Burrow utilization by springhares (*Pedetes capensis*) in the Eastern Cape, South Africa

D.M. Peinke* & C.R. Brown†

Department of Zoology and Entomology, Rhodes University, P.O. Box 94, Grahamstown, 6140 South Africa

Received 25 July 2003. Accepted 19 May 2004

The use of burrows by springhares was investigated in the Eastern Cape, South Africa using radio telemetry. Springhares utilized 4–27 different burrows scattered over areas ranging from 0.6–28.5 ha, with maximum distances of 170–1000 m between burrows. Springhares frequently changed burrows, seldom spending more than a few consecutive days in each, unless rearing young. The number of burrows used by individuals was correlated with the length of time they were tracked and, even after a year, some individuals were still occupying burrows previously unused by them. Males and females did not differ significantly in the mean number of burrows used, the mean area over which these were distributed, or the mean maximum distance between burrows. Springhares were generally solitary and occupied burrows were, with few exceptions, apparently avoided by conspecifics.

Key words: **springhares, *Pedetes capensis,* burrow utilization, burrow distribution.**

INTRODUCTION

Semi-fossorial animals use burrows for protection from predators, protection from adverse environmental conditions, and occasionally as a place to store food (Reichman & Smith 1990). Most of these animals spend a large proportion of their time within or near their burrows and knowledge of their burrow utilization is consequently central to understanding their overall behaviour and ecology. Burrow utilization, however, varies considerably amongst animals. At one extreme are animals such as banner-tailed kangaroo rats (*Dipodomys spectabilis*) (Jones 1987), eastern chipmunks (*Tamias striatus*) (Yahner 1978; Lacher & Mares 1996), plains vizcachas (*Lagostomus maximus*) (Branch 1993) and herbivorous jerboas (*Stylodipus telum*) (Heske *et al.* 1995) that generally inhabit only a single home burrow, although some of these animals maintain a number of smaller burrows scattered throughout their home-ranges that serve as temporary shelters in emergencies. At the opposite extreme are animals like Merriam's kangaroo rats (*Dipodomys merriami*) (Behrends *et al.* 1986; Jones 1989), giant jumping rats (*Hypogeomys antimena*) (Cook *et al.* 1991), woodchucks (*Marmota monax*) (Swihart 1992) and Cape porcupines (*Hystrix africaeaustralis*) (Corbet & Van Aarde 1996) that use several different home burrows scattered throughout their home-ranges. These animals, however, differ in the number of burrows they use, the frequency with which they move between them, and the amount of time they spend in each burrow.

Springhares (*Pedetes capensis*) from southern Africa and *P. surdaster* from East Africa (Mathee & Robinson 1997), are large (3–4 kg), nocturnal, bipedal, saltatorial rodents that shelter in complex burrow systems during the day. They are patchily distributed over large parts of southern and eastern Africa, where they generally inhabit relatively flat areas of short, open scrub and grassland where soft, sandy soils are suitable for burrowing (Skinner & Smithers 1990; Anderson 1996). Shortridge (1934) and De Graaff (1981), both suggested that springhares use several different burrows and that they may occupy these in turn, only remaining a day or so in each. By contrast, four radio-collared animals from the Northern Cape Province of South Africa exhibited a very different pattern of burrow utilization, using only one or two burrow systems over a period of 2–6 months (Anderson 1996). Data from these animals, however, appear to have been collected infrequently and the animals were located only 5–11 times each and at unknown intervals. Our understanding of springhare burrow utilization can consequently at best be described as sketchy. In this study we provide the first detailed, quantitative information on temporal and spatial patterns of burrow utilization by springhares.

*Author for correspondence. Present address: Gauteng Department of Agriculture, Conservation, Environment and Land Affairs, P.O. Box 8769, Johannesburg, 2000 South Africa.
E-mail: dean.peinke@gauteng.gov.za

†Present address: Hartpury College (University of the West of England), Hartpury House, Hartpury, Gloucestershire, GL19 3BE, England. E-mail: chris.brown@hartpury.ac.uk

MATERIALS & METHODS

The study was carried out on the farm Marlu, Eastern Cape Province, South Africa (33°26′S, 26°19′E). The actual study site comprised a 226 ha area of relatively flat grassland that is typical of the habitat occupied by springhares in this region.

