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Range utilization by the aardvark, *Orycteropus afer* (Pallas, 1766) in the Karoo, South Africa

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Results are reported of radio tracking five aardvark in the False Upper Karoo, South Africa. Small samples size precluded statistical comparison of home range size between sexes. Using three methods to determine home range size, namely restricted polygon, minimum convex polygon excluding excursions and MCP including excursions the mean estimates of home range size were 1·8, 2·4 and 3·5 km^2 respectively. These differences were not statistically significant. There was a small degree of overlap in home ranges between individuals and certain areas were used more frequently than others. Aardvark are nocturnal and spent less time outside their burrows during the cold, dry months and mean foraging speeds were lower in winter. They foraged over minimum and maximum distance of 0·02 and 6·75 $km\,h^{-1}$ respectively and mean distance covered was 2·21 km per night.

Introduction

Aardvark *Orycteropus afer* (Orycteropodidae) are predominantly nocturnal, solitary and secretive semi-fossorial mammals endemic to Africa south of the Sahara. As the only extant member of the Order Tubulidentata, *O. afer* are obligate myrmecophages (ant and termite-eating mammals) with the species consumed varying according to availability in the different geographical regions (see Smithers, 1971; Melton, 1975; Melton & Daniels, 1986; Willis, 1988). They are known to inhabit open woodland, scrub and grassland areas of southern Africa, and are generally absent from forests, deserts and rocky mountainous terrain (Skinner & Smithers, 1990).

Incidental field observations (Verheyen, 1951; Kingdon, 1971; Melton, 1974) and assumptions made from tracks (Pagés, 1970; Kingdon, 1971) suggest that distances travelled per night vary from 2 to 30 km (Verheyen, 1951; Kingdon, 1971; van Aarde, 1984), while Melton (1975) calculated a mean nightly distance travelled as 9·6 km, with a maximum estimated distance of 14·7 km. The hourly distance covered by aardvark has been estimated to range from 4·06 to 9·6 km (Melton, 1975). Although there has been no supporting evidence, several authors have suggested that aardvark may require very extensive home ranges (Pagés, 1970; Smithers, 1971; Rautenbach, 1978). The present paper reports on aspects of range utilization by the aardvark and is based on information obtained through a radio-tracking programme.

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Study area

The study was undertaken in the False Upper Karoo (vegetation type 36; Acocks, 1975) on Tussen-die-Riviere Game Farm (TdR) (30° 25′S, 26° 12′E) in the southern Orange Free State. The Game Farm is situated *ca* 20 km east of the town of Bethulie, on the peninsula at the confluence of the Caledon and Orange rivers and occupies an area of 22,000 ha ranging in altitude from 1250 to 1520 m above sea level (Barkhuizen, 1984).

The topography constitutes rocky ridges, occasional plateau and lower-lying grassy plains. Climate, vegetation communities and geomorphological features of the Game Farm are described in detail in Werger (1973, 1980). No resident predators of the aardvark, as described by Kingdon (1971), are known to be present on TdR. Other ant and termite eating mammals occurring in the area include the aardwolf *Proteles cristatus*, bat eared fox *Otocyon megalotis*, striped polecat *Ictonyx striatus*, small spotted genet *Genetta genetta* and the yellow mongoose *Cynictis penicillata*.

Materials and methods

Field techniques

Aardvark were captured either by hand or by using a specially designed unbaited box trap placed over an occupied burrow entrance. The trap frame consisted of a combination of 12·5 mm square, and 6·25 mm round solid steel rods.

Once caught, aardvark were immobilized by an intramuscular injection of a mixture of ketamine hydrochloride (Ketalar, Warner Lambert S.A. (Pty) Ltd., Cape Town, RSA; dosage rate 10 mg kg^{-1}) and xylazine hydrochloride (Rompun (2% solution); Bayer Pharmaceuticals (SA) (Pty), Johannesburg, RSA; dosage rate 1–1·5 mg kg^{-1}). Following immobilization, the animals were weighed, sexed, body measurements recorded and fitted with collars to which a radio transmitter and battery pack were attached.

