

## Ranging behaviour of the Cape grey mongoose *Galerella pulverulenta* in a coastal area

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(With 2 figures in the text)

Five Cape grey mongooses (*Galerella pulverulenta* (Wagner, 1839)) were radio-tracked from November 1988 to February 1989 in the West Coast National Park, Cape Province, South Africa. Animal locations numbering 2253 were recorded. Radio-tagged mongooses were diurnally active and frequented thick mediterranean-type scrub; sightings of untagged mongooses followed the same pattern. Home range size (95% harmonic mean) of resident animals in the study period ranged from 21 to 63 ha. One female had the smallest range; the other, a juvenile, ranged more widely, possibly dispersing, and utilized a more varied habitat. Home ranges overlapped widely, both within and between sexes, although territoriality among adult females cannot be ruled out. Males showed some degree of sociality. Possible reasons for this spatial system are discussed.

### Contents

	Page
Introduction . . . . .	353
Study area . . . . .	354
Material and methods . . . . .	354
Results . . . . .	356
Animals captured . . . . .	356
Home range characteristics . . . . .	357
Activity and movements . . . . .	358
Food availability . . . . .	360
Distribution of faeces . . . . .	360
Discussion . . . . .	360
References . . . . .	361

### Introduction

Mongoose (Carnivora: Herpestidae (following Wozencraft, 1982)) are one of the most interesting groups for shaping and testing theories on the evolution of social behaviour and its ecological correlates (see Rubenstein & Wrangham, 1986). As Rood (1986) has pointed out, however, a major limitation to the development of such theories is the almost complete lack of information about most of the species of this family. In particular, while the open-area dwelling, social and insectivorous species (especially *Mungos mungo* and *Helogale parvula*) are relatively well studied (e.g. Rood, 1975, 1983; Rasa, 1977, 1987), few field studies have been conducted on the behavioural ecology of the many species of the more secretive, so-called solitary, mongooses (e.g.

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Waser & Waser, 1985, on *Ichneumia albicauda*; Ben-Yaacov & Yom-Tov, 1983, on *Herpestes ichneumon*). It is not clear then how some species fit in the model proposed by Ewer (1973) and developed by Gorman (1979) and Rood (1986). Briefly, this model proposes diurnality (through increased predation risks; see Rasa, 1987) and insectivory (that lowers the cost of resource sharing; see Waser, 1981) as major forces driving towards more complex social structures.

*Galerella pulverulenta* (= *Herpestes pulverulentus*) is sometimes referred to as diurnal (Dorst & Dandelot, 1970; Smithers, 1983) or as crepuscular/nocturnal (Rood & Wozencraft, 1984); sometimes as predominantly insectivorous (Du Toit, 1980; MacDonald & Nel, 1986) or as a vertebrate-feeder (Stuart, 1981); mostly as solitary (Stuart, 1981; Rood & Wozencraft, 1984), although instances of higher sociality have been suggested (Dorst & Dandelot, 1970; Ewer, 1973).

This paper discusses some range size, spatial relationships between animals occupying the same area, activity rhythms and movement patterns, and the distribution of faeces in relation to the home range structure, of Cape grey mongooses in a coastal area, relative to the pattern of food availability and other ecological variables.

### Study area

The study was conducted in the Postberg Nature Reserve (33° 05' S, 18° E; 2700 ha), a section of the West Coast National Park, Cape Province, South Africa. The topography is dominated by two granite outcrops (189 m and 193 m a.s.l.). The climate is mediterranean. Average monthly temperatures (max., min.) range from 14.6 °C; 8.7 °C in July to 21 °C; 13.2 °C in February. Annual precipitation at Langebaan village (c. 2 km east) averages 253 mm, almost all in winter (Weather Bureau, 1965). During summer, aridity is mitigated by morning dew. The vegetation is characterized by a complex mosaic of scrubby associations, although some areas, cultivated until 1969, are covered by short grass. Boucher & Jarman (1977) give a phytosociological outline of the area. Owing to the high density of rodents (mainly *Rhabdomys pumilio* and *Otomys unisulcatus* among the diurnal, *Gerbillurus paebe* and *Tatera afra* among the nocturnal species), the area supports large numbers of raptors and snakes. Potential predators and/or competitors of the Cape grey mongoose also include a wide array of Carnivores (pers. obs., and G. Tomsett, National Parks Board, pers. comm.). Shelter in the form of thick, thorny bushes and rocks is abundant. Some holiday houses fringe the coastline.

