Seasonal, Sexual, and Age-Related Variations in the Live-Trapping Success of Woodland Dormice *Graphiurus murinus*

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Zimkitha J. K. Madikiza, Sandro Bertolino, Roderick M. Baxter, and Emmanuel Do Linh San (2010) Seasonal, sexual, and age-related variations in the live-trapping success of woodland dormice *Graphiurus murinus*. *Zoological Studies* **49**(6): 797-805. Live trapping often constitutes the simplest field technique to obtain biological information on small, nocturnal mammals. However, to be reliable, live-trapping studies require efficient traps that allow the capturing of all functional categories of the targeted population. Herein, we present the results of a live-trapping study of the woodland dormouse *Graphiurus murinus* (Gliridae), a species for which limited scientific data are available. Our aim was to evaluate the efficiency of small-mammal traps (Sherman and PVC), and investigate potential seasonal-, sexual-, age-, and microhabitat-related differences in trapping success. We conducted 12 trapping sessions and deployed 2051 trapping units between Feb. 2006 and Mar. 2007, in a riverine forest of the Great Fish River Reserve, South Africa. Only arboreal trapping with Sherman traps proved to be successful. No dormouse was ever caught on the ground with PVC traps, either inside or outside the riverine forest. We made 234 captures of 48 different dormice: 9 adult males, 17 adult females, 3 unsexed adults, and 19 juveniles. Overall, 64% of the dormice known to occur in the area during the study period were caught with Sherman traps. Individual dormice were caught on average 4.9 (range, 1-17) times. Trapping success averaged 13.3% (range, 3.0%-33.3%). It was lowest during winter (5.1%) and peaked in summer (19.0%) and autumn (16.7%). More adult males were caught in spring during the mating season, whereas more adult females were trapped in summer during the lactating period. The trapping success of juveniles peaked in summer and autumn, when they were progressively becoming independent and were probably exploring large areas in and possibly outside of the maternal home range. We conclude that arboreal live-trapping with Sherman traps would constitute an effective technique to study the population dynamics and spatial distribution of the woodland dormouse, but suggest that a nest box monitoring program (preferably running concurrently) would provide useful complementary information. http://zoolstud.sinica.edu.tw/Journals/49.6/797.pdf

Key words: Capture-mark-recapture, Gliridae, Live trapping, Sherman trap, Trapping success.

To obtain reliable data on rodent population biology and spatial behavior requires efficient traps that allow the capturing of all functional categories of the population (Krebs and Boonstra 1984). As highlighted by Voss and Emmons (1996), the sampling of rodent communities can be achieved through trapping with snap-traps, ground live-traps, arboreal traps, and pitfall traps. In dormice (of the family Gliridae), nest boxes can also successfully be used (Kryštufek et al. 2003, Juškaitis 2006, Madikiza et al. 2010). Live-trapping of mammals, in general, usually allows the trapped animals

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to be identified, aged, and sexed with accuracy; live individuals can be marked for later recapture and released, while deceased individuals can be prepared as voucher specimens (Jones et al. 1996). This enables researchers to quantitatively determine the approximate numbers of individuals of a species across a wide variety of habitats (Slade and Blair 2000). Biologists can also use trapping to determine the 3-dimensional habitat use by arboreal rodents; this can be achieved by placing traps at different heights in trees and comparing how often a species is caught on the ground versus in an arboreal trap (Pruett et al. 2002).

One of the most effective means of capturing small-sized mammals unharmed is through Sherman live-traps. Maddock (1992) stated that Sherman traps constitute an effective technique for capturing rodents and are most effective for medium-sized rodents (20-50 g), the weight of which is sufficient to trip the pan. Several authors reported that Sherman traps were the best when working with rodents since the species richness can be evaluated and their abundance determined (Petersen 1980, Lee 1997, Lacher and Alho 2001).

In terms of the family Gliridae, live-trapping of dormice was successfully employed to collect information on several aspects of dormouse biology. For example, in Poland, Sciński and Borowski (2006) investigated the population dynamics and home range of the forest dormouse *Dryomys nitedula*. Some authors conducted long-term studies on population dynamics, abundance, activity, and life-history traits adapted to mast seeding in the edible dormouse *Glis glis* (Bieber 1998, Ivashkina 2006, Bieber and Ruf 2009). In Italy, Bertolino et al. (2001) studied the population dynamics, breeding patterns, and spatial use of the garden dormouse *Eliomys quercinus*. Similarly, in Sweden, Berg and Berg (1999) used live-traps to evaluate the abundance and survival of the common dormouse *Muscardinus avellanarius*. Finally, short population studies were also carried out on 2 African dormouse species, the woodland dormouse *Graphiurus murinus* and the spectacled dormouse *G. ocularis* (Channing 1984, Kaplan 1995, Qwede 2003).

