



ORIGINAL INVESTIGATION

**Behavioural ecology of the black mongoose (*Galerella nigrata*) in Namibia**

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**Abstract**

The black mongoose (*Galerella nigrata*) occurs in northern Namibia, where it occupies habitats dominated by large boulders (petrophily). Because of its restricted distribution, virtually nothing has been documented about its natural history. To fill this data gap, six males were radio-tracked in the foothills of the Erongo Mountains, Namibia in 2003. Although largely solitary, some home ranges overlapped nearly 100%. Males sometimes formed hunting diads similar to other congeners. The animals were diurnal and denned alone, using multiple sites haphazardly from night to night. The diet included many petrophilic vertebrates. The taxonomic status of the black mongoose is controversial; in addition to morphological evidence that it is a full species, it appears to be a habitat specialist compared with other forms of *Galerella* in southern African.

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**Introduction**

The south-western arid biogeographical region of Africa (Meester 1965) includes most of Namibia, in addition to a small portion of south-western Angola, western Botswana, and north-western South Africa. The Namibian portion of this region supports a high degree of biodiversity and endemism (Barnard 1998; Griffin 1998), including the black mongoose (*Galerella nigrata*). Thomas (1928) first described *G. nigrata* from the Ruacana area of Namibia, which is on the Kunene River that forms the border with Angola. Subsequent records and observations indicate that it is distributed in a long, thin band from the region of the Kunene River south

through the Kunene Region to the Spitzkoppe and Erongo Mountains in north-central Namibia (Mills and Bester 2005). Within this area, *G. nigrata* is restricted to habitats dominated by large boulders (petrophily), especially granite outcrops (Shortridge 1934; M. Griffin, pers. comm.; Cowley and Rathbun, unpublished data). These habitats are highly localized and widely scattered, presumably resulting in relatively small and isolated populations of black mongooses. However, little is known about its distribution or biology (reviewed by Mills and Bester 2005; Taylor, in press). When we discovered that black mongooses were relatively common in a series of granite outcrops in the foothills of the Erongo Mountains near Omaruru, Namibia (Rathbun et al. 2005), we initiated a preliminary radio-tracking study to learn more about this elusive and relatively rare carnivore; here we report our findings.

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## Material and methods

Our study was done in the vicinity of the Erongo Wilderness Lodge (21°27.679S, 15°52.523E) on Okapekaha Farm, about 10 km west of Omaruru. The site is 1240 m above sea level and is characterized by massive rounded granite dikes that rise up to 100 m above the surrounding peneplain and smaller 10–20 m high granite outcrops or kopjes surrounded by intruding fingers of surrounding bushveld (Fig. 1). The area is classified as semi-desert and savannah transition zone (Giess 1971), and is dominated by small trees and shrubs that include *Terminalia prunoides*, *Acacia erubescens*, *Acacia mellifera*, *Boscia albitrunca*, *Grewia* spp., *Combretum* spp., *Dichrostachys cinerea*, and *Dombeya rotundifolia*. Thickets often occur along riparian corridors and at the bases of kopjes, whereas intervening areas are more open woodlands with perennial and annual grasses and forbs.

Mean annual rainfall at Omaruru is 292.9 mm, with virtually all of this falling during the months of November through April. Annual minimum and maximum temperatures are 11.4–31.0 °C, with May through August being the coolest as well as driest months (Rathbun and Rathbun 2005).

We trapped seven black mongooses (Table 1) with single-door wire mesh Tomahawk live traps (25 × 25 × 70 cm). The first mongoose was accidentally captured (Rathbun et al. 2005) while trapping rodents with fresh apple as bait (Rathbun and Rathbun 2005, 2006). The remaining five males were captured in traps baited with dead feral pigeons (*Columba livia*) set within a 5 ha area near a dead kudu antelope (*Tragelaphus strepsiceros*) that the mongooses were using as a source of food (Rathbun et al. 2005). These traps were set mid-day and checked at dusk and the following dawn. The six mongooses