### Material and methods

Trapping and subsequent radio-tracking of Cape grey mongooses started in March 1988. Most of the data used for this paper comes from an intensive study conducted between November 1988 and February 1989. Mongooses were trapped with 6 single-door wire mesh traps (25 × 25 × 90 cm). The animals were then anaesthetized with ketamine hydrochloride (Ketalar, Parke-Davis) at doses from 6.25 to 20 mg/kg, sexed, weighed and fitted with radio-collars or plastic collars. Tooth wear was used as an indication of age (cf. Rood & Waser, 1978; Waser & Waser, 1985). Most of the trapping effort (180 trap days) was concentrated in a small area (A in Fig. 1) in an attempt to capture all resident mongooses in that range. Later trapping (11 trap days) was done in area B (Fig. 1). Data on radio-collared animals were collected according to the following sampling methods:

- i. Two simultaneous bearings were taken on each animal every 15 min for 6 or 8 hours from 2 fixed stations. The tracking periods were evenly distributed over the daylight hours.
- ii. On the animals (M1, M3 and F6) whose range fell largely outside the main tracking area, fixes were recorded with a hand-held antenna. From 1 to 52, 15 min-fixes were recorded daily on each animal.

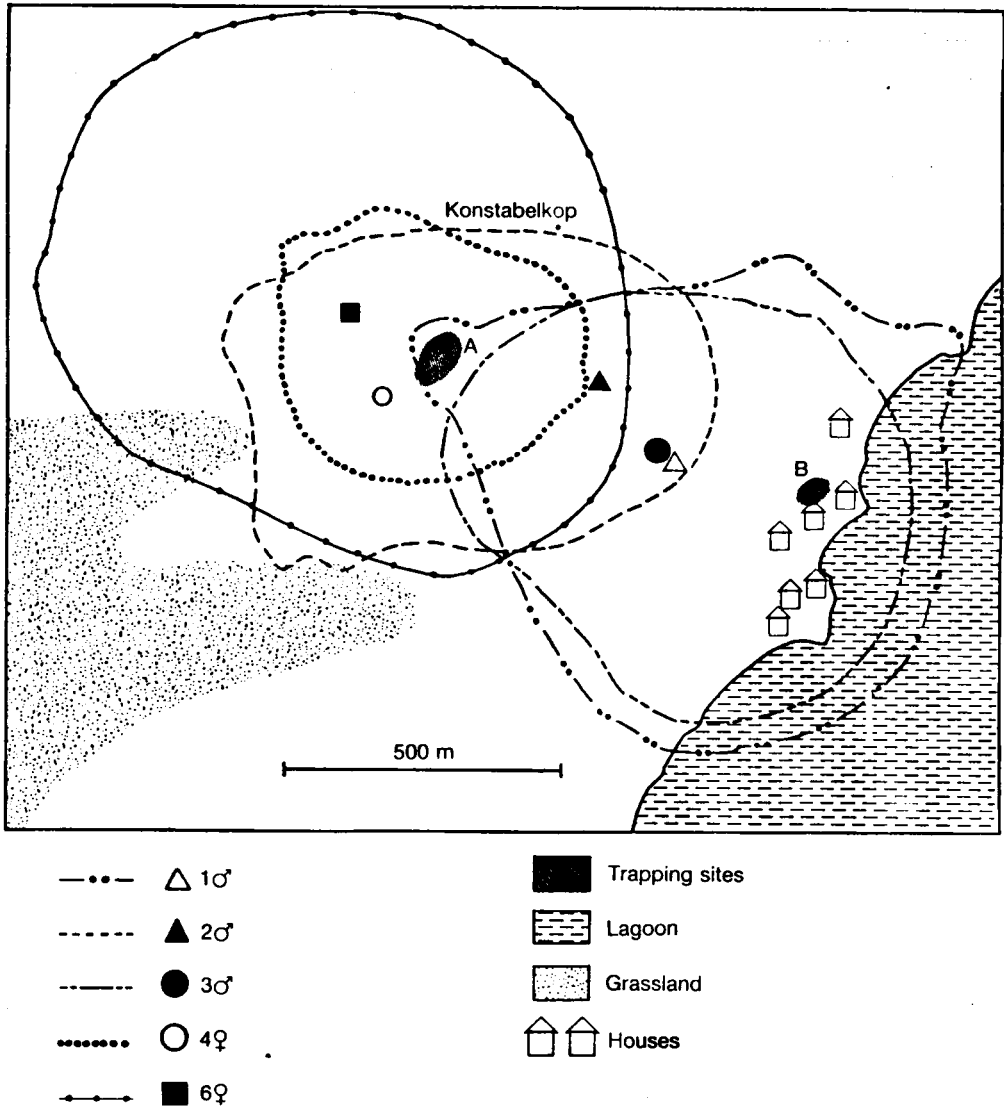


FIG. 1. Summer home ranges of five Cape grey mongooses in the West Coast National Park, South Africa. Contours were calculated with the 95% harmonic mean method (Dixon & Chapman, 1980). The north range of F6 is not shown. The height of Konstabelkop, a granite outcrop, is 189 m a.s.l.

iii. On 7 occasions, one of the radio-collared mongooses was followed in the evening until activity ceased (constant signal strength and same position for > 45 min), then relocated at 03:00 h the following morning to check for eventual nightly movements and to record the onset of activity time.

Four-element Yagi antennas and Yaesu FT-290R receivers (144–148 MHz; Yaesu Musen Co., Ltd.,