The collars (AVM 'LM') each weighed approximately 250 g. The transmitters attached to the collars were of the 'SB 2' type (weight 4·5 g) with a current drain ranging between 0·25 and 0·40 mA (AVM Instrument Company, Illinois, U.S.A.), powered by a single lithium Li-C battery of maximum current 3 mA (Tadiran, Israel Electronics Industries Ltd., Tel Aviv, Israel), a theoretical life of about 24 months and a frequency in the 151 MHz range. The transmitter and battery pack were encapsulated in protective Araldite resin XSA 205 and resin hardener HY 956 (Ciba-Geigy Plastics, Cambridge, England) before being attached to the collar. It was assumed that the use of externally-attached radio collars had minimal effects on the behaviour, and more particularly, movements of the animals concerned.

Radio-tracking was done from the ground with a four-element hand-held single Yagi directional antenna system using either a Yaesu FT-290 R Mach-2 portable transceiver (Yaesu Musen Company, Tokyo, Japan) or an AVM LA-12 receiver (AVM Instrument Company, Illinois, U.S.A.).

Monitoring sessions lasted from dusk to dawn. After an animal had been located, its position was fixed using compass bearings (corrected for magnetic declination) taken from two known locations. The position of each animal was plotted at hourly intervals on 1 : 25,000 topographical maps of the study area. Calculation of activity and rate of movement were based on straight line distances between fixes and are therefore minimum estimates. Locations of individual animals were determined at irregular intervals over a period of 35 months between November 1984 and October 1987.

Analytical techniques

Home range sizes were calculated using the minimum convex polygon (MCP) method which measures the area included by the outermost radio locations (see Macdonald, Ball

et al., 1980). As this method probably includes areas not frequented by the aardvark and does not allow for the 'objective discrimination of excursions', the restricted polygon (RP) method (Wolton, 1985), similar to the modified minimum area method (Harvey & Barbour, 1965), was used as well. Radio locations not incorporated into the RP due to their outlying positions were considered indicative of 'excursions' (Wolton, 1985). The MCP method where excursions, as defined for the RP method were excluded, was additionally used as an alternative technique for reducing the unvisited areas of a particular home range.

Areas were calculated on the flat plane of a 1 : 25,000 topographical map, and no allowance was made for the possible effects of mountain—and hillside slopes. 'Observation-area curves' (Odum & Kuenzler, 1955), where range area (as determined by the MCP method, but with the exclusion of excursions) was plotted against the cumulative number of radio relocations, were drawn to indicate whether the number of plots was adequate to describe the total area used by each individual during the study period. As home ranges vary both spatially and temporally, the terms 'range' or 'home range' in this paper are understood to mean the apparent home range during the period of radio tracking.

In order to illustrate heterogeneity in range utilization, spatial distribution of radio locations was analysed using the DISSPLA graphical computer package (Integrated Software Systems Corporation, San Diego, California), which displays spatially distributed data as a three-dimensional map, where the vertical dimension (z-axis) reflects the frequency of observations per 0·0625 km^2 (0·25 × 0·25 km) grid block superimposed on the particular home range. Statistical analyses (one-way analysis of variance [ANOVA] and two-sample *t*-tests (Zar, 1984)) were undertaken on the untransformed data with probability values of 0·05 (5%) or less accepted as being significant.

Results

Home range

Five aardvark were radio tracked for a total of 97 nights, and 469 acceptable radio relocations were made. Individual animals were successfully radio tracked for a mean duration of 19·4 nights each (n = 5; S.E. = 4·39; range = 9–32) over periods varying from three to 18 months in length. Details of the relocations are presented in Table 1.

The observation-area curves of the adult male (M2) sub-adult male (M3) and adult female (F1) attained asymptotic values between 80 and 102 radio relocations, and suggested that the number of fixed locations for these animals were sufficient for describing range size. The observation-area curves for an adult male (M1) and sub-adult female (F2), however, did not appear to level off after 54 and 29 plots respectively.