So far, scientific information on the genus *Graphiurus* is based on small sample sizes and incidental observations (reviewed in Webb and Skinner 1994). Although some behavioral (Channing 1984, Van Hensbergen and Channing 1989) and physiological (Eisentraut 1962, Lachiver and Petter 1969, Ellison and Skinner 1991, Webb and Skinner 1996, Whittington-Jones and Brown 1999, Mzilikazi and Baxter 2009) studies were conducted, comprehensive scientific data collected on African dormouse species in the wild are still lacking. One possible way of obtaining such data would be to use live-traps, as long as these are set in the proper location and allow to capture a large, and therefore representative, sample of the studied population.

In this study, we employed Sherman and PVC traps with the aim of comparing the trapping success of the woodland dormouse between different trapping protocols, classes of individuals, and seasons. Due to the arboreal nature of dormice (Holden 2005), we predicted that trapping success would be higher (1) for traps set on trees than traps set on the ground, and (2) for traps set inside the forest than traps set outside it. In addition, we hypothesized that (3) seasonal, (4) sexual, and (5) age-related differences in trapping success would respectively reflect variations in climatic conditions and activity levels (hibernation), reproductive strategies, and demographics of woodland dormice.

MATERIALS AND METHODS

Study area

This study was conducted in the Great Fish River Reserve complex (GFRR; Fig. 1), approximately 40 km northeast of Grahamstown and located 33°04'-33°09'S and 26°37'-26°49'E. The study site (called Junction 9) was located in a generally dry riverine forest, fed by an underground water table, which forms a narrow belt (< 100 m wide) along the riverbeds. Surface water occurs only during heavy rain and is temporary. More specifically, the study was conducted in a 2.5-ha stretch (breadth × length: 100 × 250 m) of riverine *Combretum* thicket dominated by stands of African bushwillows *Combretum caffrum*. This tree is prone to rotting from the inside resulting in numerous holes and hollows that can be used as nest sites by dormice and other hollow-using species. The riverine forest contains several other tree species, including *Acacia karoo*, *Acalypha glabrata*, *Olea europaea* ssp. *africana*, *Ziziphus mucronata*, and *Scutia afra*. Beneath these trees, *Azima tetracantha*, *Scutia myrtina*, *Ehretia regida*, *Carrisa bispinosa*, *C. haematocarpa*, and *Maytenus heterophylla* often form dense undergrowth. On both sides of the forest, the study area is bordered by relatively large expanses of buschclump karroid

thicket, a semi-open habitat composed of *Rhus* spp. and *Scutia myrtina* bushclumps and a karroid herbaceous layer.

Trapping protocols

Two live-trapping protocols were adopted. The 1st 1 was implemented between Feb. and July 2006. Thirty-three Sherman folding aluminum live-traps (length × breadth × height: 23 × 8 × 9 cm) were placed aboveground in trees and bushes and on logs along an irregular trail. The exact positioning of the traps was determined by the suitability of the site. Within the same time frame, a 7 × 4 grid (lines 1-7 and rows A-D) of white PVC traps (Willan 1979) was set up on the ground with stations A1 to D3 (*n* = 12) in the riverine forest, stations A5 to D7 (*n* = 12) in the bushclump karroid thicket, and stations A4 to D4 (*n* = 4) set along the ecotone. The stations were spaced 10 m apart, with 2 traps per station (*n* = 56 traps). PVC traps were preferred to aluminum traps for ground trapping, because they are more resistant to trampling by large ungulates (black rhinoceros *Diceros bicornis*, greater kudu *Tragelaphus strepsiceros*, warthog *Phacochoerus aethiopicus*, etc.) and less susceptible to overheating, which could cause the death of captured rodents, especially when traps are set in open areas.

Both types of traps were baited with a mixture of rolled oats and sunflower seed oil (Wirminghaus and Perrin 1993). Traps were set out for 2-3 consecutive nights in Feb., Apr., May and July. They were checked twice daily, in the morning and late afternoon. During the winter, a small piece of cotton cloth was inserted inside each trap to prevent captured dormice from dying of cold. We had no reason to believe that the presence of these cloth pieces affected the trapping success. At the end of July 2006, trapping on the ground was stopped, as we had trapped no woodland dormouse outside the riverine forest or on the ground inside the riverine forest (see "RESULTS"). Therefore, a decision was made instead to increase the number of traps on tree trunks and branches in the forest.

