

Spatial organization of the yellow mongoose *Cynictis penicillata* in a coastal area

PAOLO CAVALLINI¹

John Ellerman Museum, Department of Zoology, University of Stellenbosch, Stellenbosch 7600, South Africa

Received 4 May 1992, accepted 9 December 1992

Yellow mongooses (*Cynictis penicillata*) were observed from March to May 1991 in the West Coast National Park, Cape Province, South Africa. Twelve mongooses out of a population of 16-19 individuals were captured and marked. Of those, seven adults were radio-tracked. Mongooses were diurnally active and frequented short-grass fields. Home ranges of males were about 4 times as large as those of females and encompassed those of several females. Overlap was substantial also within sexes, but females based in different dens had nonoverlapping ranges. This pattern differs substantially from that previously reported for this species. Possible reasons for this are discussed.

KEY WORDS: mongooses, *Cynictis penicillata*, home range, behaviour, ecology.

Introduction	501
Study area	502
Material and methods	502
Results	503
Discussion	506
Acknowledgements	508
References	508

INTRODUCTION

Mongooses (Carnivora Herpestidae) are a large group (36 species; HONACKI et al. 1982), characterized by a high diversity in ecology and social behaviour. Attempts to draw correlations between these two aspects have been partially frus-

¹ Present address: Dipartimento di Biologia Evolutiva, Università di Siena, Via P.A. Mattioli 4, 53100 Siena, Italy.

trated by the lack of relevant data for most species. It is therefore important to collect basic data on the social behaviour and ecology of as many species as possible. Available data indicate that the group-living mongooses are probably all diurnal and insectivorous, while the solitary ones are nocturnal and/or predators of vertebrate (ROOD 1986). A few species (*Galidia elegans*, *Mungotictis decemlineata*, *Galidictis fasciata*, *Salanoia concolor*, and *Cynictis penicillata*) show an intermediate degree of sociality, called "pair?" by ROOD (1986), because "the male is an important part of the social unit". However, the social unit of these species might be more complex than a family. Studies on these "pair?"-living mongooses may therefore prove especially fruitful for shaping and testing theories on the evolution of social behaviour and its ecological correlates, as they might be in the first stages of this process (ROOD 1986). The yellow mongoose, *Cynictis penicillata* is generally referred to as mostly insectivorous, open area-dwelling, and diurnal (ZUMPT 1968, HERZIG-STRASCHIL 1977, ROWE-ROWE 1978, DU TOIT 1980, LYNCH 1980, EARLÈ 1981, STUART 1981, SHEPHERD et al. 1983, MacDONALD & NEL 1986, all reviewed by SKINNER & SMITHERS 1990, CAVALLINI in press). However, most of these papers are fairly qualitative and/or based on small sample sizes. This paper discusses home range size and overlap, and aspects of the social system of the yellow mongoose, in relation to some 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 and 193 m a.s.l.). The climate is mediterranean. Average monthly temperatures (max, min) range from 14.6 and 8.7 °C in July to 21 and 13.2 °C in February. Annual precipitation at Langebaan village (ca 2 km east) averages 253 mm, almost all in winter (May to September; WEATHER BUREAU 1965). During summer, aridity is mitigated by morning dew. Most of the area is covered by bush, but some areas (totalling 267 ha, over the whole study area of about 1500 ha), cultivated until 1969, are covered by short (\leq 10 cm) grass (70-80% cover), where the most common plant species are *Oncosiphon suffruticosum*, *Arctotis hirsuta*, *Cenia duckittae*, *Dimorphotheca pluvialis* (A. CRAVEN, Botany Department, University of Stellenbosch, pers. comm.). The succession towards bush is slowed down by grazing of autochthonous and introduced ungulates (see AVERY et al. 1990 for a checklist). In these areas, the soil is sandy and calcareous. For further details, see BOUCHER & JARMAN (1977) and CAVALLINI & NEL (1990).