**Fig. 1.** Erongo Mountains study site, looking west, illustrating major habitats used by radio-tagged mongooses (see text), including kopjes or boulder outcrops, a barren granite slab, a thicket in the lower right corner of image below the granite slab, and intervening areas of woodland. Arrow is location of Erongo Wilderness Lodge, and the large kopje beyond and above the arrow is in the western end of mongoose 856 home range (Fig. 2). The area immediately beyond the large kopje (out of sight) is the vast rockless peneplain, which was virtually unused by black mongooses (see text).

were taken to a local veterinary facility in pillow cases, where they were sedated with intramuscular medetomidine hydrochloride and fitted with radio collars (Holohil Systems Ltd., Carp, Ontario, Canada; model MD-2C), before being returned to their capture sites (Rathbun et al. 2005). The seventh mongoose (a female) was trapped at the end of our study while unsuccessfully attempting to recapture the radio-collared mongooses near their den sites. She was kept as a voucher specimen and deposited with the Ministry of Environment and Tourism in Windhoek.

Only mongoose 856 was radio-tagged initially (Rathbun et al. 2005), and then we collared an additional five mongooses (Table 1). This sequence resulted in three periods for analyses: 15 May to 2 July 2003, 3 July to 28 September 2003, and the two combined. The radio-tracking effort was more intense during the 15 May to 2 July period (Table 2).

We determined radio-fixes by using triangulation and radio-location, as detailed in Rathbun et al. (2005), but consecutive records separated by less than 30 min were disregarded to reduce the effects of auto-correlation. On days that the mongooses were radio-tracked (Table 2), multiple (but variable) locations were determined, including denning sites. Minimum convex polygon (MCP) home range areas were determined with RANGES 6 software (Kenward et al. 2002), using the arithmetic mean option when 95% of fixes were used. Kernel analyses were not used because some radio-fixes that were known to be within each mongoose's home range were mistakenly not recorded in the field after 2 July 2003.

We used binoculars to opportunistically watch the tagged mongooses, but because of the secretive nature of the mongooses, and the potential to continually disturb the radio-tagged animals, we determined activity from the characteristics of radio signals and triangulation (Rathbun et al. 2005). The radio signals from active animals were highly variable in intensity compared to those from inactive animals because all the boulders in the study area (Fig. 1) interfered with the signals of active animals as they changed position and location.

## Results

### Habitat use

The radio-tagged mongooses focused their activities on granite kopjes, and drainages and woodlands connecting these outcrops (Fig. 1). Only once did a mongoose (856) venture about 200 m into the surrounding peneplain, along a small wash, for about 2 h. When the animals were located between rocky habitats they were travelling, usually along thicket-lined washes, whereas they hunted or denned in boulder-dominated habitats. When travelling across large (> 30 m) bare granite slabs, they usually trotted or bounded until some cover was reached. Based on 472 radio-fixes during the entire study period, the mean percentage of fixes for the five radio-tagged mongooses were 65% among boulders, 20% in washes and associated thickets connecting boulder habitats, 3% on open rock faces, and 4% in

**Table 1.** Traits of black mongooses (*Galerella nigrata*) captured at Erongo Mountains study site, Namibia, during 2003

ID	Sex	Weight (g)	Total length (mm)	Tail length (mm)	Fate
811	Male	750	660	330	Abandoned
856a	Male	907	690	342	Abandoned
883-1	Male	550	640	330	Shed transmitter
915	Male	850	700	360	Abandoned
948	Male	850	685	335	Shed transmitter
883-2	Male	750	690	320	Disappeared
–	Female	850	680	340	Voucher specimen

All but the female were radio-tagged. Abandoned = attempts to recapture and remove a radio collar failed; Shed transmitter = collar was shed and the mongoose disappeared, probably due to predation; Disappeared = both the mongoose and its collar inexplicably disappeared; Voucher specimen = deposited with the Namibian Ministry of Environment and Tourism, Windhoek.

