DETERMINING ACTIVITY TYPES AND BUDGETS FROM MOVEMENT SPEED OF RADIO-MARKED MONGOOSES

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Abstract: Determination of different behaviors of active animals that are difficult to observe is a continuing problem. Thus, we developed a method to delineate foraging, eating, and walking behaviors of radio-marked Egyptian mongooses (*Herpestes ichneumon*) by monitoring their rate of movement in southwestern Spain. Mongooses spent an average of 70.1% of their time resting, 21.3% foraging, 5.8% eating, and 2.8% walking. The application of this method requires distinguishing between activity and inactivity, and accurate fixes on animal locations. Nevertheless, it is more simple and rapid than others previously reported.

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Activity budgets have been used to elucidate different aspects of the ecology, behavior, conservation, and management of animals (Jackson et al. 1972, Kenagy and Hoyt 1989). Radio tracking has allowed the description of animal activity patterns (Cochran and Lord 1963, Amlaner and Macdonald 1980), but determination of different behaviors of active animals remains a problem, except for species that are easily observed (Bekoff and Wells 1981, Estes et al. 1986). Thus, the time budgets of many species remain unknown.

We have continuously tracked, on foot and at short distances, free-ranging radio-equipped Egyptian mongooses in southwestern Spain, apparently without introducing changes in their behavior (Palomares 1990). Mongooses show diurnal activity there (Delibes and Beltrán 1985, Palomares and Delibes 1992) and use habitats with dense cover near the ground (Palomares and Delibes 1990). Direct observation is feasible occasionally, but not frequent enough to determine daily time budgets only from this source. However, from direct observations and over short time periods, we have found a close relationship between movement speed of mongooses and type of activity. Hence, movement speeds may be useful in estimating daily time budget.

Mongooses principally spend their active time walking, foraging, and eating (Palomares 1990). While foraging, they search vegetation and burrows for potential prey, they dig, and at times they capture small prey (e.g., insects). While eating from large or clumped prey they stay in 1 location for up to 2 hours. While walking, they commonly move to, or from, core areas in their home ranges.

We predicted that the movement rate of mongooses should differ among behaviors: low while eating, intermediate while foraging, and highest while walking. Herein, we describe a new method of determining behavior of radio-marked Egyptian mongooses and report on the daily time budget of some individuals so monitored.

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STUDY AREA AND METHODS

We radiotracked 6 mongooses from October 1985 to April 1986 at Doñana Biological Reserve, within Doñana National Park, southwestern Spain (37°0′N, 6°30′W). Doñana National Park is situated west of the mouth of the Guadalquivir River, and includes 3 main biotopes: marshes or marismas, scrubland, and dunes. Rivas-Martínez et al. (1980) provide a detailed description of the study area.

We equipped the mongooses with radio collars transmitting at 150–151 MHz and provided them with motion sensors (Wildlife Materials Inc., Carbondale, Ill.). Tip switches triggered a slow ($\bar{x}$ = 45 beats/min[bpm]) and a fast ($\bar{x}$ = 90 bpm) pulsing transmission mode depending on the collar position. The signal was received by an LA-12 receiver (AVM Instrument Co.,

Table 1. Accuracy in the classification of 15-minute intervals of known behaviors in 2 mongooses using movement rate ranges, Doñana National Park, southwestern Spain, November–April 1986.

Checked behavior	Intervals classified as[a]						Not classified	Total
	Foraging		Eating		Walking			
	No.	%	No.	%	No.	%		
Foraging	20	95	1	5	0	0	12	33
Eating	3	17	15	83	0	0	2	20
Walking	0	0	0	0	9	100	3	12
Total	23		16		9		17	65

[a] Total correctly classified = 93%. Ranges used in classification: foraging 3.0–11.0 m/minute, eating <1.0 m/minute; and walking >19.0 m/minute.