MATERIAL AND METHODS

After an extensive survey over the whole Reserve (February-March 1991), in which most of the dens were located, nine single-door wire mesh traps (25 × 25 × 90 cm) were set close to three dens (A, B and C in Fig. 1). Either commercial catfood, or a mixture of blood, fish and meat, or live striped mice (*Rhabdomys pumilio*) were used as bait. The traps were checked 3 times a day, and the captured mongooses anaesthetized with ketamine hydrochloride (Ketalar, Parke-Davis) at doses of about 15 mg/kg. They were sexed, weighed and

marked, and seven were fitted with radio-collars. Toothwear was also recorded. Animals weighing less than 700 g were regarded as juveniles (STUART 1981) and were not used for radio-tracking studies. Mongooses were then radio-tracked between March and May 1991, one animal per day (focal animal sampling; ALTMANN 1974), from before sunrise (6:30-7:00) until sunset (19:00-19:30). A Yaesu FT 290 RII receiver (Yaesu Musen Co., Ltd, Tokyo) and a hand-held Alcock antenna were used for tracking. Transmitters were constructed locally. Complete radio-collars weighed < 30 g, i.e. < 4% of total body weight. Mongoose locations and activity were recorded every 15 min, and individuals were observed (through 7 × 42 Leitz binoculars or 15-60 × 60 Tasco telescope) whenever possible. The area within 50-200 m (according to visibility conditions) from the focal animal was scanned and the number, location and activity of other (collared and uncollared) mongooses also recorded at 15 min intervals. The habitat was also recorded. Tracking was usually done from > 200 m from the focal animal, to avoid influencing its movements. Accuracy of fixes was estimated from observations and field tests to be within 25 m. Since none of the current measures of home range size is free of problems (e.g. HARRIS et al. 1990), four methods were used to calculate home range size: minimum convex polygon (hereafter MCP; SOUTHWOOD 1966); a modified MCP excluding the 5% of fixes furthest from the harmonic centre (hereafter 95 MCP); 95% harmonic mean (hereafter HM; DIXON & CHAPMAN 1980, with the SPENCER & BARRETT 1984, modification); and 95% kernel method (hereafter KE; WORTON 1989), with a 1.0 smoothing factor. Both harmonic mean and kernel analyses were run with a 40 × 40 grid. Core areas were calculated with the harmonic mean (50% isopleth). The number of fixes needed to calculate home-range size was calculated by plotting range size vs number of locations (fixes added sequentially, as appropriate for continuous data; HARRIS et al. 1990). The resting locations of mongooses were excluded from the home range analyses to avoid overestimating the importance of resting sites in the home range use pattern. The effect of the dependency of fixes on range size was weak and inconsistent (P. CAVALLINI unpublished data). Therefore, all fixes were used in all the home range analyses. Overlap was evaluated using the average of the percentage of overlap of range B on A and of A on B. To evaluate the spatial relationships between individuals occupying the same range, on 6 days two animals were followed simultaneously. The observed distances between the two mongooses were compared with the expected ones (as calculated from permutations; see KENWARD 1987, and CAVALLINI & NEL 1990). All occurrences of defaecations were recorded, and ranges of the study mongooses were searched for faeces by walking along random transects (totalling about 10 km). Nonparametric tests (SIEGEL 1956) were used: Spearman rank correlation (hereafter S), Mann-Whitney U test (hereafter M), and the Chi-square test (hereafter C).

RESULTS

Twelve yellow mongooses were captured or recaptured 18 times (Table 1); seven were fitted with radio-collars. No other species was captured. Trapping success was very high with the live bait (usually one mongoose was captured at each den in the 1st day of every trapping session), but was zero with all other baits. The radio-collared animals, when recaptured, did not show any loss of weight or chafing around the neck. The maximum number of mongooses sighted or trapped at each den (see Fig. 1 and Table 1) was: three at den A (1F, 2M and an uncollared juvenile); seven at den B (3F, 2M, 5F, 7M, 9M, 10M, 12F); seven at den C (4F, 6M, 8F, 11M, and three uncollared); four at den D (7M and three uncollared); and one at den E (6M). The total population size in the area studied was therefore between 16 and 19 individuals. This gives a minimum absolute density of 1.1-1.3 individuals/100 ha, and a minimum ecological density (considering only the old fields as suitable habitat, see below) of 6.0-7.1 individuals/100 ha. Altogether 2260 daytime locations of the radio-collared animals were obtained, of which 87.9% were of

Table 1.
Yellow mongooses trapped in the West Coast National Park (March-May 1991).

