Post-capture behaviour and movement analysis of two small sympatric rodents in the Setté-Cama (Gabon) coastal forest

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1 ABSTRACT

The present study aims to obtain information on qualitative (behaviour) and quantitative (movement /distance) data from two mammal species in southwest Gabon (Setté-Cama). Capture-mark-recapture studies provided data on movements and post-capture behaviour of individuals of two small forest rodents: *Hylomyscus walterverheyeni* (n = 47) and *Praomys misonnei* (n = 5). All individuals were captured at least once, banded and then released at their place of capture. Overall trap success (T_S) was 10.3% of which 20% of animals were recaptured (Tr). Distances travelled by tagged individuals varied from one individual to another (about 70 to 500 m). By contrast, the post-capture behaviour differed between the two species. *P. misonnei,* once released, moved from one shelter to another on the ground (fallen trunks) or found refuge in a nearby burrow. *Hylomyscus walterverheyeni* on the other hand climbed shrubs and small creepers of up to 3 to 4 m above the ground.

2 INTRODUCTION

Small mammals are important ecological indicators in many terrestrial ecosystems Considered as seed predators, rodents can carry, hide and discard seeds, often transporting them over considerable distances from the parent tree, thus leading to enhanced dispersal and germination rates (Evrard *et al.,* 2017). The role of rodents may be particularly crucial, in tropical forests where large mammals are subject to excessive hunting (Evrard *et al.,* 2017; Hauptfleisch *et al.,* 2017). Nevertheless, because it is hard to assess patterns of movement, the role of rodents in forest regeneration could be underestimated. However, very few studies have been conducted in central African moist forests, and their role is generally poorly understood. This lack of visibility is because many species are small and nocturnal (Genest-Villard, 1977; Cassaing, 1986). Yet rodents contribute the most to measures of species diversity in tropical forest ecosystems (Iyongo *et al.,* 2013). They also play a vital role in the functioning and regeneration of ecosystems (Denys *et al.,* 2014; Hauptfleisch *et al.,* 2017). Their ability to colonize different natural and anthropogenic habitats (Happold, 2013), and react quickly to changes in their environment (Avenant and Cavallini, 2007), make them good indicators of ecological change. However, small mammals can be easily sampled with suitable live traps such as Sherman live traps. To track and provide the necessary information on animal movements, permanent and non-permanent marking techniques such as radio-tracking, ear punching, tattooing, powders, nail-clipping, hair cutting on the back, dyes) have been used. Their population sizes can then be potentially estimated through capture-mark-recapture protocols (CMR; Smith *et al.,* 1975; Caughley, 1977; Krebs, 1989). Indeed, the monitoring of wildlife by CMR method has led to a better understanding of the population dynamics in a variety of wild animal populations. In view of the challenges facing small mammal conservation, methods have been adapted to the monitoring rodents in various ecosystems. Some methods have also shown their limitations in equatorial rainforests. For example, according to Duplantier *et al.,* (1984), the fluorescent marking method cannot be used for all small mammals under heavy rain conditions, which reduce the visibility of the tracks. The radio-tracking technique has other drawbacks: the range of the transmitter detection does not exceed 20 to 30 m, and several signals cannot be followed simultaneously (Genest-Villard, 1977). Added to these constraints is the weight of the device (which represents about half that of small rodents) and the placement of the transmitter, which in some cases causes the death of marked individuals (Genest-Villard, 1977). On the other hand, the capture mark recapture (CMR) method using live traps has enormous advantages, such as the limited handling time, ability to measure and tag individuals, all while minimizing the mortality of individuals. The few studies devoted to diachronic monitoring of rodent populations in African sub-desertic environments mainly used the capture-mark-recapture (CMR) method in permanent quadrats (Daly and Daly, 1973; 1974; 1975). In Gabonese rainforests, CMR was used by Duplantier *et al.,* (1984) to follow the movements of rodent fauna and was found to be effective in documenting travel patterns and distances travelled by individuals. Indeed, the CMR methods give satisfactory results concerning on the one hand the distances travelled and the size of the home ranges, and on the other hand the modes of movement in small rodents (Duplantier *et al.,* 1984). This method offers the undeniable advantage of providing basic information at the level of the individual. The main aim of this study was therefore to capture and mark two common rodent species to study their movements and behaviour following capture. These data will provide insight into the potential mobility of both species studied and serve as basis for future conservation efforts where they may play an important role in seed dispersal.