The 2nd protocol was initiated in Sept. 2006 and lasted until Mar. 2007. Sixty Sherman traps were randomly placed on tree branches and logs in the same riverine forest and were set for 2-3 consecutive nights every month, with the exception of Nov. when 2 trapping sessions of 3 days each were organized. The position of the traps was slightly varied (± 15 m) from 1 monthly trapping session to the next, so as to cover as much of the study site as possible and increase the likelihood of obtaining different spatial locations for individual dormice (Madikiza et al. 2010 submitted).
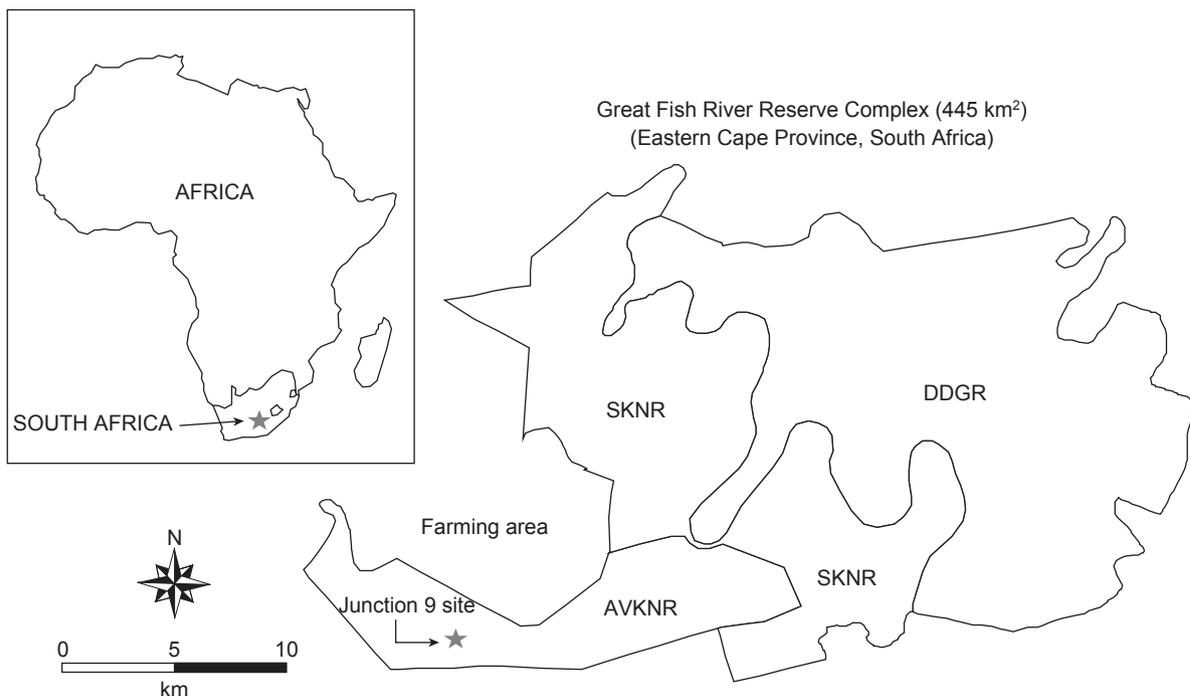

Fig. 1. Location of the Great Fish River Reserve complex. AVKNR, Andries Vosloo Kudu Nature Reserve; SKNR, Sam Knott Nature Reserve; DDGR, Double Drift Game Reserve. The sampling site of "Junction 9" is indicated by a gray-shaded star.

Manipulation and marking of dormice

At the 1st capture, dormice were transferred into a pre-weighed Ziploc plastic bag and weighed to the nearest gram with a spring balance (Pesola, Baar, Switzerland). Dormice were then lightly anesthetized using diethyl ether, aged, and sexed. The age (adult vs. juvenile) was determined based on the body size, weight, and fur characteristics. Females were differentiated from males based on the appearance of the genitalia and the presence or absence of swollen nipples. Dormice were individually tattooed on 1 or 2 ears with a unique code using single-digit spiked tattoo numbers (Hauptner Herberholz, Solingen, Germany) attached to forceps. Once the ear was pierced, tattoo-ink was rubbed into the perforations. This allowed a quick identification of dormice inside the trap when marked individuals were retrapped.

Trapping success

Trapping success was expressed as the percentage of traps containing a woodland dormouse during each trapping session. Although individuals of other rodent species (striped mouse *Rhabdomys dilectus*, Mozambique thicket rat *Grammomys cometes*, and Namaqua rock mouse *Micaelamys namaquensis*) were trapped and possibly prevented other dormice from being caught, trapping success was not adjusted to take this reduced availability of traps into account. We indeed considered that the presence of other rodent species was part of the local trapping conditions, and that the former therefore had to be taken into account in order to determine the real trapping success of dormice at the study site.

As the number of traps used differed between the 2 trapping protocols, seasonal, sexual, and age-related differences in trapping success were expressed as the percentage of traps containing a certain class of individuals, and not as the absolute number of individuals of a certain class which had been caught. A trapping unit was defined as a trap set in the field for 1 night.

We also calculated the percentage of dormice recaptured (R%) between 2 consecutive trapping sessions (irrespective of the span of time between them), as well as the percentage of new dormice (N%), i.e., individuals caught in traps for the 1st time.