Tokyo) were used; transmitters were constructed locally. Complete radio-collars weighed <4% of body weight. From field trials the error was found to be less than 15 m. All fixes were plotted on a 25 m xy grid. The habitat was also recorded, following Boucher & Jarman (1977). Since none of the current measures of home range size is free of problems (Anderson, 1982), and also to make possible comparisons with other studies, 4 methods were used to calculate home range size: 95% harmonic mean (Dixon & Chapman, 1980); 95% ellipse (Jennrich & Turner, 1969); convex polygon (Southwood, 1966); and concave polygon (referring to a grid of 50 m). The resting locations of the mongooses were excluded from the home range analyses to avoid overestimating the importance of resting sites in the home range use pattern. For the calculation of the ellipse and harmonic mean areas only one fix per hour was used, to reduce the dependency of the sample, which may produce sizeable errors (Anderson, 1982). The home range analyses were done with a McPAAL programme (Smithsonian Institution, Washington, D.C.). The linear distance between successive fixes (hereafter referred to as 'movements') was used as an index of activity. Association tendencies of collared animals were analysed (the positions of mongooses were randomly permuted 200 times and the distance between fixes calculated at every permutation for every couple of animals. The average distribution of those distances was then compared to the observed one by  $\chi^2$  test; following Kenward, 1987: 169). The main tracking area was intensively searched (> 20 searching hours) for mongoose droppings (later analysed for the presence of the distinctive *Galerella* hair to confirm field identification) and their distribution was recorded. All sightings of marked and unmarked mongooses in the study area were recorded. Nonparametric tests (Wilcoxon matched-pair signed ranks, W; Kolmogorov-Smirnoff, K; Mann-Whitney U, M;  $\chi^2$  test, C) were used (Siegel, 1956).