3 MATERIAL AND METHODS

3.1 Study area: The study was on small mammal populations in the locality of Setté Cama (02°44'S 10°11'E; Figure 1) which is part of the Gamba Protected Areas Complex (11320 km^2). Setté-Cama is located in the southern part of the Gabonese coastal sedimentary basin (Ondo Zue Abaga *et al.,* 2018) and is a protected wetland in Gabon occupying a total area of 200 km^2. This complex is one of the richest lowland wetland forest sites in Central Africa and the Congo Basin (Dallmeier *et al.,* 2006). This region occupies an important place in Gabon, which has over 80% tropical forest, and is renowned for both its plant and animal diversity (O'Brien *et al.,* 2006). Setté Cama is mainly covered by three forest types (costal forest, mangrove forest and upland forest) and flanked by two bodies of water (the Atlantic Ocean and Ngoudou lagoon). The average annual rainfall and temperature recorded in the region is approximately 2000 mm and 25°C, respectively, with few fluctuations during the course of the year (O'Brien *et al.,* 2006). The soils are mainly clayey, sandy, ferralitic at the level of coastal sediments and hydromorphic.

Figure 1: Map of study area at Setté Cama

3.2 Rodent sampling and species identification: The study was carried out entirely in lowland coastal forest within the boundaries of the Sette-Cama Reserve. Trapping was conducted for a maximum of four consecutive nights at each site: from the 23 to 27 July 2016. For this study we used four line transects of 250 m in length (spaced 500 m apart), each comprising 50 Sherman live traps (7.5 x 9 x 23 cm) for a total of 200 traps per night. The traps were spaced 5 m apart and were alternatively baited with manioc, palm nut and corn flakes mixed with peanut butter (Mboumba *et al.,* 2019). Traps were checked twice daily (every morning and afternoon) and fresh bait was applied when necessary. Species identification was based on external morphological characteristics and using the identification keys and reference works After capture, identification and determination of sex, the following external morphological measurements were taken: mass (g), head + body length (Figure 2 A), tail length, hind foot length and ear length (mm) (Stoetzel *et al.,* 2012; Kingdon 2003, Wilson and Reeder, 1993; Dieterlen, 2009; Denys and Aniskine, 2012; Denys *et al.,* 2012; Happold, 2013). The GPS points were taken for each trap station and video recordings were made of each individual released. All captured individuals were marked with an ear tag stamped with a unique number (Figure 2 B; all capture methods were approved by UNO IACUC protocol 16 – 005).

Figure 2

Figure 2: Taking biometric measurements, all animals became visibly marked to left ear and each individual was deposited at his capture station

3.3 Marking of animal: The individual marking technique using small rings (Cheylan and Granjon, 1984) was chosen in this study because it is non-invasive and respects bioethics. Indeed, the marking of the animal was done with the help of a small ring in aluminium numbered and fixed at the level of the left ear. Fixing the ring, requires two Operators: one to hold the rodent by the body and ears, while the other puts the ring in place. After the biometric measurements are taken and the ring is installed (Figure 3), individuals were later released at the station of capture. For this, is placed in a large open plastic bag and then transported to its capture point. At the point of capture, the bag is placed on the ground so that it leaves on its own after a few minutes. Once the individual comes out of the bag, we then observe the behaviour of the latter: if he immediately seeks a shelter on the ground (under the litter, under a tree trunk) or tries to climb quickly on the nearest shrub.

Figure 3

Figure 3: Movements of individuals after being deposited in the capture area, each individual slowly explores his environment then flees very quickly to a shelter

3.4 Data and statistical analyses: Trap success (Ts) or trap occupancy rate (T_o) are both indices of relative abundance (Avenant and Cavallini, 2007; Iyongo *et al.,* 2012) and is based on the number of individuals captured per 100 trap nights. Ts was calculated for both *Hylomyscus walterverheyeni* and *Praomys misonnei* using the following formula (Ts) = $[(N_m/N_{TN}) \times 100]$ where N_m is the total number of individuals and N_{TN} is the number of trap-nights (Nicolas and Colyn, 2003, Kadjo *et al.,* 2013). We also calculated the trap occupancy rate as = $[(Nt/N_{TN}) \times 100]$; where Nt: is equal to the total number of capture and recaptures and N_{TN}: is the number of trap nights. We also calculated the recapture rate (Tr). This recapture rate was expressed as a percentage (Tr: percentage of animals tagged and recaptured during a single capture period) and was calculated as follows: Tr (%) = [(Nr/ Nc) x 100], with Nr: number of recaptures and Nc: number of specimens captured and marked.