Between April 1996 and April 1998, 14 adult springhares (seven males and seven females) were caught and fitted with radio-collars. The animals were caught on dark, moonless nights by chasing them on foot with the assistance of a vehicle and spotlights. Ten of these animals were caught in the study site, fitted with AVM type P2 radio-collars (AVM Instrument Company, California, U.S.A.), and immediately released at the point of capture. Owing to difficulty in capturing sufficient animals at the study site, four additional animals were captured on surrounding farmland, collared, and released into apparently unused burrows in parts of the study site where they were unlikely to come into contact with other radio-collared animals. Introduced animals were allowed between one and two months to settle prior to data collection, whereas data collection began approximately two days after the capture and release of animals caught in the study site.

Each radio-collar transmitted on a unique frequency in the 150.0–150.7 MHz band. The collars had a total weight of 37–39 g (1% of adult body weight) and a potential battery life of 600 days. An AVM portable receiver (LA12-Q) and a collapsible three element yagi antenna were subsequently used to locate animals. Springhares were easily traced to their burrows during the day and could be pinpointed to within 0.5 m by walking in the direction of the strongest signal until it came from directly underfoot. Effective range of the radio-collars when animals were down their burrows varied, but was normally about 500 m. On completion of the study, or when necessary for battery replacement, the transmitters were recovered by digging the animals out of their burrows. The animals were subsequently released into what was left of the burrow system.

All radio-collared springhares were located at 3–4 day intervals for periods of up to a year. Each new burrow system in which an animal was found was marked by inserting a numbered pole into the soil directly above the animal. Any animal subsequently located within 10 m of this flag was considered to be in the same burrow system. All burrows used by animals were plotted onto a 1:10 000 orthophoto map, using a combination of recognizable features on the orthophoto and GPS positioning. The distance between the two burrows situated farthest apart, as well as the area of the minimum convex polygon (Mohr 1947; Macdonald *et al.* 1980) encompassing all the burrows used by each animal, were digitized and measured using computer software (SigmaScan, Jandel Scientific, San Rafael, CA).

Data obtained from the first 26 occasions that each animal was located were used to compare burrow utilization by males and females. The first 26 occasions only were used because different animals were tracked for different lengths of time and the number of burrows used by springhares was correlated with the number of times they were located and the length of the period over which they were tracked. Four animals (B, D, E and N) that were located fewer than 26 times were excluded from the analysis.

Pearson product moment correlation was used to assess significant relationships between variables. Mean values were examined for significance using *t*-tests or, where data failed to meet the assumptions required for *t*-tests, the Mann-Whitney *U*-test. All data were analysed using SigmaStat (Jandel Scientific) and in all cases the 0.05 level of probability was accepted as indicating statistical significance.

RESULTS

Owing to problems experienced with transmitters and premature battery failure, the length of time individual springhares carried radio-collars varied from 1–12 months.

Three of the animals captured on nearby farmland and relocated to the study site behaved in a similar manner to the resident springhares, but animal D left the immediate study site after 31 days and established a new home-range about 1060 m away with no overlap in area or burrows used. The two areas were consequently considered to be distinct from each other (Table 1). The number of burrows used by individual springhares ranged from 4–27 per individual (Table 1). The maximum distance between burrows used by individual springhares was 170–1000 m and burrows used covered areas of 0.6–28.5 ha. The widest-ranging individual, springhare A, used 27 different burrows spread over 28.5 ha in one year.

Overall, individual springhares were tracked for 29–362 days and within this period were located 8–100 times. The number of burrows utilized by springhares was significantly and positively corre-

Table 1. Burrow utilization and distribution by springhares.

Springhare	Sex	No. of days tracked	No. of times located	No. of burrows used	Area encompassed by burrows (ha)	Max. distance between burrows used (m)
A	Female	163	43	15	12.0	750
B	Female	47	13	5	4.7	570
C	Male	362	97	27	28.5	900
D*,†	Male	31	8	4	0.6	170
		66	16	5	0.7	220
E*	Male	47	13	7	17.8	780
F	Female	323	100	13	11.2	670
G	Male	254	83	15	16.3	870
H*	Female	225	74	12	3.0	390
I	Male	234	76	9	21.8	1000
J	Female	82	26	5	7.6	460
K	Male	154	35	8	2.0	420
L	Male	92	27	6	3.1	320
M	Female	98	30	5	0.4	190
N*	Female	29	9	4	12.4	760