Small sample sizes precluded the statistical comparison of home range sizes between the sexes. Visual inspection of the data, however, showed variation but no obvious sex-specific differences in home range size (Table 1). For each animal the RP estimate was lower than the MCP excluding excursions which was less than the MCP including excursions.

The mean of the estimates of home range size were 1·8 km^2, 2·4 km^2 and 3·5 km^2 for the three methods. These differences were not statistically significant (one-way ANOVA $F(2, 12) = 2{\cdot}88, p > 0{\cdot}05$).

Range overlap was only recorded between two of the five radio tracked aardvark, and this resulting from only a single outlying relocation point of M1 within the home range of M3, calculated using the MCP method (including excursions). Percentage overlap of the home range of M3 by M1 was 1·96%, while the degree of overlap of M1 by M3 was 0·83%. Estimated home ranges of the study animals did not overlap when using the RP and MCP (excluding excursions) methods. The timidity of aardvark precluded direct observations for extended periods, although no observations suggesting territoriality, such as

Table 1. *Home range size estimates for aardvark radio tracked on Tussen-die-Riviere Game Farm in the southern Orange Free State*

					Home range size (km^2)		
					Restricted polygon	Minimum convex polygon	
Code	Age	Number of days radio tracked	Period radio tracked	Number of radio relocations		Excluding excursions	Including excursions
M1	Adult male	12	Nov. '84–Feb. '85	54	2, 1	2, 5	4, 7
M2	Adult male*	27	Nov. '84–Jul. '85	121	1, 3	1, 6	2, 0
M3	Sub-adult male*	17	Nov. '84–Apr. '85	105	1, 8	2, 0	2, 0
F1	Adult female*	32	Dec. '84–Dec. '85	160	3, 0	4, 4	4, 4
F2	Sub-adult female	9	Nov. '84–Dec. '85	29	0, 9	1, 7	4, 6

M = Male; F = female.
* = Observation-area curve asymptote reached.