Data analysis

The following seasons were defined: spring (Sept.-Nov.), summer (Dec.-Feb.), autumn (Mar.-May), and winter (June-Aug.). When the variances of the various subsamples were similar (Levene's test, $p > 0.05$) and the data distributions did not generally depart from normality (Kolmogorov-Smirnov test, $p > 0.05$), seasonal, sexual, and age-related variations in the various studied parameters were evaluated by one-way analysis of variance (ANOVA), post-hoc Bonferroni tests, and independent-sample *t*-tests. In some instances, when data were normally distributed but the variances of subsamples differed, a *t*-test for unequal variances was used. Non-parametric procedures (Kruskall-Wallis *H*- and Mann-Whitney *U*-tests) were run as a double-check to see if they delivered similar results. In all other cases, data were analyzed by non-parametric tests, and sequential Bonferroni corrections were applied in the case of multiple pairwise comparisons (Rice 1989). With 6 pairwise comparisons, statistical significance was set at the following sequential *p* values: 0.0083, 0.01, 0.0125, 0.0167, 0.025, and 0.05.

Data were tabulated in Excel (Microsoft, Redmond, WA, USA), and statistical analyses were performed with the SPSS 15.0 for Windows (SPSS, Chicago, IL, USA) statistical package. Figures are reported as the mean ± standard deviation (S.D.).

RESULTS

Trapping sessions

We conducted 34 trapping nights during 12 trapping sessions between Feb. 2006 and Mar. 2007. On average, 3.1 ± 1.0 (range, 2-6) trapping nights were conducted each month. Overall, 671 (363 inside the forest) and 1380 (all inside the forest) trapping units were deployed using the 1st and 2nd trapping protocols, respectively. No dormouse was ever caught on the ground, inside or outside the forest. Therefore, possible variations linked to the type of trapping protocol were investigated by solely comparing trapping results for traps set above the ground inside the riverine forest ($n_1 = 33$ and $n_2 = 60$). As all but one of the parameters studied were similar with both trapping protocols (*t*-test: $p > 0.36$ in all cases), we decided to pool all data to present the trapping results.

Over the entire trapping period, we made 234 captures of 48 different dormice: 9 adult males, 17 adult females, 3 unsexed adults, and 19 juveniles. The age classification given here corresponds to the ages of marked dormice during the study period of June 2006 - Mar. 2007. Some dormice were therefore trapped as both juveniles (before June 2006) and adults (from June 2006 onwards). Overall, 64% of the dormice known to occur in the area, based on both live trapping and the occupation of wooden nest boxes (Madikiza et al. 2010), during the study period were caught with Sherman traps. Individual dormice were trapped on average 4.9 ± 4.0 (range, 1-17) times. The distribution of trapping events for the dormice under study is presented in figure 2.

Trapping success

Between Feb. 2006 and Mar. 2007, trapping success averaged 13.3% ± 8.5% (range, 3.0%-33.3%). Trapping success was lowest during winter (Table 1). It increased in spring and peaked in summer and autumn (Table 1). Seasonal variations observed were statistically significant (Kruskal-Wallis H-test: H = 18.12, $d.f.$ = 3, p < 0.001). Post-hoc Mann-Whitney U-tests based on paired seasons indicated significant differences between spring and summer (U = 3.00, p < 0.001) and summer and winter (U = 0.00, p = 0.005).

Although the trapping success of male dormice did not differ seasonally (H = 5.43, $d.f.$ = 3, p = 0.14), a strong tendency was found for male trapping success to be higher in spring than in summer (U = 36.50, p = 0.069). Female trapping success, on the contrary, clearly varied on a seasonal basis (H = 12.22, $d.f.$ = 3, p = 0.007; Table 1). Dyadic statistical tests revealed that female trapping success was significantly higher in summer than in spring (U = 16.50, p = 0.001).
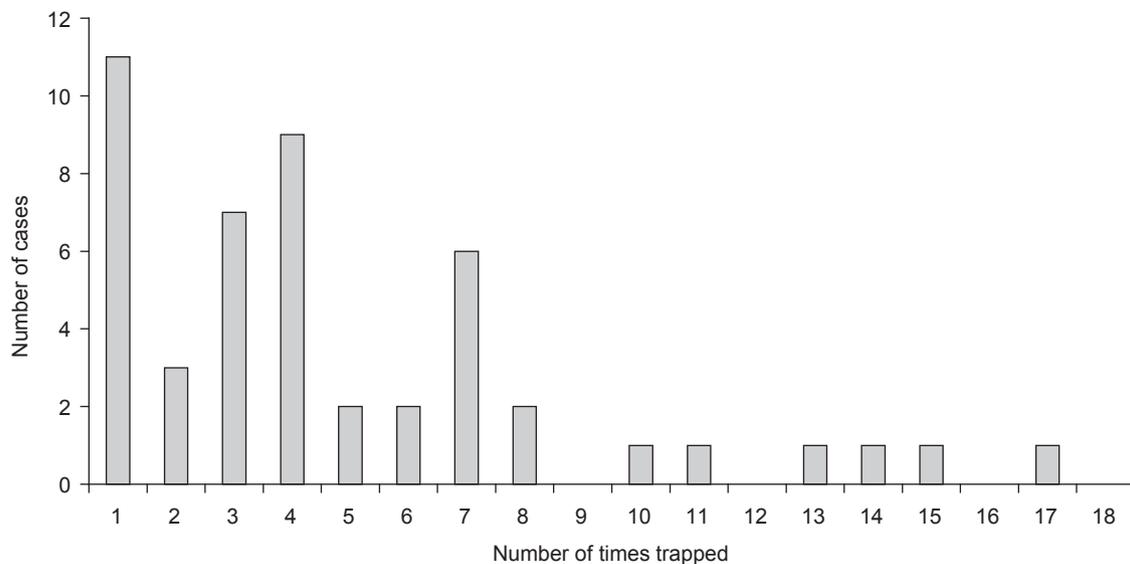