*Animals caught at a nearby site and released into the study area; †springhare D had two separate home ranges.

lated with both the number of times the animals were located ($r = 0.772$, $P = 0.001$) and the length of the period over which they were tracked ($r = 0.845$, $P < 0.001$), suggesting that individuals continually exploited previously-unused burrows. The overall pattern of burrow utilization appears to be one whereby springhares regularly move from one burrow system to another. Only occasionally were individuals found in the same burrow system on more than two or three consecutive occasions, although some previously-used burrows were frequently reused on a different occasion by the same radio-collared individual. Even animals tracked for >300 days were periodically found in burrows they had not previously used.

Burrow utilization by five male and five female springhares was assessed over the first 26 occasions that they were located (see methods). This occurred over a period of 90 ± 2 days, during which both sexes used an average of 7.2 burrows ($t = 0.690$, $P = 0.510$) and although burrows used by males were on average scattered over a slightly larger area than those used by females (males 7.0 ± 5.4 ha; females 5.2 ± 3.7 ha) and had a greater maximum distance between them (males 572 ± 351 m; females 392 ± 146 m), the differences were not significant (Table 2).

Most of the burrows used by individual springhares were used only infrequently and they exhibited no great fidelity to any. Of the 101 different burrows used by the 14 springhares, 98 (97%) had springhares in them <10% of the total number of times the springhares were located. Although some individuals were located in the same burrow for extended periods, in at least some cases this can be attributed to them having given birth and subsequently being confined to the burrow system by rearing young (Table 3). Springhares A and M were both found to be lactating when they were dug up and had been consistently located in the same burrows for 36 and 32 days, respectively. Springhares F and J were consistently located in single burrows for 45 and 43 days, respectively. Both were females thought to have given birth. Animal K, a male, was the only other animal to be found in one burrow for an extended period; he was located in the same burrow for 39 days.

Table 2. Burrow utilization and distribution of male and female springhare during the first 90 ± 2 days of radio-tracking.

	No. of burrows used	Area (ha)	Max. distance between two burrows (m)
Males	7.2 ± 3.6	7.0 ± 5.4	572 ± 351
Females	7.2 ± 3.2	5.2 ± 3.7	392 ± 146
	$t = 0.690$	$t = 1.230$	$U = 33.000$
	$P = 0.510$	$P = 0.254$	$P = 0.310$

Burrows used by springhares were scattered throughout the areas encompassed by the minimum convex polygons, or occasionally clustered in parts of these polygons (Fig. 1). Although there

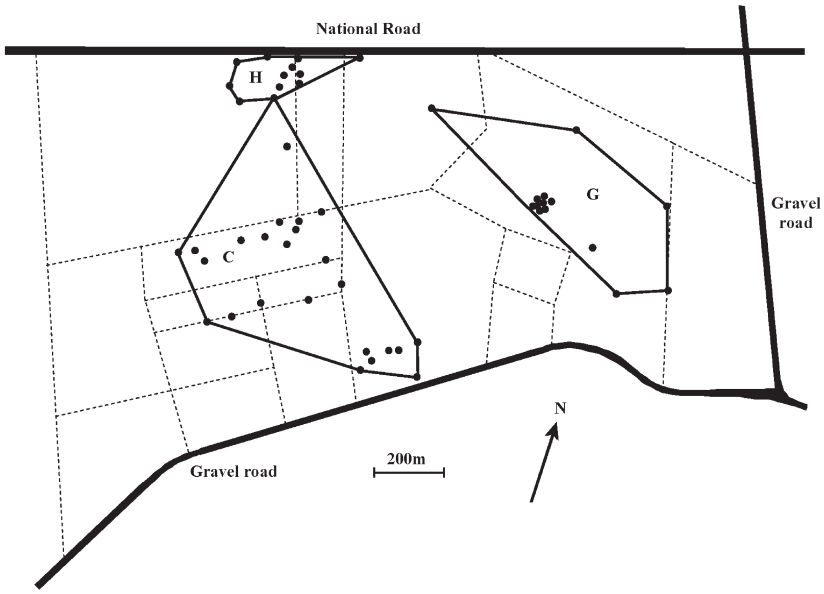

Fig. 1. Burrow distribution within the minimum convex polygons of three different springhares, illustrating the different patterns of burrow distribution within the area. Dashed lines demarcate boundaries of individual fields within the study site.