The main prey species of the Cape grey mongoose in our study area were the 2 rodents *Otomys unisulcatus* and *Rhabdomys pumilio* (Cavallini & Nel, In press). We therefore trapped *Rhabdomys* with 60 live-traps set in the centres of each mongoose range. In the same areas, *Otomys* nests (always associated with this rodent's presence, see Vermeulen & Nel, 1988) were counted along 24 transects (100 m x 2 m).

## Results

### Animals captured

Eight Cape grey mongooses were captured or recaptured 15 times (Table I); five (see Table I for sex and estimated age) were fitted with radio-collars. The trapping success (i.e. mongooses trapped

TABLE I  
*Mongooses trapped in the West Coast National Park (November 1988-January 1989)*

No.	Sex	Weight (kg)	Tooth-wear <sup>1</sup>	Estimated age class <sup>2</sup>	Capture site	No. of captures	Notes
1	M	0.85	S	Subad.	A	1	
2	M	0.90	M	Ad.	A	6	Died (23.1.89), prob. killed by caracal
3	M	1.00	H	Ad.	A, B	2	
4	F	0.80	M	Ad.	A	1	
5	F	?	S	Subad.	A	1	Trapped in the same area (4.88) as Juv.
6	F	0.77	S	Juv.	A	2	Badly infested with ticks and scabies; recovered by the second capture
7	F	0.69	S	Juv.	B	1	Badly infested with scabies and ticks
8	F	?	S	?	B	1	

<sup>1</sup> S = slight; M = medium; H = heavy

<sup>2</sup> Juv. = juvenile; Subad. = subadult; Ad. = adult

per trap-day  $\times$  100) was much higher at site B (27%) than at site A (2.7%). Ketalar at 15–20 mg/kg provided sufficient anaesthesia to handle animals, but not to make them motionless (this is substantially more than the 7 mg/kg used by Beltran, Delibes & Ibanez, 1985, for *H. ichneumon*). Of the 43 sightings, 41 were of a single and two of two mongooses. On the basis of the number and distribution of captures and sightings, the number of untagged animals was estimated at 0–1 in the range of M2 and F4, and 2–4 in the range of M1 and M3.

#### Home range characteristics

Altogether 2253 animal locations were obtained. The distribution of the radio-locations, as well as that of sightings, corresponded to that of bushy areas, mainly covered by the Hillside Dense Shrubland (*Ehrharta-Maurocenia*) and the Consolidated-dune Dense Evergreen Shrubland (*Maytenus-Kedrostis*); the only animal to show a partially different habitat selection was F6. The various estimates of home range size for the radio-collared animals are given in Table II; these figures refer to the seasonal range, possibly different from the annual or life-time one. Although different methods of calculation resulted in a great deal of variation in home range size of specific individuals, the relative sizes agreed well. The home ranges of males were bigger than that of female 4. All methods (except for the convex polygon) tend to overestimate the range size of males 1 and 3 because of the presence of natural movement restrictions (i.e. the lagoon). The centres of the home ranges were quite stable during the study period. The only exception was F6, a juvenile female. She moved from a southern range to a northern one (distance between the centres = 2.25 km). Both of these ranges were larger than those of the other mongooses. In this case the convex polygon and ellipse methods drastically overestimated the size of the home range. This female frequented a more open habitat, composed for the larger part of Hillside Closed Dwarf Shrubland (*Galenija-Senecio*).

The home ranges of the radio-tracked mongooses overlapped to a large extent, both between and within sexes (Table III). From our sample, however, the occurrence of exclusive ranges (i.e.