Fig. 2. Numbers of times that marked woodland dormice *Graphiurus murinus* (*n* = 48) were trapped between Feb. 2006 and Mar. 2007 (*n* = 34 trapping nights) in the study area.

Table 1. Seasonal variation in the percentage of traps (± S.D.) containing different age- and sex-classes of the woodland dormouse *Graphiurus murinus* between Feb. 2006 and Mar. 2007 in the study area

Season	*n*	Adult males	Adult females	Adults	Juveniles	Total
Spring	12	3.19 ± 1.94	3.61 ± 1.99	7.08 ± 2.37	0.69 ± 1.32	7.78 ± 2.28
Summer	11	2.07 ± 1.46	7.11 ± 2.12	9.45 ± 1.01	9.59 ± 7.41	19.04 ± 7.88
Autumn	8	2.27 ± 4.51	3.48 ± 5.30	5.76 ± 8.81	10.97 ± 4.89	16.72 ± 9.72
Winter	3	2.02 ± 1.75	3.03 ± 0.00	5.05 ± 1.75	0.00 ± 0.00	5.05 ± 1.75

n, number of trapping nights conducted during each season.

Differences between summer and autumn (U = 16.50, p = 0.02), and summer and winter (U = 1.50, p = 0.017) were nearly statistically significant (using the Bonferroni correction).

The trapping success of both adult (H = 9.86, *d.f.* = 3, p = 0.020) and juvenile dormice (H = 22.18, *d.f.* = 3, p < 0.001) significantly varied in the course of the year (Table 1). Adult trapping success was significantly higher in summer than in winter (U = 0.00, p = 0.005). The difference with spring was nearly significant (U = 28.50, p = 0.019, using the Bonferroni correction). The trapping success of juveniles was far lower in spring than in summer (U = 11.50, p < 0.001) and autumn (U = 0.00, p < 0.001), while no juvenile dormice were caught in winter.

Percentage of recaptures and new dormice

The percentage of dormice recaptured (R%) between consecutive trapping nights (irrespective of the time elapsed between them) varied between 0% and 100% (mean: 45.7 ± 31.3%, n = 33) and was fairly constant on a seasonal basis (H = 1.81, *d.f.* = 3, p = 0.61).

The percentage of new dormice (N%) per session averaged 27.4% ± 30.3% (range, 0%-100%, n = 34), with no inter-seasonal variation (H = 0.95, *d.f.* = 3, p = 0.81). However, N% was the only parameter which significantly varied between the 2 trapping protocols (t = 3.81, *d.f.* = 32, p = 0.001). As expected, N% was significantly higher at the beginning (51.6% ± 33.8%, n = 11 trapping nights) than during the 2nd part of the study (15.9% ± 20.8%, n = 23 trapping nights).

DISCUSSION

In agreement with our 1st 2 predictions, we noted that woodland dormice were never caught on the ground, either outside the riverine forest or on forest edges. As an arboreal species, the woodland dormouse possibly avoids open areas and isolated trees. This suggests that the colonization potential of this species might well be dependent on wooded corridors. In a similar way, the common dormouse *Muscardinus avellanarius* does not normally travel very far and is reluctant to cross open ground (Bright and Morris 1991 1992). In Russia, Ivashkina (2006) reported that the population density of the edible dormouse *Glis glis* is lower near forest edges, and hypothesized

that, in addition to the lower canopy cover, this observation was related to greater predation pressure. Previous studies investigating the influence of forest fragmentation on bird survival and densities documented a similar edge effect, with an increased nest predation rate at the edge of forests with open habitats (Andrén and Angelstam 1988, Keyser 2002). Although this statement cannot be confirmed by our study, it is highly likely that the risks of predation at the study site by both avian (barn owl *Tyto alba*) and terrestrial nocturnal predators (e.g., small-spotted genet *Genetta genetta*, water mongoose *Atilax paludinosus*, striped polecat *Ictonyx striatus*, striped weasel *Poecilogale albinucha*, black-backed jackal *Canis mesomelas*, and caracal *Caracal caracal*) are higher in open and semi-open terrain than inside the riverine forest. This said, other dormouse species may have different habitat requirements, and *Muscardinus avellanarius* seems to prefer forest edges (Juškaitis 2008).