No.	Sex	Weight (g)	Tooth-wear ¹	Capture den ²	No. of captures	Notes
1	F	880	M	A	2	Collared
2	M	1000	H	B	2	Collared
3	F	830	M	B	1	Collared
4	F	900	S	C	1	Collared
5	F	650	S	B	2	Uncollared. Recaptured (15.V.1991: 770 g)
6	M	1000	M	C	2	Collared. Died (28.IV.1991), prob. killed by caracal
7	M	830	S	B	1	Collared. Died (5.4.91) in den (unknown causes)
8	F	780	S	C	1	Collared
9	M	860	M	B	2	Uncollared
10	M	900	M	B	2	Uncollared
11	M	810	VS	C	1	Uncollared. Abdominal testes
12	F	520	MT	B	1	Uncollared

¹ MT = milkteeth; VS = very slight; S = slight; M = medium; H = heavy. ² See Fig. 1.

active individuals. Of the active locations 67.8% were obtained by direct observation. One of the ranges reached an asymptote at 100 fixes (6M), one at 170 (8F), one at 200 (3F), one at 270 (2M), and one at 280 (1F). Two of the ranges (4F and especially 7M) were therefore likely to be not fully described by the MCP method. Over 99% of all locations were in old fields. Mongooses were located in bushy areas only when they moved quickly from one field to another, or when making short forays from the edges of the fields. The relative agreement in home range size using the four computational methods was good (S, $rs > 0.82$, $P < 0.045$, $n = 7$; Table 2). The 95 MCP range sizes of males were almost equal to the MCP ones, indicating an absence of occasional excursions; those of females were 23% smaller on average. Male ranges were larger than those of females (M, $P < 0.05$, $n_1 = 3$, $n_2 = 4$; on average, 4 times larger), and included the ranges of several females. The movements of two males (6M and 7M) between different fields caused the MCP range to include large unused bushy areas. The range of the old male (2M) included less than 15% of unused areas. On the other hand, both the HM and the KE 95% isolines for males and females "ballooned" outside the areas actually used by mongooses, and included extensive bushy areas. Therefore MCP was used for presentation. Mean overlap among females that frequented the same den (4F + 8F) was very high (MCP: 75.4%; HM: 76.1%; KE: 77.7%), even for core areas (59%). Females from different dens (1F and 3F) had contiguous but nonoverlapping ranges (MCP: 2.4%; HM: 4%; KE: 4.4%; core area: 0%; Fig. 1), suggesting some form of territoriality among females. However, serious aggression was never observed, and trapped animals had no visible scars, suggesting that fighting was rare in this population. Two of the males (2M and 7M) had overlapping ranges (MCP: 38.2%; HM:

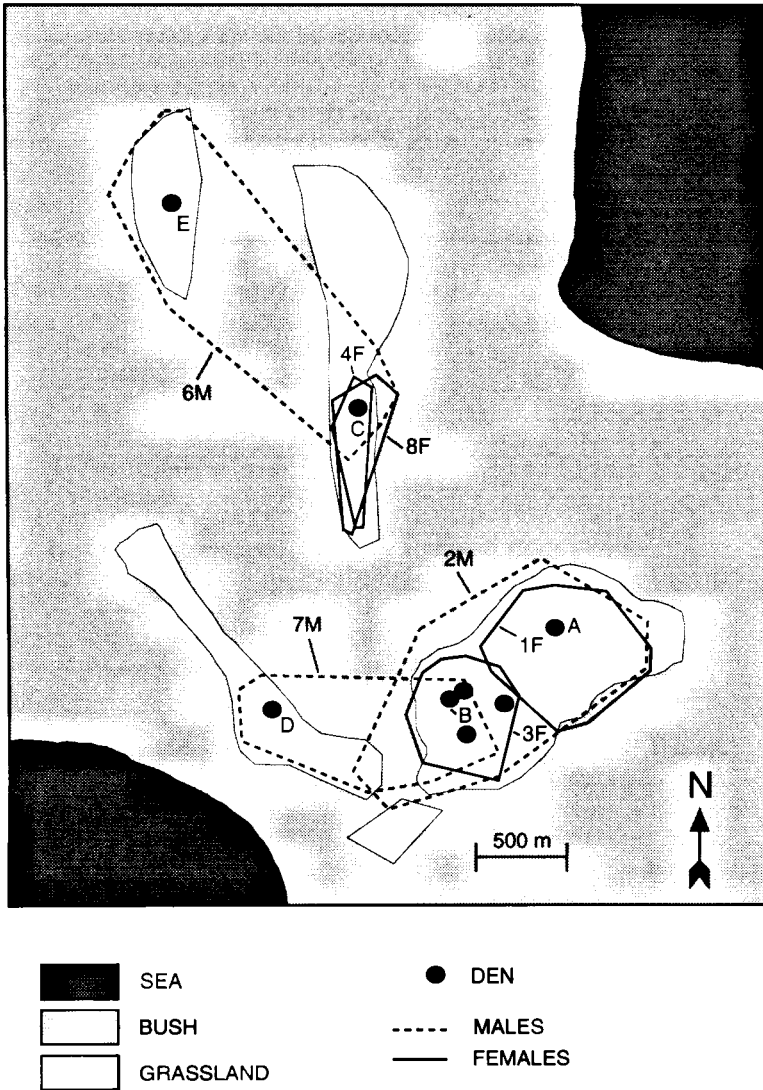


Fig. 1. — Home ranges (minimum convex polygon, SOUTHWOOD 1966) of seven yellow mongooses in the West Coast National Park, South Africa.

17.2%; KE: 26.4%), but nonoverlapping core areas. There was no correlation between the percentage of daily range overlap and the time elapsed between two samples ($S, r_s > -0.18, P > 0.43, 37 > n > 6$). Home ranges were therefore stable, at least during the study period. The only exception was 2M, who shifted his range. At first he was based mainly at den A, then later on at den B; in this case the correlation was negative (i.e., the further apart the tracking days, the less the relative daily ranges overlapped; $S, r_s = -0.35, P = 0.019, n = 45$).

Table 2.

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 1.

No.	Total no. of active fixes	Home range size				Kernel analysis 95%
		Minimum convex polygon		Harmonic mean		
		100%	95%	95%	50%	
1F	420	49.3	38.9	40.9	10.2	36.9
2M	489	118.9	118.9	110.3	33.8	93.8
3F	435	30.6	21.1	22.5	7.1	23.2
4F	135	10.5	8.0	29.5	1.6	12.2
6M	387	121.6	109.4	93.0	12.3	108.7
7M	119	65.6	65.6	50.1	14.1	60.3
8F	342	18.3	15.3	23.3	3.1	16.0

Only rarely did study animals use their home ranges in a patchy way: in 35 instances (over 565 observation hours) a collared mongoose remained within a 25-m radius for more than 30 min, and only 6 times an animal stayed for more than 1 hr. In 2 days, a female (3F) remained alone in the same patch for 3.45 and 4 hr. Subsequent examination of the patch revealed numerous small (< 5 cm) diggings.