TABLE II  
Home ranges in hectares of radio-collared mongooses in the West Coast National Park. See text for references to computational methods. The identification numbers are the same as in Table I

Id. no.	Total no. of fixes	Home range size				
		Harmonic mean		95% Ellipse	Minimum convex polygon	Concave polygon
		95%	50%			
M1	461	63.1 50.1 <sup>1</sup>	9.4 9.4 <sup>1</sup>	83.2	92.3	46.2
M2	541	44.7	5.0	55.6	55.5	41.5
M3	375	49.7 43.5 <sup>1</sup>	8.0 8.0 <sup>1</sup>	65.7	55.2	29.4
F4	568	21.4	3.4	24.6	30.6	20.6
F6	308	85.0 <sup>2</sup> 124.5 <sup>3</sup>	20.6 <sup>2</sup> 23.7 <sup>3</sup>	470.0	359.0	107.3

<sup>1</sup> Excluding the area that falls within the lagoon

<sup>2</sup> South range (see text)

<sup>3</sup> North range (see text)

TABLE III

Home range overlap (percentage of the range of animal A shared with animal B). 95% harmonic mean method (Dixon & Chapman, 1980); in brackets the actual overlap area (in ha) is given

		B				
		M1 <sup>1</sup>	M2	M3 <sup>1</sup>	F4	F6 <sup>2</sup>
A	M1 <sup>1</sup>	—	36 (18.0)	84 (42.3)	12 (6.1)	26 (13.0)
	M2	40 (18.0)	—	40 (17.7)	45 (20.3)	84 (37.5)
	M3 <sup>1</sup>	97 (42.3)	41 (17.7)	—	10 (4.6)	28 (12.0)
	F4	29 (6.1)	95 (20.3)	22 (4.6)	—	100 (21.4)
	F6 <sup>2</sup>	15 (13.0)	44 (37.5)	14 (12.0)	25 (21.4)	—

<sup>1</sup> Excluding the area that falls within the lagoon

<sup>2</sup> Only south range

territoriality) among adult females cannot be excluded. On the basis of the home range overlap, two spatial groups could be identified:

– M1 + M3, whose ranges were almost identical

– M2 + F4 + F6, whose range overlap ranged from 44% to 100%, with the exception of F6–F4; the low overlap value (25%) in this case results from F4's small range size, completely included in F6's large range (Fig. 1).

The spatial relationships of individuals within these two groups seem to be quite different. Overall the study animals did not show avoidance or associations ( $C, P > 0.1$ ). M1 and M3, on the contrary, spent 11.5% of the activity time within 25 m of each other, more than expected by chance ( $C, P < 0.01$ ). Nocturnal associations, such as those reported by Ewer (1973) for the same species and by Earle (1981) for *Cynictis penicillata* were recorded only twice (M1 with M3). Although associations with non-collared mongooses cannot be excluded, these are unlikely to be common, at least in the range of M2 + F4 (with an estimated 0–1 untagged animals).

#### Activity and movements

Mongooses were active during the day. Activity ceased between 19:00 h and 20:45 h (mode: 20:45 h;  $n = 23$ ) until 04:15 h–08:00 h (mode: 06:00 h;  $n = 30$ ) next morning. Only twice (at 04:15 h and 04:30 h) was activity recorded when completely dark. The sleeping places were scattered over the area frequented during the day, and were changed from day to day. No attenuation of the radio-signal was noted during night-time; the animals therefore did not rest in underground dens. A great deal of variation, both intra- and inter-individual, was apparent for the onset of activity and in the distances moved during the day. However, all animals travelled faster during the morning and the evening than the middle of the day (Fig. 2). F4 started moving earlier ( $M, Z = -1.93, P = 0.05, n = 16$ ) and stopped later ( $M, Z = 2.36, P = 0.02, n = 12$ ) than M1. Males 1 and 3 moved about the same distance ( $W, Z = 0.78, P > 0.4, n = 72$ ), as well as M2 and F4 ( $W, Z = 0.83, P = 0.4, n = 72$ ), while both M2 and F4 moved more than M1 and M3 ( $W, 6.14 < Z < 5.09, P < 0.001, n = 66$ ); female 6 moved about the same extent as M2 ( $W, Z = 1.23, P = 0.22, n = 65$ ), but more than other mongooses ( $W, 5.65 < Z < 5.01, P < 0.001, n = 65$ ) (see Fig. 2). During 3 days, M1 and M3 rested most of the time near the remains of a porcupine (*Hystrix africaeaustralis*). The relevant data were excluded from the analyses.