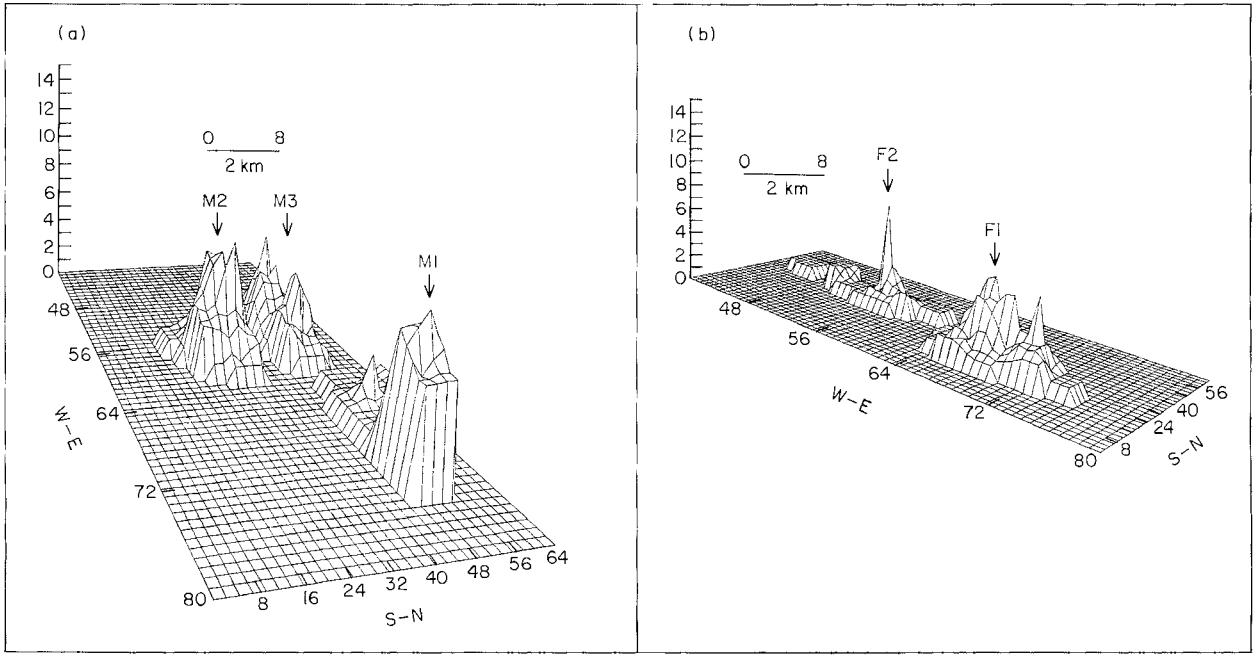

Figure 1. The itensity of range use by (a) three male [two adults (M1 and M2) and a sub-adult, M3] and (b) two female [one adult (F1) and a sub-adult, F2] aardvark radio tracked on Tussen-die-Riviere Game Farm. The intensity of utilization of grid squares is indicated by the height of peaks. Data were not obtained simultaneously.

aggression between individuals, were made during the course of the study. Individuals, however, were seen scent marking while moving around.

The intensity of range utilization based on the number of radio locations determined for each 0·0625 km^2 grid block within the home ranges of the radio tracked aardvark is illustrated in Fig. 1. Males and females used certain areas of their respective home ranges more frequently than others, with apparent activity centres situated centrally within each home range (Fig. 1).

Activity patterns and seasonal influences

Aardvark spent less time foraging and traversing their home ranges during the cold, dry months (May–August) than during the warm, wet months of the year (September–April) (Fig. 2). They were recorded as being active from 1930 h to 0530 h in summer, compared with 1800 h to 0130 h in winter (Fig. 2). No obvious trends in nocturnal activity patterns occurred, although activity periods tended to peak around 1900 h and 0100 h in the warm months and around 2000 h and 2400 h during, the cold months (Fig. 2). Mean foraging speeds (mh) were lower during the cold, dry months than during the warm, wet months. Aardvark also travelled significantly shorter distances per night ($t = 2{\cdot}26$; df. = 95; $p < 0{\cdot}05$) during the cold, dry months ($\bar{x} = 1{\cdot}25$ km; S.E. = 0·24; $n = 17$) than during the warm, wet months ($\bar{x} = 2{\cdot}28$ km; S.E. = 0·20; $n = 80$).

The radio collared aardvark foraged over minimum and maximum distances of 0·02 and 6·75 km per hour respectively during the night. The mean distance covered by aardvark between sunset and sunrise was 2·21 km per night (S.E. = 0·10; $n = 87$), varying from