The mongooses from each den did not move together as a pack, but in 4 out of 6 days (always the pair 1F-2M) the animals stayed significantly closer than expected ($C, P < 0.05$). On the other 2 days (2M-3F and 3F-7M), distances apart were not different from random ($C, P > 0.10$). The movements of uncollared mongooses were often correlated with those of collared ones, especially in the morning, when all the animals emerged from the den at approximately the same time and started foraging in the same direction. In the evening, they came back to the same den (CAVALLINI in press). No difference was noted between the behaviour of collared and uncollared animals; in both cases, auto- and allogrooming was very rarely observed. Females used only one den (one or more holes in a 50 m radius), located within 50 m from the harmonic mean activity centre. Only 3F moved frequently between four dens, 100-350 m apart. Males, on the other hand, all used more than a den, often located in different fields, and separated by up to 1600 m (6M). Defaecations ($n = 15$) occurred only at dens, and correspondingly faeces were found only in large (> 50) clumps (latrines), close to den entrances.

Predation pressure could not be assessed. However, one of the collared mongooses was found dead, probably killed by a caracal (*Felis caracal*). No attacks from birds of prey were observed. On two occasions, yellow mongooses mobbed a Cape fox (*Vulpes chama*) and a Cape grey mongoose (*Galerella pulverulenta*; a similar-sized animal; CAVALLINI & NEL 1990), causing it to leave the field.

DISCUSSION

Groups of female yellow mongooses (possibly territorial) in Postberg Nature Reserve were based in different dens, while males (not territorial) frequented more than one den, and therefore more than one group of females. This confirms the

suggestion of ROOD (1986) that the social units of *Cynictis* may be more complex than a simple family unit. The only published study on the social behaviour of the yellow mongoose (EARLÈ 1981) describes a system of group territories defended by both males and females, in which the territory was coincident with the home range. This contrasts strikingly with the findings of the present study (large range overlap between neighbouring males, home ranges of males much larger than those of females). The sexual dimorphism of home ranges is more reminiscent of the pattern typical of many carnivores (e.g. POWELL 1979). The male-male overlap is less common in the order Carnivora, but is reported for other Herpestidae [e.g. *Herpestes auropunctatus*: GORMAN 1979; *Galerella* (= *Herpestes*) *pulverulenta*: CAVALLINI & NEL 1990]. Furthermore, the average home range size in the present study was much larger than that found by EARLÈ (1981: 5-6 ha), while the colony size followed an opposite trend: 1-7 individuals per den vs an average of 8 individuals per colony (EARLÈ 1981). The regular border patrolling described by EARLÈ (1981) was not recorded in the present study. Also the distribution of the latrines was quite different: only around the dens in the present study, along the borders of territories in EARLÈ (1981). The different data collection techniques (direct observation vs radio-tracking) might explain part of the discrepancies (e.g. quick movements outside the usual range may be missed without the use of radios). Other factors, however, may be more important. The presence of a garbage tip in EARLÈ's study area may have influenced the social structure of the yellow mongooses he observed. Such an abundant and clumped food source allows in the golden jackal, *Canis aureus*, a shrinking of home ranges, the delimitation of territory borders through communal latrines and the patrolling of borders (MACDONALD 1979). Related to an increase in the food resources, as well as to limited emigration opportunities, mongoose density in EARLÈ's (1981) study area (133-200 individuals/100 ha, according to different methods of calculation) was far higher than in the present one (6-7 individuals/100 ha). The higher density make territorial defence more profitable, or even necessary, through an increased intruder pressure (GILL & WOLF 1975). Home range sizes found in the present study are small when compared to previous anecdotal reports: "600-3000 m in radius" (i.e. less than 113-2800 ha) in the arid South African central plateau (ZUMPT 1982); "up to 1.3 km from the burrows" (i.e. less than 530 ha; STUART 1981). Also in this species therefore, as in many other carnivores (MACDONALD 1983), differences in food resources and population density appear to underlie a considerable flexibility in the spatial and social systems.