Livermore, Calif.) and a Yagi antenna. During the daily activity period, we tracked mongooses (0600–1900 GMT; Palomares and Delibes 1992) on foot and at short distances (30–100 m from the animals), which allowed contact without disturbing them (Palomares 1990). We split each tracking day into 15-minute intervals, estimating for each the distance the animal traveled and how long the animal was active. When a behavior was checked, it was assigned to one or more of the 15-minute intervals, depending on the length of the observation. Different behaviors of animals were directly observed, listened to, or verified by later inspection.

When direct observation was not possible, we determined behaviors by measuring both the activity time and the distance traveled during short time intervals, to obtain movement rate for these intervals. Later, by comparing movement rate with the known ranges, we attempted to assign each telemetry observation period to one of the 3 described behaviors. Resting (inactivity), characterized by no movement, was easily differentiated from eating behavior (without spatial movement as well) by tip switches on radio collars. We estimated movement rate for each interval by dividing the distance (m) traveled by the net active time (min.). Activity time was obtained from tip switches of animal radio collars (i.e., the animal was making some movement that frequently switched the pulse rate), and distance traveled was measured as the shortest distance between 2 consecutive locations separated by 15 minutes. We excluded 15-minute intervals with <5 minutes of net active time from calculations, assigning them to the resting category. We gathered data during 13 intensive 24-hour tracking periods for 2 radio-marked adult females from February to April 1986.

We used the Kruskal-Wallis test (H-test statistic) to determine statistical differences of mongoose movement speeds among behaviors, and Chi-square analysis of contingency tables to compare frequencies of observed and estimated behaviors. Differences were considered significant if $P < 0.05$.

RESULTS

For 65 15-minute intervals, we were able to verify the type of behavior performed by the tracked animals. For these intervals, movement rate varied from zero to 39 m/minute. Movement rate differed ($H = 43.9$, $P < 0.001$) among foraging, eating, and walking. Mean movement rate while foraging was 6.4 m/minute (SE = 0.7, range = 0–18.3, n = 33), whereas eating was 0.9 m/minute (SE = 0.4, range = 0–5.3, n = 20), and while walking was 25.6 m/minute (SE = 2.3, range = 11.3–39.3, n = 12). Nevertheless, ranges of movement rate overlapped among behaviors. When we used movement rate values of <1 m/minute for eating behavior, from 3 to 11 m/minute for foraging behaviors and >19 m/minute for walking behavior, 22.6% of intervals were unclassified, but 93% of the remaining classifications were correct (Table 1). There were no differences ($\chi^2 = 0.31$, 2 df, $P = 0.86$) when comparing results of estimated behaviors and real observed behaviors in these 65 intervals. When we used these ranges of movement rate to assign behaviors to the 628 intervals for which direct observation was not possible, 282 (44.9%) were classified as resting, 60 (9.6%) as eating, 172 (27.4%) as foraging, 26 (4.1%) as walking, and 88 (14.0%) were unclassified.

Assuming that during unclassified intervals mongooses were eating or foraging if movement rate ranged between 1.1–2.9 m/minute, and foraging or walking if movement rate ranged between 11.1–18.9 m/minute, the percentage of time devoted to each activity type from 0600 to 1900 in the 13 tracking days was: 39.3% to foraging, 10.7% to eating, 5.1% to walking, and