4 RESULTS

4.1 Quantitative analysis and distance of movement:

A total of 47 *Hylomyscus walterverheyeni* and 5 *Praomys misonnei* were captured (*Table 1*) for a total trap effort of 600 trap nights. *Praomys misonnei* was less common than the *H. walterverheyeni* during the period of our study. *H. walterverheyeni* was collected on all traplines in coastal forest, where it appears to occur in sympatry with *P. misonnei.* Apart from these two species, no other species were caught during the same trapping period (*Table 1*). All individuals were captured only in the morning; no captures were recorded from our afternoon checks. The overall Ts for both species was 8.6%. The trap occupancy rate was 10.3% while the recapture rate was around 20%. We observed differences in Ts between the two species. Furthermore, from the recaptures made, it was possible to obtain information on the potential extent of the movements made (between the capture and recapture point) by the banded individuals of the two species. This made it possible to assess, as a first approximation, the minimum and maximum distances travelled in 24 hours and the number of individuals recaptured at least once (*Table 1*). The results obtained show that these rodents travel a minimum of 70 to 100 m and a maximum of 200 to more than 500 m per day.

Table 1: Summary of all captures and recaptures made during this study.

	N_c	N_r	N_t	Ts (%)	T_r (%)	D_{min} (m)	D_{max} (m)
Species							
Hylomyscus stella	47	9	56	9.3	19.15	70	500
Praomys misonnei	5	1	6	1	20	70	70
Total	**52**	**10**	**62**	**10.3**	**19.2**		

Nc: number of specimens caught and marked; Nr: number of recaptures; Nt: total number of catches and recaptures; N_{TN}: is the number of trap-nights. T_o (T_n / N_{TN}): rate occupancy of trap; T_r :(N_r / N_c) recapture rate; D_n: distance minimal et D_m: travelled distance maximal

4.2 Post-capture behavioural analysis:

At each capture we observed the post-capture behaviour of individuals (Table 2) when they were released (Figure 3). The results showed that for *H. walterverheyeni*, all released individuals sought shelter above ground and often at the top of a shrub (Figure 4 A, B and C). In contrast, *P. misonnei* individuals sought shelter in the litter layer on the ground or in available burrows (Figure 4 D, E and F).

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Figure 4

Figure 4: Post-capture Behaviour, each species has a different shelter, for *H. walterverheyeni* above the ground and in the ground for *P. misonnei*.

Table 2: Post-capture behaviour of captured specimens

Species	Post-capture Behaviour		
	Agressivity	Post-ring look	Shelter Research
Hylomyscus stella	yes	not bothered by the ring	top of a shrubs 3 to 4 m above the ground
Praomys misonnei	yes	not bothered b the ring	under the litter or tree trunk on the ground

5 DISCUSSION

5.1 Capture and recapture rate: The above data, although based on relatively few records, are sufficient; the marking technique employed at the Setté-Cama was able to successfully track the movements and behaviour of two species (*H. walterverheyeni* et *P. misonnei*) that are dominant members of central African rodent communities. It should also be noted that through these studies it was possible to highlight the distances travelled in 24 hours by adult individuals on the one hand, and to observe the post-capture behaviour of individuals of both species on the other hand. No other species were caught during our study period, and all catches took place in the morning. The absence of capture in the afternoon shows that both rodent species have a crepuscular and nocturnal activity. This result suggests that increasing the number of checks to twice a day (Zaime and Pascal, 1988; Mboumba *et al.,* 2019) did not result in any additional information pertinent to this study. The capture results show that the number of *P. misonnei* caught and recaptured was significantly lower than that of *H. walterverheyeni*. Is this the result of a differential behaviour of the two species at a particular moment in the annual cycle? Or simply a phenomenon that lasts throughout the year in these forests of the Setté-Cama coastal forest? In other words, if the first hypothesis seems likely, it will be sufficient in this case to change the sampling period in future studies. On the other hand, if this the second hypothesis that seems potentially plausible, we will have to give up the hope of being able to sample *P. misonnei* using a single type of trap, and consider associating other types of traps. According to the literature, it would appear that the first hypothesis is credible, as several authors (Mboumba *et al.,* 2019; Katy *et al.,* 2020) have used this same type of trap (Sherman) in Gabonese forests for sampling small rodents in various projects, and the frequency of capture of