More surprisingly, no dormouse was ever caught on the ground inside the forest. Qwede (2003) found the same result in a pilot study at the "Junction 9" site. As a large proportion of the woodland dormouse's diet in the GFRR is comprised of tenebrionid beetles and millipedes (Baxter et al. 2005), which are generally ground-dwelling, we expected higher trapping success on the ground due to the terrestrial foraging activities of dormice. This expectation was supported by various other authors who stated that *G. murinus* is partly terrestrial, and that ground-dwelling insects are frequently found in their diet (de Graaff 1981, Rowe-Rowe 1986, Skinner and Chimimba 2005). Furthermore, Qwede (2003) reported that in the Afromontane forest of Hogsback (Eastern Cape, South Africa), nearly 20% of woodland dormice were caught on the ground with PVC traps. Similarly, in a forest remnant of Thomas Baines Nature Reserve (Eastern Cape, South Africa), Kaplan (1995) successfully trapped dormice on the ground, albeit in that case with Sherman traps. The difference between our results and those of other workers remains unexplained, especially since our study site is located approximately 50 km from the Thomas Baines Nature Reserve.

We recorded a very high trapping success (13.3%) with arboreal trapping. This might have been related to a number of factors, one being that branches or tree trunks channel the movement of dormice. Kaplan (1995) also had a high trapping success (9.1%) of *G. murinus* at the Thomas Baines Nature Reserve, but rather related this

result to the dormice frequently venturing to the forest floor. Population density might also have an influence on trapping success. Indeed, Qwede (2003) had a very low trapping success (1.8%) at the "Junction 9" site. This discrepancy might have been related to the fact that the population density has increased since Qwede's study: there was a maximum of 10 individuals (ind.)/ha in 2003 vs. a maximum of 16 ind./ha in 2006-2007 (Madikiza et al. unpubl. data). An alternative or additional explanation could be that during the study period, the woodland dormouse population was subjected to a more-intensive trapping effort. However, we did not establish if trapping success increased with trapping effort.

As expected, seasonal, sexual, and age-related variations in the trapping success of *G. murinus* were observed (predictions 3 to 5), and these were indeed most likely linked to variations in climatic conditions, activity levels, reproductive strategies, and demographics of woodland dormice. There was a gradual increase in the trapping success from spring onwards, with a peak in summer and autumn, and a decrease in winter. This pattern can be explained by variations in dormouse numbers during the year, and the warm, rainy season (Oct.-Nov.). At the study site, young are born in spring/summer (Oct.-Jan.) and become part of the trappable population at an age of 3-4 wk (Madikiza et al. unpubl. data). The lower numbers of dormice trapped in winter might have been due to both decreased mobility during the coldest season of the year (hibernation) and possible increased mortality, as observed in other dormouse species (Bertolino et al. 2001).

Trapping success of male woodland dormice was constant from summer to winter, but was much higher in spring. We suspect that statistical significance was not reached due to the small sample size. The higher trapping success of male dormice during spring might have resulted from increased mobility during the mating season in order to locate females in estrus. This behavior could also be explained by an increase in territorial movements (spatial exclusion of rivals), but our spatial data indicated that several males occupied largely overlapping home ranges and shared nestboxes just before and/or during the mating season (Madikiza et al. 2010 submitted).

Alternatively, the variation in male trapping success could also be interpreted as a sharp decrease in the number of males trapped from the population, starting at the end of spring and continuing to autumn. A similar pattern was observed by Mann (1976) and Baudoin (1980) in garden dormice in Europe. Those authors suggested that during the mating season, males are prone to a higher mortality rate, linked to the energetic costs of intrasexual competition. Our data do not seem to support this hypothesis, as only 1 male died after the mating season, and his death was probably related to heat stroke inside a trap.

The pattern of female trapping success was very similar to that recorded for males, but the peak had shifted towards summer. This result can probably be explained by an increase in mobility, as females need to find favorable nesting areas (several litters were born in Dec.) and enough food for milk production during the reproductive season.

The percentage of dormice recaptured between consecutive trapping nights was high (46%) and fairly constant on a seasonal basis. This clearly shows that dormice are not dissuaded from re-using the same (foraging) areas due to the presence of traps, nor even re-entering the traps. Virtually no data on short-term recapture rates of dormice are available in the literature; therefore it is unknown whether the high figure obtained in our study is common for the Gliridae. In Poland, Sciński and Borowski (2006) reported that the recapture rate of the forest dormouse *Dryomys nitedula* from 1 yr to another year was 34% (*n* = 25), but such summative data collected over several months every year are indicative of interannual survival rather than trapping efficiency.