Insectivory has been suggested to allow group formation in the mongooses (ROOD 1986), and *Cynictis* conforms to this general trend, being mainly insectivorous and comparatively social. It is not clear, however, what factor is causing the observed sociality. For *Helogale parvula*, predation pressure, especially by birds of prey, appears to be the major drive towards sociality (RASA 1987). For *Cynictis*, predation from the air seems to be less important, at least in my study area, while ground predators and competitors may have an influence. The patchy distribution of at least some food resources (e.g. termites; WILSON & CLARK 1977) might be an important factor leading to the observed range sharing, as in the European badger (KRUUK 1978). The collared mongooses, however, did not often use their home ranges in a patchy way. The scarcity of den sites (promoting sociality in *Ichneumia albicauda*; WASER & WASER 1985) does not seem important in this case. In fact, the soil in Postberg Nature Reserve is very loose, and the yellow mongoose is an "avid digger" (EARLÈ 1981, pers. obs.); furthermore, a female (3F) and its group had four dens available, but the whole group used only one of them per night.

A limit to the increase of sociality in this species may be direct competition over food. In fact, in one of four observed cases of predation on rodents, a mongoose attempted to steal from the owner of the prey. Although rodents are a secondary food source for *Cynictis*, disputes over food disrupt social behaviour, forcing individuals to forage alone. A comparison of social systems between populations with different percentages of vertebrates in their diet is needed to test this hypothesis.

ACKNOWLEDGEMENTS

I wish to thank: the Trustees of the New Moorgate Trust Fund for the award of a John Ellerman Scholarship, which made this study possible; Prof. J.A.J. Nel (Department of Zoology, University of Stellenbosch) and Prof. R. Dallai (Dipartimento di Biologia Evolutiva, Università di Siena) for kindly providing facilities; the Oude Post Syndicate and the National Parks Board for permission to work in the West Coast National Park; D. Mostert, A. Craven, and especially N.L. Avenant for help both in the field and in the laboratory; F. Di Fuccia and P. Pisino for drawing the figure. J.A.J. Nel, S. Lovari, O.A.E. Rasa, H. Kruuk and M.E. Taylor kindly spared the time to read the manuscript making useful comments on it.

REFERENCES

- ALTMANN J. 1974. Observational study of behaviour: sampling methods. *Behaviour* 49: 227-267.
- AVERY D.M., RAUTENBACH I.L. & RANDALL R.M. 1990. An annotated check list of the land mammal fauna of the West Coast National Park. *Koedoe* 33: 1-18.
- BOUCHER C. & JARMAN M.L. 1977. The vegetation of the Langebaan area, South Africa. *Transactions of the Royal Society of Southern Africa* 42: 241-288.
- CAVALLINI P. (in press). Activity of the yellow mongoose *Cynictis penicillata* in a coastal area. *Zeitschrift für Säugetierkunde*.
- CAVALLINI P. & NEL J.A.J. 1990. Ranging behaviour of the Cape grey mongoose *Galerella pulverulenta* in a coastal area. *Journal of Zoology, London* 222: 353-362.
- DIXON K.R. & CHAPMAN J.A. 1980. Harmonic mean measure of animal activity areas. *Ecology* 61: 1040-1044.
- DU TOIT C.F. 1980. The yellow mongoose *Cynictis penicillata* and other small carnivores in the Mountain Zebra National Park. *Koedoe* 23: 179-184.
- EARLÈ R.A. 1981. Aspects of the social and feeding behaviour of the yellow mongoose *Cynictis penicillata* (G. Cuvier). *Mammalia* 45 (2): 143-152.
- GILL F.B. & WOLF L.L. 1975. Economics of feeding territoriality in the golden-winged sunbird. *Ecology* 56: 333-345.
- GORMAN M.L. 1979. Dispersion and foraging on the Small Indian mongoose, *Herpestes auropunctatus* (Carnivora: Viverridae) relative to the evolution of social viverrids. *Journal of Zoology, London* 187: 65-73.
- HARRIS S., CRESSWELL W.J., FORDE P.G., TREWHELLA W.J., WOOLLARD T. & WRAY S. 1990. Home-range analysis using radio-tracking data — a review of problems and techniques particularly as applied to the study of mammals. *Mammal Review* 20 (2/3): 97-123.
- HERZIG-STRASCHIL B. 1977. Notes on the feeding habits of the yellow mongoose *Cynictis penicillata*. *Zoologica Africana* 12 (1): 225-229.
- HONACKI J.H., KINMAN K.E. & KOEPL J.W. 1982. Mammal species of the world: a taxonomic and geographic reference. *Lawrence: Allen Press*.
- KENWARD R. 1987. Wildlife radio tagging. *London: Academic Press*.