**Table 2.** Home range (minimum convex polygon, MCP) characteristics of male black mongooses (*Galerella nigrata*) at Erongo Mountains, Namibia, study site

ID	Date captured and last tracked	No. of loci	Days tracked	95% MCP, ha	100% MCP, ha	Max. span, m	No. of dens	100% MCP dens, ha
811	2 July 2003 26 September 2003	62	25	50.83	53.63	1243	4	9.56
856a	15 May 2003 23 August 2003	305	46	144.94	190.86	2677	–	–
856b	15 May 2003 23 August 2003	49	17	68.45	82.01	1934	10	42.59
883-1	2 July 2003 22 August 2003	43	15	15.44	30.41	892	4	1.26
883-2	22 August 2003 24 August 2003	5	2	–	–	–	–	–
915	2 July 2003 25 September 2003	32	20	12.58	21.10	1043	4	0.73

See methods for an explanation why mongoose 856 data are split into two study periods (856a: 15 May to 2 July; and 856b: 3 July to 28 September). The number of night dens is for the 3 July to 28 September study period within 100% MCP home ranges, and the area covered by these dens is in the last column. Dashes = no data.

open woodland between or adjacent to boulder habitats and washes (Fig. 1).

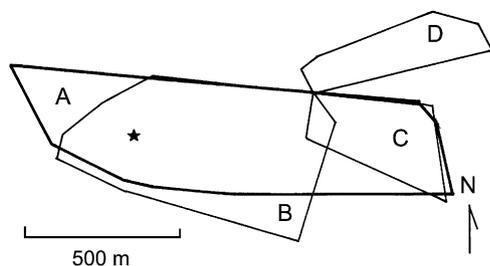
### Activity

The mongooses were diurnal. During 10 nights (3 July to 28 September study period), from 1 h after sunset to 1 h before sunrise, we continuously monitored the activity (radio signal quality and location by triangulation) of mongoose 856 and found that he was not active at night. We also determined the denning location (based on radio triangulations) of mongoose 856, during the 15 May to 2 July study period, after he entered a den at dusk and then the following morning at dawn. He changed sites only 2 out of 24 nights. The radio-tagged mongooses became active 1–2 h after sunrise and remained active until 1–2 h before sunset. Rarely, mongooses (856 twice and 833 once) did not leave their

den sites during an entire day and during several periodic radio-checks during the days they were inactive.

### Home range

We plotted the cumulative home range area against the number of location fixes for mongoose 856 during the 15 May to 2 July study period (Table 2) and determined that the asymptote of his 190.96 ha home range was reached at about 50 loci, whereas at 35 loci about 80% of the asymptote was accounted for. This indicates that our home range determinations for mongooses 883-1 and 915 may be about 20% smaller than if we had gathered at least 50 loci (Fig. 2, Table 2). Therefore, the four home range estimates (Table 2) are not strictly comparable, but nevertheless, several features are still of interest. The mongooses did not maintain exclusive home ranges or defend these areas



**Fig. 2.** Minimum convex polygon home range boundaries for radio-tagged black mongooses (Table 2) at Erongo Mountains study site using 95% of loci during 3 July to 28 September 2003 study period. Star = location of Erongo Wilderness Lodge (see Fig. 1). The area north of the home ranges is rockless peneplain (see Fig. 1 and text). Mongoose identifications: *A* = 856, *B* = 811, *C* = 883-1, and *D* = 915. Overlap data are shown in Table 3.

**Table 3.** Home range overlap (Fig. 2) by four radio-tagged black mongooses at Erongo Mountains, Namibia, study site based on 3 July to 28 September 2003 study period (Table 2)

Mongoose no.	811	856	883	915
811	–	100	3.5	0
856	35.6	–	10.3	1.0
883	11.1	93.0	–	0
915	0.1	12.1	0	–

Animals in rows are overlapped (%) by those in columns.

as territories. Indeed, home range overlap spanned from 0% to 100% and the largest home range (mongoose 856) was overlapped by the other three, but there was not necessarily overlap among the three (Table 3).

