# CIRCADIAN ACTIVITY PATTERNS OF FREE-RANGING LARGE GRAY MONGOOSES, *HERPESTES ICHNEUMON*, IN SOUTHWESTERN SPAIN

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**Activity of female large gray mongooses, *Herpestes ichneumon*, was studied and related to daily cycle of light and darkness, temperature and age, in southwestern Spain. Female mongooses were diurnal. Activity was detected in 79% of 301 bearings during daylight, but only in 10% of 236 bearings at night ($n = 4$). Activity was higher at 1400 h. Average daily activity started 119 min after sunrise ($SD = 44$, $n = 29$, range = 21-195), ended 65 min before sunset ($SD = 60$, $n = 27$, range = 191 min before and 27 min after sunset), and lasted for 357 min ($SD = 76$, $n = 28$, range = 195-500). Only sunrise affected activity onset significantly ($b' = 0.850$; $P = 0.0071$), and only total activity time and activity onset influenced the end of activity significantly ($b' = 0.008$ and 0.172 respectively; $P < 0.04$). An adult female spent less time in activity, starting later and ending earlier than a young female ($P < 0.032$). Resting was divided into a continuous longer nocturnal period, and several shorter periods that interrupted activity during the day. Mongoose daily activity time coincided with resting time of its staple prey.**

**La actividad de hembras de meloncillo, *Herpestes ichneumon*, fue estudiada y relacionada con el ciclo diario de luz y oscuridad, temperatura y edad, en el suroeste de España. Las hembras de meloncillos feuron diurnas. Actividad fue detectada en el 79% de los 301 registros durante el periodo diurno, pero solo en el 10% de 236 durante la noche ($n = 4$). La actividad fue mayor sobre las 1400 h. En promedio, la actividad diaria comenzó 119 min después de la salida del sol ($SD = 44$, $n = 29$, rango = 21-195), finalizó 65 min antes de la puesta del sol ($SD = 60$, $n = 27$, rango = 191 min antes y 27 min después), y duró 357 min ($SD = 76$, $n = 28$, rango = 195-500). Solo la salida del sol afectó significativamente el comienzo de la actividad ($b' = 0.850$; $P = 0.0071$), y solo el tiempo total de actividad diaria y la hora del comienzo de la actividad influyeron significativamente sobre el final de la actividad ($b' = 0.008$ y 0.172 respectivamente; $P < 0.04$). Una hembra adulta pasó menos tiempo activa, y comenzó después y finalizó antes la actividad que una joven ($P < 0.032$). El descanso diario estuvo repartido en un periodo nocturno largo y continuo, y en varios cortos intercalados entre la actividad. La actividad de los meloncillos coincidió con los periodos de descanso de sus presas principales.**

**Key words:** ***Herpestes*, circadian activity, carnivores**

Circadian activity of captive and free-ranging carnivores has been related to endogenous rhythmicity and external factors such as daily cycle of light and darkness, climate, season, site, and activity of prey (Ables, 1969; Garshelis and Pelton, 1980). Except for reports on captive animals (Kavanau and Ramos, 1972, 1975; Zielinski, 1986), most studies of carnivore activity describe the general daily pattern of activity, without considering other aspects such as time budget and timing of the onset and end of the activity, and factors influencing them.

In southwestern Spain, we studied cir-

cadian activity of the large gray mongoose or ichneumon, *Herpestes ichneumon,* the only European mongoose (Delibes, 1982). The species also occupies most of Africa and the Middle East (Corbet, 1984). It is considered diurnal in Spain (Delibes and Beltrán, 1985; Valverde, 1960), primarily crepuscular in Israel (Ben-Yaacov and Yom-Tov, 1983), and diurnal and nocturnal in Africa (Michaelis, 1972; Smithers, 1971). Herein, we present a detailed description of the daily activity of several individual mongooses in the Doñana Biological Reserve and relate their patterns with daily cycle of light and darkness, temperature, age, and other factors.

## Methods

The Doñana Biological Reserve occupies 6,700 ha in Doñana National Park, located on the west bank of the mouth of the Guadalquivir River, in southwestern Spain (37°N, 6°30'W). It includes marshes, scrubland, and dunes. Marshes usually are flooded in winter and covered by *Scirpus* sp. Scrubland may be a dry, xerophytic scrubland vegetated by *Halimium* sp. and *Rosmarinus* sp., or a dense, mesic scrubland, vegetated by *Erica* sp. and *Calluna vulgaris.* Sand dunes are mobile and bare, separated by depressions or valleys usually colonized by pine (*Pinus pinea*) forests. The climate is mediterranean subhumid, characterized by dry, hot summers and mild, wet winters. Mean temperatures during the study ranged from 9.0°C in January to 19.5°C in October.

From October 1985 to April 1986 (the rainy period of the year) we tracked two adult and four young female mongooses. They were equipped with radio-collars provided with motion sensors (Wildlife Materials Inc., Carbondale, IL) that produce tips switches by animal movement (Knowlton et al., 1968). The signal was received by a portable La-12 receiver (AVM Instrument Co., Livermore, CA) via a 3-element Yagi antenna. Length of monitoring sequence was 129 and 51 days for adults and 280, 17, 2, and 2 days for young, respectively.