- LYNCH C.D. 1980. Ecology of the suricate, *Suricata suricatta* and yellow mongoose, *Cynictis penicillata* with special reference to their reproduction. *Memoirs van die Nasionale Museum Bloemfontein* 18: 1-218.
- KRUUK H. 1978. Spatial organization and territorial behaviour of the European badger *Meles meles*. *Journal of Zoology, London* 184: 1-19.
- MACDONALD D.W. 1979. Flexibility of the social organization of the golden jackal, *Canis aureus*. *Behavioral Ecology and Sociobiology* 5: 17-38.
- MACDONALD D.W. 1983. The ecology of carnivore social behaviour. *Nature, London* 301: 379-384.
- MACDONALD J.T. & NEL J.A.J. 1986. Comparative diets of sympatric small carnivores. *South African Journal of Wildlife Research* 16 (4): 115-121.
- POWELL R.A. 1979. Mustelid spacing pattern: variations on a theme by *Mustela*. *Zeitschrift für Tierpsychologie* 50: 153-165.
- RASA O.A.E. 1987. The dwarf mongoose: a study of behaviour and social structure in relation to ecology in a small, social carnivore. *Advances in the Study of Behavior* 17: 121-163.
- ROOD J.P. 1986. Ecology and social evolution in the mongooses, pp. 131-152. In: Rubenstein D.I. & Wrangham R.W., Edits. Ecological aspects of social evolution. Birds and mammals. *Princeton, N.J.: Princeton University Press*.
- ROWE-ROWE D.T. 1978. The small carnivores of Natal. *The Lammergeyer* 25: 1-48.
- SHEPHERD A.J., LEMAN P.A. & HARTWIG E.K. 1983. Analysis of viverrid scats from the northern Orange Free State. *South African Journal of Zoology* 18 (4): 400-401.
- SIEGEL S. 1956. Nonparametric statistic for the behavioral sciences. *New York: McGraw-Hill*.
- SKINNER J.D. & SMITHERS R.H.N. 1990. The mammals of the southern African subregion, 2nd Ed. *Pretoria: University of Pretoria Press*.
- SOUTHWOOD T.R.E. 1966. Ecological methods. *London: Methuen*.
- SPENCER W.D. & BARRETT R.H. 1984. An evaluation of the harmonic mean measure for defining carnivore activity areas. *Acta Zoologica Fennica* 171: 255-259.
- STUART C.T. 1981. Notes on the mammalian carnivores of the Cape Province, South Africa. *Bontebok* 1: 1-58.
- WASER P.M. & WASER M.S. 1985. *Ichneumia albicauda* and the evolution of viverrid gregariousness. *Zeitschrift für Tierpsychologie* 68: 137-151.
- WEATHER BUREAU 1965. Climate of South Africa. *Pretoria: Government Printer*.
- WILSON D.S. & CLARK A.B. 1977. Above ground predator defence in the harvester termite, *Hodotermes mossambicus* (Hagen). *Journal of the Entomological Society of Southern Africa* 40 (2): 271-282.
- WORTON B.J. 1989. Kernel methods for estimating the utilization distribution in home range studies. *Ecology* 70: 164-168.
- ZUMPT I.F. 1968. The feeding habits of the yellow mongoose, *Cynictis penicillata*, the suricate, *Suricata suricatta* and the Cape ground squirrel, *Xerus inauris*. *Journal of the Southern African Veterinary Medical Association* 39 (4): 89-91.
- ZUMPT I.F. 1982. The yellow mongoose as a rabies vector on the central plateau of South Africa. *South African Journal of Science* 78: 417-418.