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ACTIVITY PATTERNS OF ADULT COMMON GENETS *Genetta genetta* (LINNAEUS, 1758) IN NORTHEASTERN SPAIN

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Abstract

The seasonal and sexual variations in the daily activity rhythms of 9 adult common genets *Genetta genetta* (Linnaeus, 1758), 4 males and 5 females, were studied in a Mediterranean habitat in the northeast of the Iberian Peninsula and attempts were made to establish the factors that influence this activity. Both males and females displayed almost exclusively nocturnal activity throughout the year, with very little diurnal activity, mainly coinciding with dusk and dawn. The activity pattern in both sexes, which was mainly unimodal, varied considerably depending on the season. The percentage of nocturnal activity differed in males and females – being higher in males – but did not vary with the seasons. At night, the common genets were active on average 55.7% (± 11.8%) of the time, with maximum activity values in the spring and summer. The start and end of the activity were synchronized with sunset and sunrise respectively, although at these times activity was minimal. In some cases intrasexual, intersexual and seasonal differences were observed in the activity displayed in the two hours after sunset and the two hours before sunrise. The percentage of nocturnal activity was positively correlated with the individual's weight, but not with any of the climatic variables studied. It was concluded that the common genet's activity pattern is affected by factors such as sex, body weight, the biological cycle and the length of the night.

Key words: activity pattern, body weight, genet, *Genetta genetta*, season

Resumen

Patrón de actividad de la gineta Genetta genetta (Linnaeus, 1758) en el NE de España

Se estudiaron las variaciones estacionales y entre sexos del ritmo de actividad de 9 ginetas adultas (4 machos y 5 hembras) en un hábitat mediterráneo situado en el noreste de la Península Ibérica, intentando determinar los factores que lo condicionan. Tanto machos como hembras mostraron una actividad casi exclusivamente nocturna durante todo el año, con una escasa actividad diurna, coincidiendo principalmente con las horas crepusculares. El patrón de actividad de ambos sexos, que fue mayoritariamente bimodal, varió sensiblemente en función de la estación. El porcentaje de actividad nocturna mostró diferencias entre sexos, siendo más elevado en los machos, pero no entre estaciones. Durante las horas nocturnas, las ginetas estuvieron activas una media del 55,7% (± 11,8%) del tiempo, con valores máximos de actividad durante la primavera y el verano. El inicio y el fin de la actividad se sincronizaron con la puesta y salida de sol, respectivamente, aunque cabe constatar que en estas horas la actividad fue mínima. En algunos casos se detectaron diferencias intrasexuales, intersexuales y estacionales en la actividad detectada durante las dos horas posteriores a la puesta de sol y durante las dos anteriores a la salida del mismo. El porcentaje de actividad nocturna se correlacionó positivamente con la masa corporal del individuo, pero con ninguna de las variables climatológicas estudiadas. Se concluye que el patrón de actividad de las ginetas está influenciado por factores como el sexo del individuo, la masa corporal, el ciclo biológico y la duración de la noche.

Palabras clave: estación, *Genetta genetta,* gineta, masa corporal, patrón de actividad.

Introduction

In most mammals, the activity rhythm has an endogenous basis (Aschoff 1963, 1966), mainly determined by the length of the photoperiod (Hainard 1961). In carnivores, these activity patterns are affected by various factors, such as the availability and the activity patterns of their prey (Curio 1976, Kruuk 1995, Lodé 1995), the animal's size (Bunnell and Harestad 1990), their body condition (Green 2001), their reproductive behaviour (Debrot and Mermod 1983, Arthur and Krohn 1991), their social behaviour (Ewer 1973, Gittleman 1986), interference with competitors (Carothers and Jaksic 1984), the effect of predation (King 1975), the weather (Ewer 1973), temperature variations (Schmidt-Nielsen 1983), light levels (Kavanau and Ramos 1975, Shivik and Crabtree 1995), the limitations of the animals' visual system (Walls 1963, Dunstone and Sinclair 1978), thermoregulatory behaviour (Chappell 1980) or even human activity (Gese *et al.* 1989). Thus, a wide variety of activity patterns have been described in carnivores adapted to each situation (Kavanau 1971, Ewer 1973, Curio 1976, Daan 1981, King 1989, Shivik *et al.* 1997).

Several authors have studied the activity rhythm of both the common genet (Palomares and Delibes 1988, 1994) and other species of genets (Ikeda *et al.* 1982, 1983, Fuller *et al.* 1990, Maddock and Perrin 1993), which varies depending on the location and the age and sex of the individual (Palomares and Delibes 1994). However, at present little is known about which factors affect the genets' activity patterns or how they affect them.

This study provides data on the annual activity pattern of the common genet in a Mediterranean habitat in the northeast of the Iberian Peninsula. Seasonal and sexual variations in the activity rhythms and some of the factors that can affect them have been studied. (I) Given the differences between sexes and seasons in the use of space recorded in this area (Camps and Llimona 2004), males should show higher activity than females as a consequence of their larger home ranges and their different reproductive behaviour. (II) Given variations in the length of the day and night, it can be predicted that there may also be some variation in the individuals' activity cycles (Kavanau and Ramos 1975). (III) Body weight largely affects behavioural decisions of individuals (Peters 1983). Then, it could be predicted that heavier individuals need to undertake larger activity periods. And finally, (IV) activity rhythms could be varied as a consequence of the seasonal climatic variations and of most critical climatological conditions (eg. low temperatures) (Ewer 1973).