The very low percentage of new dormice found in traps throughout the 2nd part of the study period is an indication that the use of Sherman traps for 2-3 nights per month over a period of 4-6 mo is sufficient to trap over 80% of the adult population. Our data certainly showed that about 36% of dormice found in nest boxes at "Junction 9" during the study period were never caught in Sherman traps. However, as some individuals (essentially juveniles) were probably transient, the percentage of resident dormice never caught in live traps was assuredly lower. We therefore conclude that arboreal live-trapping with Sherman traps would constitute an effective technique to study the population dynamics (Madikiza 2010) and the spatial distribution of the woodland dormouse (Madikiza et al. 2010 submitted), and hence could provide valuable biological information on this poorly studied species. However, nest box studies run concurrently would probably provide additional or complementary information on aspects such as litter size, socio-ecology (including communal

breeding), and the occurrence of torpor under natural conditions (Madikiza 2010, Madikiza et al. 2010).

REFERENCES

Andrén H, P Angelstam. 1988. Elevated predation rates as an edge effect in habitat islands: experimental evidence. Ecology **69:** 544-547.

Baudoin C. 1980. Organisation sociale et communications intraspécifiques d'un hibernant. BSc thesis, Univ. of Franche-Comté, Besançon, France.

Baxter RM, ZJK Madikiza, M Villet. 2005. The diet of the woodland dormouse, (*Graphiurus murinus*), in the Great Fish River Reserve, South Africa. 6th International Conference on the Biology of Dormice (Gliridae), September, Siedlce, Poland.

Berg L, A Berg. 1999. Abundance and survival of the hazel dormouse *Muscardinus avellanarius* in a temporary shrub habitat: a trapping study. Ann. Zool. Fennici **36:** 159-165.

Bertolino S, C Viano, I Currado. 2001. Population dynamics, breeding patterns and spatial utilisation of the garden dormouse (*Eliomys quercinus*) in an Alpine habitat. J. Zool. Lond. **253:** 513-521.

Bieber C. 1998. Population dynamics, sexual activity, and reproductive failure in the fat dormouse (*Myoxus glis*). J. Zool. Lond. **244:** 223-229.

Bieber C, T Ruf. 2009. Habitat differences affect life history tactics of a pulsed resource consumer, the edible dormouse (*Glis glis*). Populat. Ecol. **51:** 481-492.

Bright PW, PA Morris. 1991. Ranging and nesting behaviour of the dormouse, *Muscardinus avellanarius*, in diverse low-growing woodland. J. Zool. Lond. **224:** 177-190.

Bright PW, PA Morris. 1992. Ranging and nesting behaviour of the dormouse, *Muscardinus avellanarius*, in coppice-with-standard woodland. J. Zool. Lond. **226:** 589-600.

Channing A. 1984. Ecology of the namtap *Graphiurus ocularis* (Rodentia: Gliridae) in the Cedarberg South Africa. S. Afr. J. Zool. **19:** 144-149.

De Graaff G. 1981. The rodents of southern Africa. Pretoria: Butterworths.

Eisentraut M. 1962. Wie verhalten sich verwandte Vertrerter von heimischen Winterschläfern aus wärmeren Gebieten unter veranderten Temperaturbedingungen? Zool. Anz. **169:** 429-432.

Ellison GTH, JD Skinner. 1991. Thermoregulation and torpor in African woodland dormice, *Graphiurus murinus*, following cold acclimation. Z. Säugetierkunde **56:** 41-47.

Holden ME. 2005. Family Gliridae. *In* DE Wilson, DM Reeder, eds. Mammal species of the world: a taxonomic and geographic reference. Third ed. Baltimore, MD: John Hopkins Univ. Press, pp. 819-841.

Ivashkina VA. 2006. Abundance and activity of the edible dormouse (*Glis glis* L.) in the Zhiguli Mountains (Russia, Middle Volga region). Pol. J. Ecol. **54:** 337-344.

Jones C, W McShea, M Conroy, T Kunz. 1996. Capturing mammals. *In* D Wilson, F Cole, J Nichols, R Rudran, M Foster, eds. Measuring and monitoring biological diversity: standard methods for mammals. Washington, DC: Smithsonian Institution Press, pp. 115-122.

Juškaitis R. 2006. Nestbox grids in population studies of the common dormouse (*Muscardinus avellanarius* L.): methodological aspects. Pol. J. Ecol. **54:** 351-358.

Juškaitis R. 2008. The common dormouse *Muscardinus avellanarius*: ecology, population structure and dynamics. Vilnius, Estonia: Institute of Ecology of Vilnius Univ. Publishers.

Kaplan TE. 1995. The habitat and ecology of small mammals in an Eastern Cape forest remnant. B.Sc. Honours thesis, Rhodes Univ., Grahamstown, South Africa.

Keyser AJ. 2002. Nest predation in fragmented forests: landscape matrix by distance from edge interactions. Wilson Bull. **114:** 186-191.

Krebs CJ, R Boonstra. 1984. Trappability estimates for mark recapture data. Can. J. Zool. **62:** 2440-2444.