Table 3. Springhares that used a single burrow for extended periods of time.

Animal	Sex	Time spent in burrow	Given birth
A	Female	36 days	Yes
F	Female	45 days	Possibly
J	Female	43 days	Possibly
K	Male	39 days	No
M	Female	32 days	Yes

was considerable male/male, male/female and female/female overlap of the areas over which the burrows of individual springhares were distributed (Fig. 2), there was very little overlap in the use of burrows themselves by different animals (Table 4).

Although at most only five collared springhares were ever simultaneously present at the study site, two collared animals were found down the same burrow on three separate occasions. The same two animals (female H and male I) were involved in all three cases and always in the same burrow system, which was relatively small with only two entrances. On all three occasions the animals were 2–3 m apart. With the exception of these animals, none of the burrows were used by a radio-collared springhare within one month of them having been previously used by another radio-collared animal (Table 4).

Only one of the 101 different burrows used by radio-collared animals was excavated during the course of this study, following a period of heavy rain. The excavation was initiated by animal H and gradually extended over a period of eight months by animal H and later by I from a system with a single entrance to one with five entrances.

DISCUSSION

Springhares of both sexes in the present study used numerous different burrows scattered throughout their presumed home range and seldom remained in any one burrow for more than a few consecutive days. This pattern of burrow utilization is similar to that previously suggested by Shortridge (1934) and De Graaff (1981) but unlike that described by Anderson (1996), who suggested from radio-tracking of four individuals for 2–6 months, that springhares in the Northern Cape Province of South Africa use only one or two burrows. Anderson's (1996) observations were, however, based on a small sample size and few locations per animal. He does, however, point out that the animals tracked by him inhabited a pan border densely populated by springhares and that those animals inhabiting less densely populated areas of Kalahari sandveld appeared to use up to four different burrow systems. This suggests that the number and distribution of burrows used by

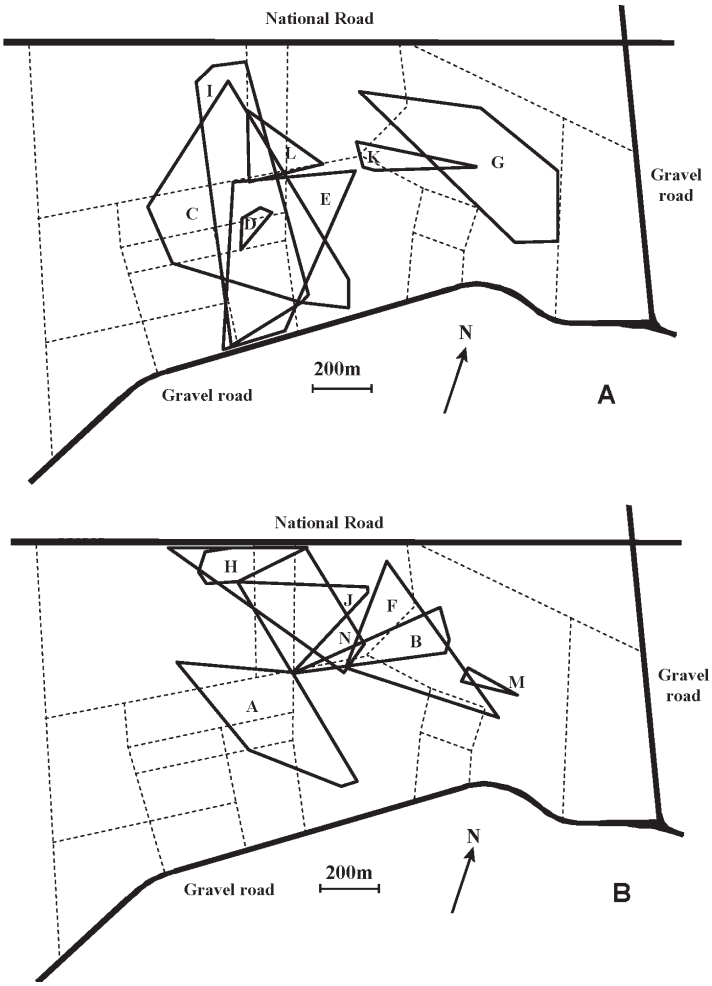

Fig. 2. Diagram of the study site showing the areas (minimum convex polygons) over which the burrows used by male (**A**) and female (**B**) springhares were located. Dashed lines demarcate boundaries of individual fields within the study site.

individual springhares may vary with population density.