## Denning

Mongooses used crevices and small caves among boulders as nocturnal den sites, and there was no evidence of nesting material in those that we examined. The radio-tagged mongooses used more than one den each; mongoose 856 had the largest home range and also the most dens (Table 2). However, the dens were not used in equal frequency. For example, during the entire study period mongoose 856 used 30 different den sites and three of these were used six times each, two twice each, and the rest once. We found several small piles of faeces (probably representing one or two defecations each) within a few metres of the most frequently used dens, but otherwise the sites were unremarkable. During the 3 July to 28 September study period, two of the four mongooses (856 and 883-1) used the same den site three times each, but not concurrently. The home range of mongoose 856, which was the largest of the four (Table 2), overlapped 883-1 by 93% (Table 3), but a large overlap did not mean mutual den use (i.e., 811 was

overlapped 100% by 856, but they never used the same den sites). The only pattern discernable for den site distribution was that the mongooses with the larger home ranges had dens distributed most widely. For example, the 100% MCP home range of each mongoose (Table 2, 3 July to 28 September study period) was overlapped by the area encompassed by each 100% MCP of den sites by 51.9% for 856, 44.1% for mongoose 811, 4.1% for 883-1, and 3.5% for 915.

## Social behaviour

During the 3 July to 28 September study period, mongoose 811 was observed travelling or foraging in close association with another untagged mongoose in two of eight visual sightings, and similarly 856 was seen hunting with another mongoose during two out of nine sightings. As the animals moved and foraged among boulders, the lead was rotated by members of a diad, with no sign of dominance. Our impression was that they were hunting cooperatively – one mongoose opportunistically flushing prey for the other.

We observed two instances of dominance between mongoose pairs, where a smaller animal was submissive to a larger individual by attempting to crawl underneath the abdomen of the larger mongoose and rolling on its back with all four legs in the air. In one case the larger mongoose occasionally nudged the smaller one with its nose. On both occasions it was only possible to sex one of the individuals; the larger mongoose was a male in one instance, and in the other the smaller mongoose was a male.

Potential scent marking behaviour that we observed included urination, defecation, and throat-chest rubbing, but we did not see marking with cheeks or anal glands. During urination, a lone mongoose stopped walking several times every 4–5 steps and carefully sniffed a small object on the ground before urinating on it, and then proceeding to the next object. Urination was not accompanied by a squat, but rather lowering the entire body. When we closely inspected these sites the urine was extremely concentrated and resembled thick syrup. During defecation individuals squatted like a dog, but faeces were not accumulated in latrines at single sites. On two occasions, we observed mongooses persistently rubbing their throat and chest on the edges of a rock for nearly 15 min, presumably depositing scent gland products, although we found no sign of any secretions.

We observed single black mongooses basking in the early morning sun on several near-freezing mornings. The basking was associated with auto-grooming, including licking the abdominal, peri-anal and tail region. We never observed allo-grooming.

## Predator–prey behaviour

Black mongooses fed on a wide range of prey items. Once, we watched mongoose 811 unsuccessfully stalk a group of rock hyraxes (*Procavia capensis*), which became visibly agitated while giving alarm calls, but they did not bolt for cover. The larger hyraxes positioned themselves prominently in view of the mongoose. We observed the same mongoose attempt to capture a redbilled francolin (*Francolinus adspersus*). As in the case of the hyraxes, the mongoose sniffed small insignificant close-by objects while slowly approaching the bird. Eventually, the mongoose chased the francolin, which reacted with loud alarm calls and flew into a nearby *Combretum imberbe* tree. The mongoose climbed the tree in pursuit with no difficulty, but the francolin flew off. Robert Simmons (pers. comm.) reported that guinea fowl (*Numida meleagris*) have been successfully captured by black mongooses, and mongooses elicit alarm calls and mobbing by fork-tailed drongos (*Dicrurus adsimilis*) and African paradise flycatchers (*Terpsiphone viridis*). During a study of colour-ringed white-tailed shrikes (*Lanioturdus torquatus*) at our study site, Robert Simmons (pers. comm.) found a surprisingly low nesting success, which we speculate was due to black mongoose predation. One faecal pellet that we found near a black mongoose den caught our eye because of protruding rosy-faced lovebird (*Agapornis roseicollis*) feathers.