Kryštufek B, A Hudoklin, D Pavlin. 2003. Population biology of the edible dormouse (*Glis glis*) in a mixed montane forest in central Slovenia over three years. Acta Zool. Acad. Sci. Hung. **49:** 85-97.

Lacher TE Jr, CJR Alho. 2001. Terrestrial small mammal richness and habitat associations in an Amazon Forest-Cerrado Contact Zone. Biotropica **33:** 171-181.

Lachiver F, F Petter. 1969. La léthargie du graphiure (*Graphiurus murinus lorraineus* Dollman 1910) (Rongeurs, Gliridés). Mammalia **33:** 193-205.

Lee LL. 1997. Effectiveness of live traps and snap traps in trapping small mammals in Kinmen. Acta Zool. Taiwan. **8:** 79-85.

Maddock AH. 1992. Comparison of two methods for trapping rodents and shrews. Isr. J. Zool. **38:** 333-340.

Madikiza ZJK. 2010. Population biology and aspects of the socio-spatial organization of the woodland dormouse *Graphiurus murinus* (Desmaret, 1822) in the Great Fish River Reserve, South Africa. M.Sc. thesis, Univ. of Fort Hare, Alice, South Africa.

Madikiza ZJK, S Bertolino, RM Baxter, E Do Linh San. 2010. Nest box use by woodland dormice (*Graphiurus murinus*): the influence of life cycle and nest box placement. Eur. J. Wildl. Res. **56:** 735-743.

Madikiza ZJK, S Bertolino, E Do Linh San. 2010. Female in space, or female in space and time? First data on the socio-spatial organization and mating system of the woodland dormouse (*Graphiurus murinus*). J. Ethol. (submitted)

Mann CS. 1976. Étude du cycle annuel, de la démographie, de l'écologie et du comportement vis à vis de l'espace du lérot *Eliomys quercinus* dans le Briançonnais. BSc thesis, Univ. of Paris VI.

Mzilikazi N, RM Baxter. 2009. Heterothermy in free-ranging woodland dormice *Graphiurus murinus*. Talk presented at the 10th International Congress of Mammalogy, 9-14 Aug. 2009, Mendoza, Argentina.

Petersen MK. 1980. A comparison of small mammal populations sampled by pitfall and live-trapping in Durango, Mexico. Southwest. Nat. **25:** 122-124.

Pruett A, C Christopher, G Barret. 2002. Effects of a forested

riparian peninsula on mean home range size of the golden mouse (*Ochrotomys nuttalli*) and white-footed mouse (*Peromyscus leucopus*). GA J. Sci. **60:** 201-208.

Qwede K. 2003. Observations on two populations of the woodland dormouse (*Graphiurus murinus*) in the Eastern Cape, South Africa. Unpublished B.Sc. thesis, Univ. of Fort Hare, Alice, South Africa.

Rice WR. 1989. Analyzing tables of statistical tests. Evolution **43:** 223-225.

Rowe-Rowe DT. 1986. Stomach contents of small mammals from the Drakensberg, South Africa. S. Afr. J. Wildl. Res. **16:** 32-35.

Sciński M, Z Borowski. 2006. Home ranges, nest sites and population dynamics of the forest dormouse (*Dryomys nitedula*) (Pallas) in an oak-hornbeam forest: a live-trapping and radio-tracking study. Pol. J. Ecol. **54:** 391-396.

Skinner JD, CT Chimimba. 2005. The mammals of the southern African subregion. Third ed. Cambridge, UK: Cambridge Univ. Press.

Slade N, S Blair. 2000. An empirical test of using counts of individuals captured as indices of population size. J. Mammal. **81:** 1035-1045.

Van Hensbergen HJ, A Channing. 1989. Habitat preference and use of space by the namtap *Graphiurus ocularis* (Rodentia: Gliridae). Mammalia **53:** 25-33.

Voss RS, LH Emmons. 1996. Mammalian diversity in Neotropical lowland rainforests. A preliminary assessment. Bull. Am. Mus. Nat. Hist. **230:** 3-115.

Willan K. 1979. Design and field tests of a modified small mammal livetrap. S. Afr. J. Zool. **14:** 81-84.

Webb PI, JD Skinner. 1994. The dormice (Myoxidae) of southern Africa. Hystrix Ital. J. Mamm. **6:** 287-293.

Webb PI, JD Skinner. 1996. Summer torpor in African woodland dormice *Graphiurus murinus* (Myoxidae: Graphiurinae). J. Compar. Physiol. B **166:** 325-330.

Whittington-Jones CA, CR Brown. 1999. Thermoregulatory capabilities of the woodland dormouse, *Graphiurus murinus*. S. Afr. J. Zool. **34:** 34-38.

Wirminghaus JO, MR Perrin. 1993. Seasonal changes in density, demography and body composition of small mammals in a southern temperate forest. J. Zool. Lond. **229:** 303-318.