The pattern of burrow utilization exhibited by springhares in this study most closely resembles that of another bipedal rodent from arid areas, Merriam's kangaroo rat. Like springhares, it utilizes a number of different burrows, frequently changes burrows and seldom spends more than a few consecutive days in each (Behrends *et al.* 1986; Jones 1989). They differ from springhares only in that they remain relatively faithful to at least one burrow, to which they frequently return and in

Table 4. The number of burrows used by one, two, three and four different radio-collared springhare during the course of the study and the minimum duration between occupancy.

Number of springhares	Number of burrows	Minimum time interval between use by different animals (days)
1	70	–
2	25	29
3	4	34
4	2	33

which they are found on average 64% of the time (Behrends *et al.* 1986). Although some springhares use some burrows more frequently than others, none were used with such regularity.

Only one new burrow was excavated during the course of this study, which is consistent with an earlier report by Butynski & Mattingly (1979) that most burrows are utilized by a succession of springhares over many years. As suggested by Butynski & Mattingly (1979) this new burrow system was gradually extended to a five-entrance system over a period of eight months. Successional use of burrows appears to be a relatively common feature among animals that inhabit elaborate burrow systems (Reichman & Smith 1990).

Although springhares were originally described as colonial (FitzSimons 1920) and later thought to live in pairs (Shortridge 1934; De Graaff 1981), it is now generally accepted that they are solitary animals with at most a mother and its young associated with each burrow system (Butynski & Mattingly 1979; Anderson 1996). The present study did, however, find a pair of springhares (a male and a female) in the same burrow on three occasions, confirming earlier reports by Smithers (1971) and Kingdon (1974) that pairs may occasionally be found in the same burrow. A similar situation has been reported in woodchucks (Swihart 1992).

Among solitary rodents, adult males generally range more widely than females, especially during the breeding season (Brown 1966; Brooks & Banks 1971; Daly & Daly 1975a,b; Yahner 1978; Madison 1980). Anderson & Kok (2003), however, suggested that there is no difference in the spatial activities between male and female springhares and the lack of any sex-related differences in the number of burrows used and the size of the areas over which burrows were distributed supports this. Unlike many rodents, springhares are reproductively active throughout the year (Butynski 1979; van der Merwe *et al.* 1980; Peinke 2000), which may account for the absence of differentiation between the sexes. This has also been reported in Merriam's kangaroo rat and the chisel-toothed kangaroo rat (*Dipodomys microps*) (Allred & Beck 1963; Chew & Butterworth 1964; Maza *et al.* 1973; Behrends *et al.* 1986).

During extensive nocturnal observations conducted as part of a broader study on springhares (Peinke 2000), no intra-specific aggression or active defense of any area was observed. Furthermore, springhares were often observed feeding in large groups, which individuals appeared to join and leave without any adverse reaction from other animals. These observations, along with the fact that there was considerable overlap of the areas in which the burrows of different animals were found, confirm earlier suggestions that springhares have widely overlapping home-ranges and do not have actively defended territories (Butynski 1984; Skinner & Smithers 1990; Anderson 1996). Whether or not burrows are defended against conspecifics, however, remains unclear. Seventy per cent of the burrows used by radio-collared springhares were used by only a single animal and very few burrows were used by more than two animals, even over long periods of time, suggesting that springhares do display some degree of burrow segregation. Moreover, when disturbed or pursued, springhares attempt to return to their own burrows, ignoring other burrows in the immediate vicinity (Smithers 1971; Skinner & Smithers 1990; pers. obs.). Scent marks, made with the pair of perineal glands located in the anogenital region, or by urinating at the burrow entrance (frequently observed), may serve to warn conspecifics that a burrow is occupied. If the burrow is, however, not frequently reused these scent marks presumably fade and the burrow may then be used or occupied by another animal. This is supported not only by Anderson's (1996) observation that re-colonization of the burrows of deceased animals occurred only after four to six months, but also by the observation in the present study that no animal used a burrow within one month of it previously being used by another. The frequent burrow changes displayed by springhares may thus ensure that scent marks at the set of burrows used by the animal remain fresh and deter occupation by other individuals.