P. misonnei individuals was higher or inversely lower in some localities compared to that of *H. walterverheyeni* (or other small rodents). Nevertheless, we cannot exclude the possibility of a differential attractiveness of the bait traps between the two species. Moreover, the recapture rate obtained is relatively low (about 20%) for both species. Several assumptions can be made to justify a relatively low recapture rate. First, individuals moved away from the trapping area (high mobility of individuals, and change in activity areas during the study period). Another reason for these results would be that they demonstrated avoidance behaviour: individuals would systematically avoid traps once captured. Another reason is that the community itself can also influence the recapture rate or abundance of natural resources in this zone. The presence of dense vegetation in the study area (forested habitats) and the abundance of food provide all the resources necessary for the protection and survival of individuals. In such a case, the bait becomes less attractive and individuals have little interest in returning to these traps to shelter and find food. Lastly our findings could be a result of sampling bias. Of these assumptions, the first seems most likely. This assumption is consistent with our observations, including one individual of *H. walterverheyeni* first captured on line 2 (L2), this same individual was captured a second time on line 3 (L3), more than 500 (m) from the point of its first capture.

5.2 Movements and Behaviour (Quantitative and qualitative Analyses**):** Given the few numbers of individuals of *P. misonnei* banded and recaptured, our analysis of distances travelled will focus primarily on individuals of *H. walterverheyeni* (banded and recaptured). The results (*Table 1*) of this study illustrate the capability of small rodents to move over comparatively long distances. They show that in the case of the *H. walterverheyeni*, movement was generally larger than those obtained by other methods for this species, particularly: radio-tracking or marking with fluorescence (30 to 70 m; Genest-Villard, 1977; Duplantier, 1982). Recorded distances varied by individual (*H. walterverheyeni* case), likely due to by various elements of the landscape or by individual (behavioural) stress-related behaviour. The CMR method employed here revealed that distance movements accomplished by *H. walterverheyeni* individuals ranged between 200 and 600 m in 24 hours. These results are best compared to those obtained by Genest-Villard, (1977) and Duplantier *et al.,* (1984), who studied the species' movements (*H. walterverheyeni*), respectively in the rainforest in the Central African Republic (CAR) and in Gabon using two different methods (radio-tracking vs fluorescent marking). According to Genest-Villard, (1977), is the movements of *H. walterverheyeni* were handicapped by the weight of the transmitter around its neck, which weighed half his weight. The author states that the transmitter hampered the dispersal capacity of this species and curtailed its movements. It is certain that the CMR method used in this study did not results in a similar disability. Given our results, it is likely that the movement capacities of *H. walterverheyeni* individuals are still widely underestimated, as are all other small mammals (Muridae). However, we remain cautious about this outcome because we have little recapture data. Once released, we found movement behaviour differed between the two species: All individuals of *H. walterverheyeni* systematically searched for a shrub and once found quickly climbed up it (or along small creepers) for up to 3 to 4 meters from the ground. By contrast, *P. misonnei* never climbed and stayed on the ground, moving from one shelter to another in search of logs (for example) or burrows. At this stage of the study, we can try to draw some methodological lessons and offer research perspectives. Indeed, the CMR method using ear tags does have some limits. Firstly, ear tags can fall off, leading to an underestimation of recapture rates. Secondly, this approach is only suited to species that are relatively abundant in the wild: Despite these disadvantages, this method has many advantages over other tracking methods: it allows us to follow several species and individuals at once; the tags used are very light; they do not disturb the animal and do not risk its death (by infection).

6 CONCLUSION

In conclusion, non-invasive monitoring methods using the Capture-Mark-Recapture (CMR) approach for rodents are part of an integrated vision that reconciles basic research objectives, biodiversity conservation needs and the interests of a low-cost, easy-to-implement and universally accessible method. It should be borne in mind, however, that the use of the CMR method, does not, however, replace other means of tracking (fluorescent marking, etc.), but this marking technique provides additional information that was previously difficult to obtain using other methods. Future studies should extend the number of trap nights in order to better compare the modes of movement of two species dominating the communities of small forest rodents of Gabon.

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