We suspect that predation was responsible for the sudden disappearance of one of our tagged animals (883-2), and collar loss from two others (Table 1). The collar from mongoose 948 was found badly damaged in a thicket about 5 m from his capture site, but still transmitting, and the collar from mongoose 883-1 was found in perfect condition in very thick vegetation about 500 m outside the animal's home range. Although no carcasses were found with these transmitters, the collars cannot be shed over the head nor removed without wire cutters, which suggests raptor predation. Indeed, we observed two unsuccessful attempts by large unidentified hawks to capture mongooses crossing open habitats.

## Discussion

The taxonomy of the genus *Galerella* in southern Africa has a confusing history (reviewed by Bronner et al. 2003; Mills and Bester 2005; Wozencraft 2005; Taylor, in press). Based on these reviews, there are three species of *Galerella* in southern Africa: the slender mongoose (*G. sanguinea*), the Cape grey mongoose (*G. pulverulenta*) and the Kaokoland mongoose (*G. flavescens*). These authors consider the black mongoose (*G. nigrata*) to be the same as *G. flavescens*, based largely on Crawford-

Cabral (1996), and refer *nigrata* to *flavescens* because of priority (Crawford-Cabral 1989).

We believe that the mongoose we studied is referable to *G. nigrata*, which is probably a different species than *G. flavescens*, which is found in extreme south-western Angola. This is based on past morphological studies (Watson and Dippenaar 1987; Taylor and Goldman 1993; Taylor and Matheson 1999), the occurrence of black (*nigrata*) and chestnut-coloured (*flavescens*) forms in the Kunene River area that are apparently spatially segregated with no intermediate colour forms (Shortridge 1934; Crawford-Cabral 1996), and the apparent absence of *flavescens* forms in Namibia. In addition, there is no rigorous taxonomic study of the two forms that supports conspecific status. Although Crawford-Cabral (1996) is often cited as the authority for combining the two forms, this study focused on *G. flavescens* and *G. sanguinea* and includes few identifiable comparative data or analyses on *flavescens* and *nigrata*. Lastly, the ecology of the two may be different (Shortridge 1934; Rathbun 2004; this paper), although virtually nothing is known about the behavioural ecology of *G. flavescens*. Based on the locations of *G. flavescens* specimens in Crawford-Cabral (1996), however, we surmise that this mongoose is not as closely associated with habitats dominated by granite boulders as *G. nigrata*.

Our observations support the literature (Shortridge 1934) that indicates black mongooses are closely associated with habitats dominated by large boulders. Behaviourally and morphologically, *G. nigrata* appears to be a habitat specialist. For example, the black colouration camouflages them while they hunt in the deep shadows of boulders (Rathbun 2004). As with other Namibian rupicolous (rock-dwelling) mammals (Rathbun and Rathbun 2005), their diet is closely tied to their habitat. For example, nokis or dassie-rats (*Petromus typicus*) and Namibian rock agamas (*Agama planiceps*) are common obligate boulder-dwellers that are eaten by black mongooses (Cowley and Cunningham 2004; Rathbun and Rathbun 2006). Both prey species are strictly diurnal and become fully active only after the sun rises, as is true of many other diurnal rupicolous prey. Similarly, adult flies (Sarcophagidae) attracted to rotting carcasses are probably an important (although ephemeral) source of food (Rathbun et al. 2005), but again only during the heat of the day. Many mongoose prey species bask before becoming fully active, which may partially explain why black mongooses are only active after sunrise and before sunset. It is not clear why the radio-tagged mongooses occasionally were inactive during an entire day, unless a particularly successful hunt was followed by a day of rest.