Although burrows are generally used only by individual springhares, the animals changed burrows frequently, seldom occupying a burrow for more than a few consecutive days. Regular movement between burrows may be attributed to two factors. First, animals may regularly switch burrows to avoid predators that may be attracted to the odour of a frequently-used burrow (Behrends *et al.* 1986). Second, they may move frequently to escape parasites that might infest their burrows (Yahner 1978; Behrends *et al.* 1986). There is considerable evidence to support the latter suggestion. Individual badgers, for example, use a number of different setts and frequently move from one to another to avoid accumulating

ectoparasites (Broseth *et al.* 1997). Removal of parasites from Brant's whistling rats (*Parotomys brantsii*) has also been demonstrated to reduce the frequency with which animals change nest chambers and burrows (Roper *et al.* 2002). Springhares are hosts to a number of ectoparasites, especially mites, lice, fleas and ticks (Anderson & Kok 2003) and frequent burrow changes may limit the accumulation of these by the animals.

ACKNOWLEDGEMENTS

The authors thank all those who helped to catch springhares for the study, as well as Allan Page and Jimmy Emslie for allowing ready access to their farms. The financial assistance of the Rhodes University Joint Research Committee and the South African National Research Foundation is also gratefully acknowledged. We also acknowledge the support and provision of a vehicle by Ric Bernard.

REFERENCES

ALLRED, D.M. & BECK, D.E. 1963. Range of movement and dispersal of some rodents at the Nevada Atomic Test Site. *Journal of Mammalogy* **44**: 190–200.

ANDERSON, P.C. 1996. The population dynamics and ecological role of the springhare *Pedetes capensis* (Forster, 1778) in the Kimberley area, Northern Cape Province, South Africa. Ph.D. thesis, University of the Orange Free State, Bloemfontein.

ANDERSON, P.C. & KOK, O.B. 2003. Ectoparasites of springhares in the Northern Cape Province, South Africa. *South African Journal of Wildlife Research* **33**:23–32.

BEHRENDS, P., DALY, M. & WILSON, M.I. 1986. Range use patterns and spatial relationships of Merriam's kangaroo rats (*Dipodomys merriami*). *Behavior* **96**: 187–209.

BRANCH, L.C. 1993. Intergroup and intragroup spacing in the plains Vizcacha, *Lagostomus maximus. Journal of Mammalogy* **74**: 890–900.

BROOKS, R.J. & BANKS, E.M. 1971. Radiotracking study of lemming home range. *Communications in Behavioural Biology* **6**: 1–5.

BROSETH, H., BEVANGER, K. & KNUTSEN, B. 1997. Function of multiple badger (*Meles meles*) setts: distribution and utilization. *Wildlife Biology* **3**: 89–96.

BROWN, L.E. 1966. Home range and movement of small mammals. *Symposium of the Zoological Society of London* **18**: 111–142.

BUTYNSKI, T.M. 1979. Reproductive ecology of the springhaas, *Pedetes capensis,* in Botswana. *Journal of Zoology, London* **189**: 221–232.

BUTYNSKI, T.M. 1984. Nocturnal ecology of the springhare, *Pedetes capensis,* in Botswana. *African Journal of Ecology* **22**: 7–22.

BUTYNSKI, T.M. & MATTINGLY, R. 1979. Burrow structure and fossorial ecology of the springhare *Pedetes capensis* in Botswana. *African Journal of Ecology* **17**: 205–215.

CHEW, R.M. & BUTTERWORTH, B.B. 1964. Ecology of rodents in Indian Cove (Mojave Desert), Joshua Tree National Monument, California. *Journal of Mammalogy* **45**: 203–225.

COOK, J.M., TREVELYAN, R., WALLS, S., HATCHER, M. & RAKOTONDRAPARANY, F. 1991. The ecology of *Hypogeomys antimena,* an endemic Madagascan rodent. *Journal of Zoology, London* **224**: 191–200.

CORBET, N.U. & VAN AARDE, R.J. 1996. Social organization and space use in the Cape porcupine in a southern African savanna. *African Journal of Ecology* **34**: 1–14.

DALY, M. & DALY, S. 1975a. Socio-ecology of Saharan gerbils, especially *Meriones libycus. Mammalia* **39**: 289–311.