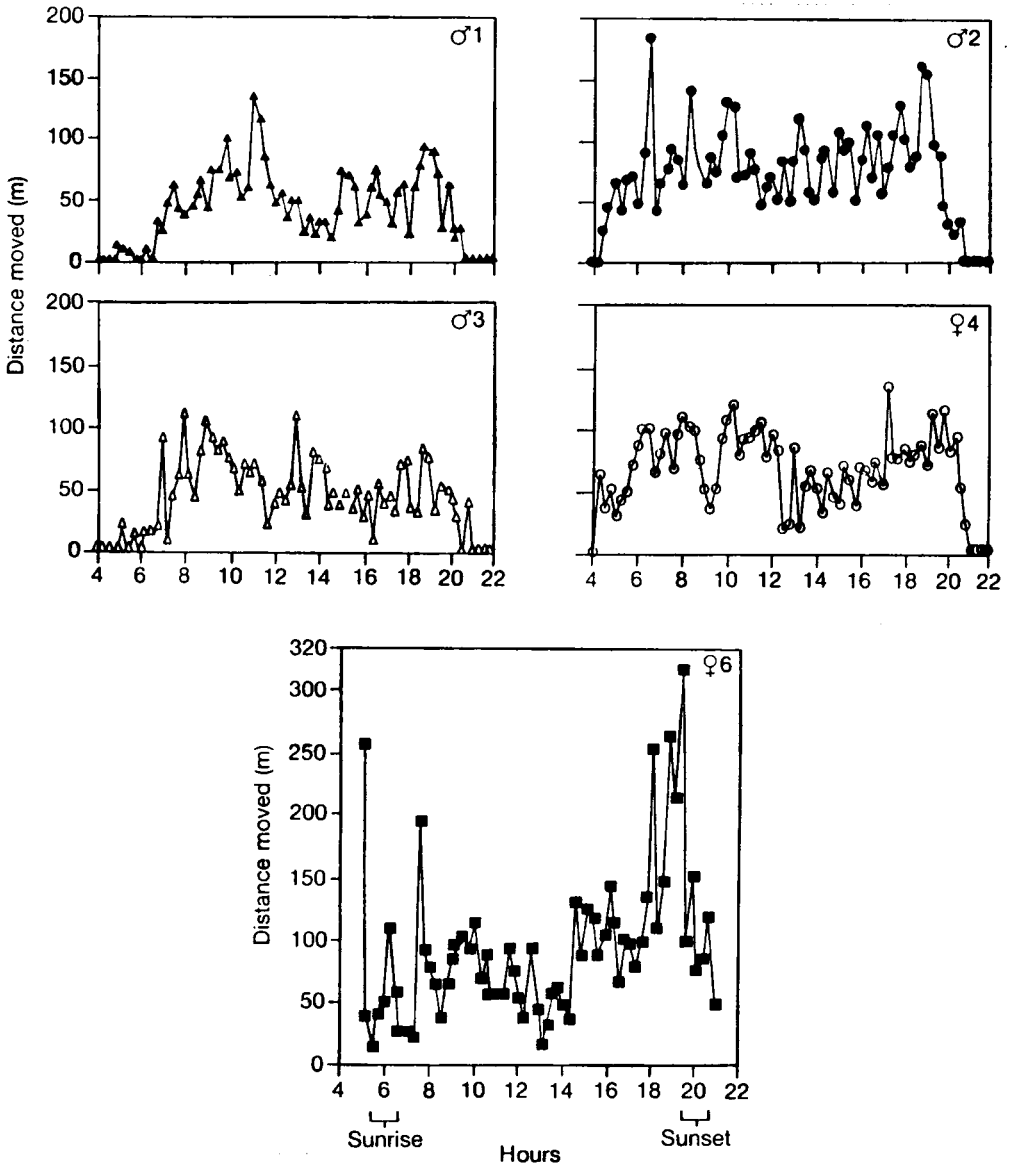


FIG. 2. Distance in metres moved per 15 min by five Cape grey mongooses in the West Coast National Park, South Africa.