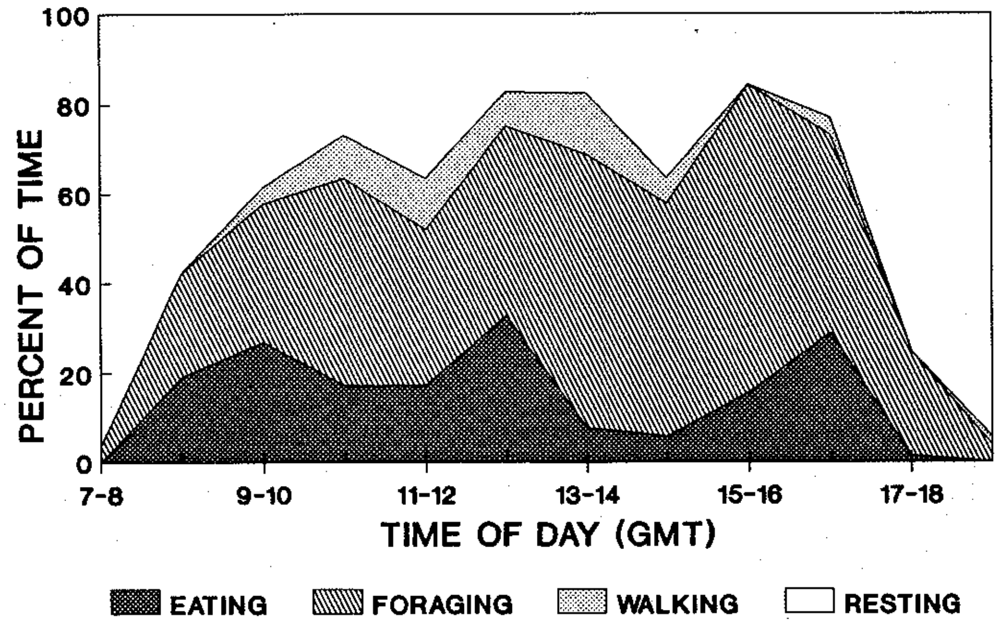

Fig. 1. Activities of 2 female mongooses relative to time of day, Doñana National Park, southwestern Spain, February–April 1986.

44.9% to resting. Mean active time was 379 minutes/day. When the 24-hour day was considered, 21.3% of the time was spent foraging, 5.8% eating, 2.8% walking, and the remaining 70.1% resting. The 3 activity types were recorded at all hours of the day, but foraging was more frequent from 1300 to 1600, eating predominated in the morning and evening, and walking occurred mostly in the morning (Fig. 1).

DISCUSSION

We have considered only 4 types of behavior, although other important activities, such as grooming, playing, and mating, likely are performed on occasion. Some of these behaviors would not be differentiated by using our proposed method. Nevertheless, the social status of our study animals, neither of which were breeding adults, and our direct observations strongly suggest these other behaviors were absent or sporadic. Hence, we believe that the 4 behavioral categories we considered fairly represent the behaviors of our study animals. Although Rasa (1977) described a variety of behaviors of captive dwarf mongooses (*Helogale undulata*), little information on time allotment of free-living herpestids has been published. Only Buskirk et al. (1990) presented data on time spent resting and active by 2 female small Indian mongooses (*Herpestes auropunctatus*).

Several authors have delineated several types of activity from changes in radio-telemetry signals related to body posture in mammals (Jackson et al. 1972, Kawai and Mito 1973, Gillingham and Bunnell 1985). This requires having a transmitter fixed firmly to the body of the animal, which is difficult to achieve in Carnivora. Also, signal strength can be used to determine whether aquatic mammals are in or out of water (Loughlin 1980, Ralls and Siniff 1990). Recently, Nams (1989) proposed a technique that distinguishes on the basis of pulse intervals and signal amplitude, foraging, walking, and eating activities of radio-marked striped skunks (*Mephitis mephitis*). This technique requires automatic signal registration and information processing, which is costly.

RESEARCH IMPLICATIONS

Our indirect method of determining activity is simple and inexpensive and allows collection of data about certain behaviors of an active species that otherwise would be unavailable. The method works best if radio transmitters are equipped with motion sensors to differentiate time of inactivity and activity. Nevertheless, signal strength also may be used for this differentiation (e.g., Buskirk et al. 1990).

Researchers also should realize that errors in the animal location must be minimized while using our technique. Using normal techniques of triangulation (Mech 1983) could result in associated error (Heenze and Tester 1967, Mills and Knowlton 1989) that would alter estimations of movement distances and render useless the value of movement rate. Thus, we recommend determining levels of error for each species under study when using triangulation. We avoided this problem by tracking from short distances, which allowed fairly accurate and precise locations of the animal; however, this procedure may be impossible with other species.

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