Denning patterns in mammals are highly variable, from species that do not use sheltering sites at all, such as many large antelopes, to those that occupy only

a single site, like most rodents. However, there are also many mammals that use multiple shelters from day to day. These fall into two categories: those that use temporary sites, such as chimpanzees (*Pan troglodytes*; Plumptre and Reynolds 1997), and those that repeatedly use several permanent sites in a haphazard order, such as golden-rumped sengis (*Rhynchocyon chrysopygus*; Rathbun 1979) and the black mongooses that we radio-tracked. It has been suggested that the haphazard use of several permanent sites may be related to preventing potential predators from predicting den locations (Rathbun 1979). Additionally, in the case of those black mongooses that have relatively large home ranges, conserving energy by not travelling relatively long distances to a single site every night may be an important factor. There may be other factors involved, such as avoiding parasite build-up associated with few permanent den sites. However, the comparatively small number of dens for the radio-tagged mongooses with the smallest home ranges favours the energy conservation hypothesis.

Our observations represent the only information on the behavioural ecology of *G. nigrata*, and there are no similar published data on *G. flavescens* for comparison. However, comparisons with other *Galerella* species are possible. Our data suggest that the large overlap in home ranges between some males and the occasional association between hunting pairs of presumed males are similar to *G. pulverulenta* (Cavallini and Nel 1990, 1995) and *G. sanguinea* (Rood and Waser 1978; Rood 1989), indicating that the social structure of the black mongoose is probably similar to the largely solitary system found in these congeners. However, Rood (1989) suggests that at least some of the cases of highly overlapping male home ranges and loose male groups in “solitary” mongooses may be related to unusually abundant food supplies, which probably occurred during our study in association with a dead kudu antelope (Rathbun et al. 2005) as well as unintentional provisioning at an ecotourism lodge (Rathbun and Rathbun 2006). Overall, however, our understanding of the social organization of black mongooses is poor because we were unable to trap any females at the beginning of our study. Nevertheless, the presumed solitary denning habits that we found, and the aggressive intra-specific behaviour described by Rathbun et al. (2005) in association with a temporarily abundant source of food, indicates that black mongooses are not highly social as in the dwarf mongoose, *Helogale parvula*; banded mongoose, *Mungos mungos*; and suricate, *Suricata suricatta* (Estes 1991).

Large hawks and eagles are known to prey on diurnal mongooses (Rood 1990; Maclean 1993), and in addition to our observations of unidentified large raptors stooping on black mongooses, Rathbun (2004) reported an attempt by an African hawk eagle (*Hieraaetus spilogaster*)

to capture an un-collared black mongoose crossing a large granite slab at Erongo. These observations, plus the behaviour of mongooses in open habitats, further support the hypothesis that the colouration of black mongooses is highly adaptive and probably related to their petrophily (Hoesch 1956; Rathbun 2004).

Although there are still large gaps in our knowledge of black mongoose behavioural ecology, especially related to females, we know that several features of its natural history indicate that it is an obligate petrophile. We hope that taxonomists will take this into consideration as they further explore the poorly understood phylogenetic relationships of the different forms of *Galerella* in southern Africa.

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## Zusammenfassung

### Verhaltensökologie der Schwarzmanguste (*Galerella nigrata*) in Namibia

Die Schwarzmanguste (*Galerella nigrata*) kommt im nördlichen Namibia vor. Ihr Lebensraum zeichnet sich durch große Felsbrocken aus. Aufgrund ihres beschränkten Verbreitungsgebietes und ihrer Vorliebe für Felsen, wurde praktisch fast nichts über ihre Biologie dokumentiert. Um diese Datenlücke zu füllen, wurden 2003 sechs Männchen in den Ausläufern des Erongo-Gebirges in Namibia besendet. Obwohl sie nahezu solitär leben, überlappten ihre Streifgebiete fast 100%. Zur Jagd formierten sich die Männchen, ähnlich wie andere Angehörige dieser Gattung, manchmal in Zweier- oder Dreiergruppen. Die Tiere waren tagaktiv und zogen sich allein in Höhlen zurück, die sie willkürlich von Nacht zu Nacht wählten. Die Nahrung umfasste viele petrophile Wirbeltiere. Die taxonomische Stellung der Schwarzmanguste ist kontrovers, aber ergänzend zu ihrer morphologischen Erscheinung als eigene Art,

scheint sie im Vergleich zu anderen *Galerella*-Formen des südlichen Afrika auf einen bestimmten Lebensraum spezialisiert zu sein.

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