We obtained two observations of activity per animal in a 24-h period, one during any time of the day and the other at night, usually from 2100 to 0300 h. The animal was considered active when the radio signal indicated movement. Ninety-six percent of the observations were of two adults and one young that lived in three different areas. In addition, for these individuals we conducted 30 intensive tracking periods from October to April. Twenty-four of these periods were undertaken on foot and close to animals, allowing frequent visual contact with them; for the remainder we used triangulation at a distance of 50–300 m. During the periods of intensive tracking, we noted the net activity time (total time the animal was moving) and the position at 0.5-h intervals during the day, and at 1.0-h intervals at night. Each day we also noted the times of onset (determined when the animal had been active for >5 min and had left the night resting place) and end of activity (when the animal settled in a usual resting place and remained inactive for >2 consecutive h near sunset). The pattern of activity was determined on the basis of the distance traveled in each hourly period at night and on the amount of time active and distance traveled in each 0.5-h interval during the day.

We used multiple regression analysis to study the effects of sunrise time, and minimum and maximum temperatures on the mongooses onset of activity. This test also was employed to analyse the effects of sunset time, minimum and maximum temperatures, total daily activity time, and onset activity time on the end of activity of mongooses. Other tests used were chi-square ($\chi^2$) to compare frequency of bearings with activity during daylight and night, Spearman rank correlation coefficient ($r_s$) to detect individual variations in the patterns of activity, and Student's *t*-tests when the variances were homogeneous to compare means.

## Results and Discussion

Female mongooses were diurnal. Of 236 independent bearings at night, we detected activity only in 10%, whereas there was activity in 79% of 301 bearings during daylight ($\chi^2 = 114.59$, $d.f. = 3$; $P < 0.001$; bearings from intensive tracking periods are not included).

The daily activity pattern determined from intensive tracking periods showed a maximum activity at 1400 h and two peaks of large movements at 1130 and 1400 h (Fig. 1). At night, movements were limited (3.8% of the total distance traveled, e.g.,

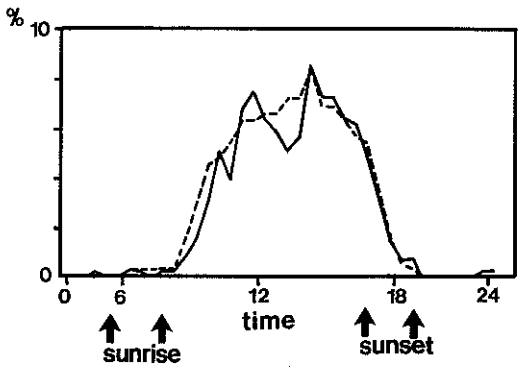


FIG. 1.—Average daily activity pattern of three large gray mongooses in Doñana Biological Reserve from October, 1985 to April, 1986. Patterns of activity are represented as percentage of distance traveled (continuous line) each 1-h (from 1900 to 0600) or 0.5-h (from 0600 to 1900) and percentage of total activity time (discontinuous line) each 0.5-h.

36,460 m), because mongooses usually remained in the same resting place all night (Palomares, 1986). These data indicate a clear and detectable onset and end to daily activity.

The pattern of activity was similar for the three mongooses ($r_s$ = 0.8639, 0.8986, and 0.8698, $P < 0.0001$), and agreed with previous observations of an adult male radiotracked in summer by Delibes and Beltrán (1985) in the same area. The presence of cones and rods in the retina of the ichneumon (Dücker, 1965), permitting color vision, could be an adaptation to diurnal activity. Perhaps in Israel, where mongooses feed on rubbish piles and frequently are attacked by dogs (Ben-Yaacov and Yom-Tov, 1983), crepuscular activity may minimize the risk of detection. Also, nocturnal activity of mongooses reported by Michaelis (1972) in Africa could be an adaptation to avoid detection by predators in open savannahs.

Average onset of activity was at 0859 h ($SD$ = 0.85, $n$ = 29, range = 0715–1045 h). Average activity started 119 min after sunrise ($SD$ = 44, $n$ = 29, range = 21–195; Fig. 2). Combined effects of sunrise time and maximum and minimum temperature explained 25% ($R^2$ adjusted) of variation in the time of the onset of activity, but only the effect of sunrise was statistically significant ($b'$ = 0.850; $t$ = 2.933; $P$ = 0.0071).

Average end of activity was at 1641 h ($SD$ = 0.87, $n$ = 27, range = 1459–1825 h). The average end of activity was 65 min before sunset ($SD$ = 60, $n$ = 27, range = 191 min before and 27 min after sunset; Fig. 2). Combined effects of sunset time, maximum and minimum temperature, total daily activity time, and onset activity time explained 38% ($R^2$ adjusted) of the variation in the time of the end of activity, although partial regression shows that only total activity time and onset activity time exhibited statistical significance ($b'$ = 0.008 and 0.172; $t$ = 4.361 and 2.199; $P$ = 0.0003 and 0.0392, respectively).