### Food availability

Density and clumpedness of both *Rhabdomys* captures and *Otomys* nests did not differ between the centre of M1+M3 range and that of M2+F4 (respectively: M,  $P=0.19$ ; K,  $P>0.1$ ). *Rhabdomys* captures were not clumped ( $\sigma^2/\bar{x} < 1$ ). *Otomys* nests were concentrated in a single large patch at mid-slope ( $\sigma^2/\bar{x} > 1$ ). In F6's northern range *Rhabdomys* density was lower (M,  $P < 0.01$ ) and no *Otomys* nest was recorded.

### Distribution of faeces

Altogether 194 droppings were found. Most of them (29.9%) were in groups from 2-5, 26.7% from 6-10, 22.2% in groups containing more than 10 droppings, and 21.3% single. The latrines were not concentrated either in the centre of home ranges or in the overlap areas, nor in areas of especially high rodent density, but rather approximately followed the distribution of sleeping sites, all but one being situated at mid-slope.

### Discussion

Individual study animals showed a considerable variation in their ranging behaviour. Part of that variability can be explained by: (i) sex and age (i.e. the mature female F4 had a smaller range than males, and the young female F6 had a relatively large and non-fixed range, possibly as a result of juvenile dispersal); (ii) food availability (i.e. the higher activity levels of F6 could be due to the lower mouse density in her range; the lower activity of M1 and M3, as well as the likely higher mongoose density in their range, might be related to the availability of a concentrated food resource, i.e. food remains from the houses).

The pattern of overlapping ranges found in this study resembles that found by Gorman (1979) for *Herpestes auropunctatus*, although in his study a temporal overlap could not be demonstrated. The radio-collared mongooses did not avoid each other; in fact, even caged mongooses did not show signs of aggression when the traps were placed side by side (pers. obs.), as more territorial animals (e.g. raccoon *Procyon lotor* and red fox *Vulpes vulpes*) do (Barash, 1976). This may suggest a high level of intraspecific tolerance. In fact, the distribution of the two main food resources does not appear to be clumped in small patches as is the case, e.g. of badgers *Meles meles* feeding on earthworms (Kruuk & Parish, 1981). Food may therefore not be economically defensible, making the observed lack of territoriality adaptive.

A small, diurnal and small vertebrate feeder mongoose like *Galerella* is expected to be solitary (Rood, 1986). In spite of this, however, at least two of our mongooses, a young male (M1) and an old one (M3) showed associative tendencies. Rood & Waser (1978) also found two associations of this type in male slender mongooses *Galerella sanguinea* (= *Herpestes sanguineus*). In both cases, the possible human-induced greater food availability might be the main factor inducing a higher sociality, as can happen in several carnivores, e.g. the golden jackal *Canis aureus* (Macdonald, 1979). The difference in size and age between the two associated males found both by us and by Rood & Waser (1978) suggests that this association might result from natal philopatry.

In the present study the animals that moved least (M1 and M3) were also the ones that spent more time together. Accounts on the sociality of small carnivores are often based on sightings (e.g. Mills, Nel & Bothma, 1984) and travelling animals are more likely to be encountered; this could lead to an underestimation of the sociality of the Cape grey mongoose, as well as of other species.



We suggest that due to their social flexibility, this and other species of mongooses now labelled as solitary could prove as valuable as the more social ones to help understand the mechanisms of social evolution.

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