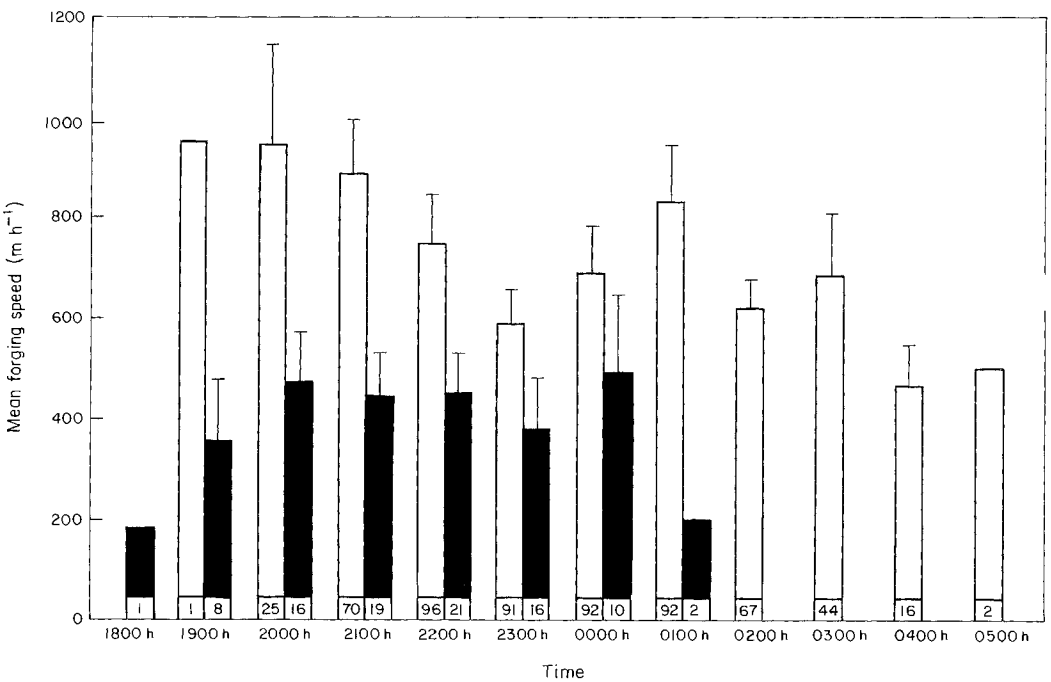

Figure 2. The mean hourly foraging speed of radio tracked aardvark recorded during the cold, dry months (■, May–August) and warm, wet months (□, September–April) of the year. The bars above the columns indicate 1 S.E.M. while the numbers beneath each column show the respective sample size.

0·50 km to 6·97 km per night. The mean distances travelled per hour for males varied from 0·18 to 0·83 km, while those of female aardvark ranged between 0·46 and 0·94 km. The difference in mean distance travelled per night between male and female aardvark was not significant ($t = 0·75$; df. = 13; $p > 0·05$). Direct observations suggest that aardvark generally follow a zig-zag path when foraging, and the actual distances travelled per night will therefore be longer than the straight line-distance estimates between radio relocations recorded above.

Discussion

The present study provides the first quantitative data on aspects of range utilization by aardvark, with the consequence that intraspecific comparisons with studies on animals inhabiting contrasting habitats and environments in different geographical locations cannot be made.

Limited overlap found between home ranges suggests that aardvark may maintain individual territories. Definite conclusions concerning territoriality (where both males and females defend territories against conspecifics of the same sex) in aardvark cannot, however, be made from this study due to insufficient data and the fact that other, unobserved aardvark without radio collars could have been traversing the home ranges of the collared animals. The estimated aardvark home range sizes for three radio tracked individuals (M2, M3 and F1) on TdR are probably a realistic representation of the true home ranges of these animals under the prevailing conditions, as the observation area curves showed these areas to be based on a sufficient sample of plots.

The true home ranges of both the adult male (M1) and sub-adult female (F2), however, could have been larger as the observation-area curves for these individuals showed no evidence of reaching an asymptote and levelling off by the time radio tracking was stopped after 54 and 29 plots respectively. Home range sizes determined here, furthermore, are applicable only to the present study, as the relative size will necessarily vary from one area to another depending on the local topography, resource distribution and density.

The observed intensity of range utilization by the aardvark suggests the presence of certain 'core' areas within their respective home ranges, with concentrations of relocation points in specific areas and a more diffuse pattern in others. This behaviour pattern suggests that these core areas may provide some requirement for aardvark survival in terms of potential food sources or shelter. This requisite is more likely to be for food rather than for shelter, since the signals from the radio tracked aardvark could only be received once the animals were outside their burrows.

The presence of burrows and food patches may be indirectly associated with one another, however, since aardvark are adept at excavating their own burrows (serving both as temporary and permanent shelters), and thus are capable of reducing the distance between their refugia and local food concentrations. This phenomenon may be a possible explanation for the reduced activity of aardvark observed during the cold, dry months of winter although prevailing weather conditions including precipitation, temperature, cloud cover and wind speed are likely to have a profound influence on the activity of both aardvark and their potential prey.

Our results and limited direct observations are in accord with Melton & Daniels (1986) conclusions that area utilization is significantly 'affected' by the density of termitaria, ant nests and the degree of rockiness, with open grassland being the most favoured habitat. Aardvark in our study occasionally moved into steep rocky terrain generally unsuitable for excavations, possibly in search of isolated termitaria or simply to go from one part of the home range to another.

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