DALY, M. & DALY, S. 1975b. Behaviour of *Psammomys obesus* (Rodentia: Gerbillinae) in the Algerian Sahara. *Zeitschrift für Tierpsychologie* **37**: 298–321.

DE GRAAFF, G. 1981. *The Rodents of Southern Africa.* Butterworths, Durban.

FITZSIMONS, F.W. 1920. *The Natural History of South Africa,* Vol. 4. Longmans Green, London.

HESKE, E.J., SHENBROT, G.I. & ROGOVIN, K.A. 1995. Spatial organization of *Stylodipus telum* (Dipodidae, Rodentia) in Dagestan, Russia. *Journal of Mammalogy* **76**: 800–808.

JONES, W.T. 1987. Dispersal patterns in kangaroo rats (*Dipodomys spectabilis*). In: *Mammalian Dispersal Patterns: the Effects of Social Structure on Population Genetics,* (eds) B.D. Chepko-Sade & Z.T. Halpin, pp. 119–127. University of Chicago Press, Chicago.

JONES, W.T. 1989. Dispersal distance and the range of nightly movements in Merriam's kangaroo rats. *Journal of Mammalogy* **70**: 27–34.

KINGDON, J. 1974. *East African Mammals. An Atlas of Evolution in Africa,* Vol. 2B. Academic Press, London.

LACHER, T.E. & MARES, M.A. 1996. Availability of resources and use of space in eastern chipmunks, *Tamias striatus. Journal of Mammalogy* **77**: 833–849.

MACDONALD, D.W., BALL, F.G. & HOUGH, N.G. 1980. The evaluation of home range size and configuration using radio-tracking data. In: *A Handbook on Biotelemetry and Radio-tracking,* (eds) C.J. Amlaner, & D.W. Macdonald, pp. 405–424. Pergamon Press, London.

MADISON, D.M. 1980. Space use and social structure in meadow voles, *Microtus pennsylvanicus. Behavioural Ecology and Sociobiology* **7**: 65–71.

MATTHEE, C.A. & ROBINSON, T.J. 1997. Molecular phylogeny of the springhare, *Pedetes capensis,* based on mitochondrial DNA sequences. *Molecular Biology and Evolution* **14**: 20–29.

MAZA, B.G., FRENCH, A.R. & ASCHWANDEN, A.P. 1973. Home range dynamics in a population of heteromyid rodents. *Journal of Mammalogy* **54**: 405–425.

MOHR, C.O. 1947. Table of equivalent populations of North American small mammals. *American Midland Naturalist* **37**: 223–249.

PEINKE, D.M. 2000. The ecology and physiology of the springhare (*Pedetes capensis*) in the Eastern Cape Province of South Africa. Ph.D. thesis, Rhodes University, Grahamstown.

REICHMAN, O.J. & SMITH, S.C. 1990. Burrows and

burrowing behaviour by mammals. In: *Current Mammalogy,* Vol. 2, (ed.) H.H. Genoways, pp. 197–244. Plenum Press, New York.

ROPER, T.J., JACKSON, T.P., CONRADT, L. & BENNETT, N.C. 2002. burrow use and the influence of ecto-parasites in Brant's whistling rat (*Parotomy brantsii*). *Ethology* **108**: 557–564.

SHORTRIDGE, G.C. 1934. *The Mammals of South West Africa,* Vol. I. Heinemann, London.

SKINNER, J.D. & SMITHERS, R.H.N. 1990. *The Mammals of the Southern African Subregion.* University of Pretoria, Pretoria.

SMITHERS, R.H.N. 1971. *The Mammals of Botswana.* Museum Memoir No. 4, National Museums and Monuments of Rhodesia, Salisbury.

SWIHART, R.K. 1992. Home-range attributes and spatial structure of woodchuck populations. *Journal of Mammalogy* **73**: 604–618.

VAN DER MERWE, M., SKINNER, J.D. & MILLAR, R.P. 1980. Annual reproductive pattern in the springhaas, *Pedetes capensis. Journal of Reproduction and Fertility* **58**: 259–266.

YAHNER, R.H. 1978. Burrow system and home range use by eastern chipmunks, *Tamias striatus*: ecological and behavioural considerations. *Journal of Mammalogy* **59**: 324–329.