mountaines, Tanzania (Mammalia : Insectivora and Macroscelidae). *Zoologische Abhandlungen : Staatliches Museum fur Tierkunde Dresden,* 49 : 131-147.

WIENER, J.G. & M.H. SMITH (1972). Relative efficiencies of four small mammal traps. *Journal of Mammalogy,* 53 : 868-873.

WILSON, E.O. (1988). *Biodiversity.* National Academy Press, Washington D.C.

WILSON, E.O. (1992). *The diversity of life.* The Belknap Press of Harvard University Press, Cambridge.

WOODMAN, N., R.N. TIMM, N.A. SLADE, & T.J. DOONAN (1996). Comparison of traps and baits for censusing small mammals in neotropical lowlands. *Journal of Mammalogy,* 77 : 274-281.

Received : March 18, 2005
Accepted : August 2, 2005