Factors influencing the onset and end of activity in mongooses appear to be different. Although the onset shows a more regular pattern (Fig. 2), mainly influenced by an external factor as the time of sunrise, the end shows a less predictable pattern, influenced by other factors, mainly behavioral, such as the onset time of activity and total activity time. Kavanau and Ramos (1972) studied carnivores in captivity, and observed a similar pattern of response to sunset or sunrise in the beginning of daily activity of *Genetta genetta, Potos flavus,* and *Bassariscus astutus.* Amount of food consumed also could influence the end of activity. On five occasions we observed animals ending their activity soon after eating a large amount of food. Quantity of food consumed was estimated by analysis of food remains. An influence of the amount of food eaten on decreased activity also was observed by Garshelis and Pelton (1980) in the black bear, *Ursus americanus.*

Average time of total daily activity was 357 min ($SD$ = 76, $n$ = 28, range = 195–500), 25% of the available 24-h period. Individual differences in daily time budget were detected. By comparing the two animals sampled (one adult and one young) in

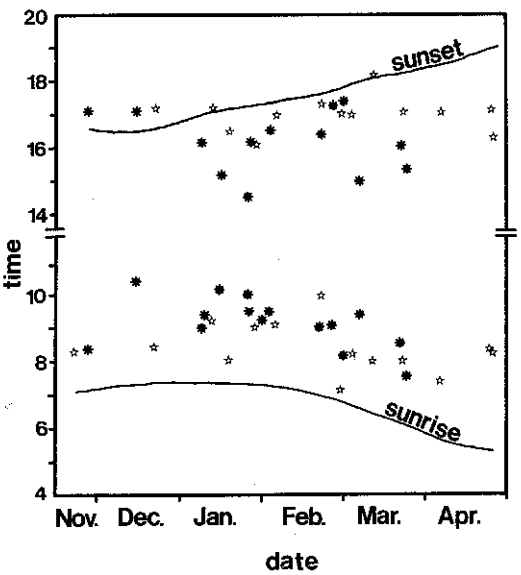


FIG. 2.—Time of onset and end of activity of three large gray mongooses in Doñana Biological Reserve, in relation to sunrise and sunset time. Stars = young female, asterisks = adult females.

the period from January to March (when both were tracked simultaneously), the young mongoose appeared active during 401 min each day ($SD = 69$, $n = 9$, range = 285–500) and the adult during 302 min ($SD = 75$, $n = 11$, range = 195–430; $t = 3.083$, $P = 0.0064$). The differences occurred because the young initiated activity earlier than the adult (mean of the young = 93 min after sunrise, $SD = 47$, $n = 9$, range = 30–179; mean of the adult = 132 min after sunrise, $SD = 30$, $n = 12$, range = 86–184; $t = 2.319$, $P = 0.0317$) and ended later (mean of the young = 40 min before sunset, $SD = 30$, $n = 9$, range = −9–80; mean of the adult = 93 min before sunset, $SD = 61$, $n = 11$, range = 30–191; $t = 2.338$, $P = 0.0312$; Fig. 2). Juvenile sea otters, *Enhydra lutris,* also devote more time each day to foraging and less to resting than adults (Ralls and Siniff, 1990).

The amount of daily activity was similar to that estimated by Erlinge (1980) in wild stoats, *Mustela erminea.* However, daily activity of mongooses was greater than that observed in free-living feral cats, *Felis catus,* and lions, *Panthera leo,* active 20 and 17% of the day, respectively (Izawa, 1983; Schaller, 1972), and shorter than that observed in Iberian lynxes, *Felis pardina,* living in the same area, active 42% of the day (Aldama, 1986).

Resting in mongooses was divided into two or more periods: a continuous and longer nocturnal resting time, and one or several shorter periods that interrupted activity during the day. The average time of resting during darkness was 971 min ($SD = 70$, $n = 28$, range = 837–1,146), with the young individual resting less than the adult (mean of the young, 922 min, $SD = 53$, $n = 9$, range = 837–990, and mean of the adult, 1,026 min, $SD = 89$, $n = 11$, range = 894–1,146; $t = 3.030$, $P = 0.0072$). Time for short resting periods averaged 111 min/day ($SD = 64$, $n = 28$, range = 0–259). There were no statistical differences in short resting time between young and adult mongooses ($t = 0.228$, $P = 0.8221$).

Usually the pattern of circadian activity of carnivores coincides with that of their most common prey (Ables, 1969; Zielinski et al., 1983); however, in the area and the seasons of this study, diurnal mongooses mainly consumed rabbits, *Oryctolagus cuniculus,* and small mammals (Palomares and Delibes, in press), and these prey primarily were nocturnal and crepuscular in their habits (Kufner, 1986). Because mongooses seek and capture rabbits and small mammals inside their burrows or hideouts, it is advantageous for the predator to coincide its activity time with the resting time of its prey. Nevertheless, mongooses also frequently capture species active during daytime, such as reptiles and birds.

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