Study area

The study was carried out in Collserola Natural Park (41º 25' N, 2º 7' E), situated in northeast Spain, around 7 km from the coast. It is a natural Mediterranean area covering around 8,000 ha, 6,000 ha of which consist of Aleppo pine forest *Pinus halepensis*. Lower down one can find evergreen holm oak *Quercus ilex* and deciduous *Quercus cerrioides* woods, with well-developed undergrowth. The rest of the area is made up of a humanized Mediterranean environment, which forms a complex mosaic of meadows, scrub, maquis, crops, built-up areas and abandoned fields and pastures. The climate is typically Mediterranean, with moderate temperatures and rainfall, which is mainly concentrated in the autumn and spring. In general, the summers are hot and dry and the winters are not too cold or wet (Table 1).

Table 1
Monthly variations in the main climatological variables during the study period (source: Fabra Observatory).

Variaciones mensuales de las principales variables climáticas durante el período de estudio (fuente: Observatorio Fabra).

	1999 July	Aug.	Sept.	Oct.	Nov.	Dec.	2000 Jan.	Febr.	Mar.	April	May	June
Mean min. Tº (ºC)	19.1	20.6	17.6	13.8	6.7	6.2	4.3	7.6	8.3	9.1	14.0	17.3
Mean max. Tº (ºC)	27.8	28.6	25.7	20.3	12.6	11.9	12.5	17.3	18.5	19.3	24.5	29.0
Precipitation (mm)	10.5	5.3	171.7	116.1	61.6	12.2	27.2	1.0	40.6	71.2	77.4	0.8
Mean relative humidity (%)	64	68	69	70	68	59	71	69	67	71	76	80
Mean wind speed (m/s)	4.2	4.4	3.9	4.4	4.4	5.0	6.4	5.0	5.2	5.7	4.2	4.1

Material and methods

Trapping and radiotracking

Between June 1999 and February 2000, 9 adult common genets (4 males and 5 females) were caught using wooden box traps (110X27X27cm) made by the author, baited with sardine, tuna and chicken. Once caught, the genets were immobilized and anaesthetized under veterinary supervision (Zoletil, with a dose of 0.8 mg/kg administered as an intramuscular injection). Each animal was marked with a subcutaneous microchip in order to identify the individual in subsequent recaptures and equipped with a radio-collar (TW-3 transmitters, Biotrack, Wareham, U.K.). A portable Mariner 57 radio-receiver and a 3-element directional Yagi antenna (Biotrack, Wareham, U.K.) were used. Moreover, the animal's weight was recorded.

Radio-collars have no activity sensor so it was established whether the animal was active or not by obtaining a second or third fix in a short interval of time in order to detect any possible spatial variation between consecutive fixes. Obviously, genets could be active without movement, and therefore it was not detected. So movement was assumed as an adequate measure of activity. Sometimes the spatial variation between two fixes was probably due to error in determining the locations (i.e. signal bounces). In these and other cases where it was not possible to establish reliably whether the animal was active or not (i.e. the animal was active but did not move), the data obtained were disregarded when calculating the activity pattern.

The radiotracking was carried out between 30th June 1999 and 20th June 2000, on a total of 120 days, on which one or two fixes were obtained for each individual. The time interval between the obtaining of the two daily fixes of the same individual was calculated in order to ensure the statistical independence of the data and to avoid bias in the calculations of the activity patterns caused by intensive monitoring (Swihart and Slade 1985, Kenward and Hodder 1996). The solar time (GMT) of each fix was recorded.

The data were pooled in three-month periods, in accordance with the four astronomical seasons: summer (21st June-21st September), autumn (22nd September-20th December), winter (21st December-19th March) and spring (20th March-20th June).

Although the common genet is an essentially nocturnal animal, (Palomares and Delibes 1988, 1994), samples were taken over 24-hour of the day, both nocturnal (X=20 fix/hour and season) and diurnal (X=8 fix/hour and season). This systematic monitoring throughout the day is a good way to estimate the activity pattern accurately (Palomares and Delibes 1991). Similar efforts were made to carry out sampling in all four seasons, 30 days per season and with different individuals, enough to have an accurate estimate of the seasonal daily activity for a species such as the common genet (Palomares and Delibes 1991).

Additionally, one whole day's intensive, simultaneous monitoring was carried out in spring on a male and a female with continuous fixes being obtained every 15 minutes from the beginning to the end of their respective activity periods. Thus, it was possible to record accurately the total activity of the two individuals over a whole day (White and Garrott 1990).

Data analyses

The data were analyzed in accordance with the four seasons. The daily activity pattern for each season is shown in periods of one solar hour (GMT), with the activity being defined as the percentage of active fixes of all the individuals per hour. For each season the approximate time of sunset and sunrise is given. Dusk is defined as the period from when the sun sets until one hour after sunset. Dawn is defined as one hour before sunrise until sunrise.

An ANCOVA test was used in order to analyse whether the daily activity was influenced by the individual's sex, the season and the main climatological variables: minimum temperature, maximum temperature, seasonal precipitation, relative humidity and wind speed (Table 1). A logit transformation was used to adjust the logistical curve of the data. A chi-squared test was used to compare the differences between diurnal and nocturnal activity and between the beginning and the end of the activity periods. Correlation was made in order to look for possible relationships between the percentage of nocturnal activity and the individual's weight. Given that the number of individuals of each sex was insufficient, the correlation was carried out counting the males and females together.

Results

The males' average body weight was 1.95 kg (SD= 0.16, range= 1.73-2.12, n= 4) and the females' 1.62 kg (SD= 0.91, range= 1.55-1.77, n= 5) differed significantly (t= 3.622, df= 4.505, P= 0.018). A total of 1,345 fixes of 9 individuals were obtained (595 males and 750 females).

Both the male (χ^2= 240.02, df= 1, P< 0.0001) and female (x^2= 252.70, df= 1, P< 0.0001) common genets displayed almost exclusively nocturnal activity throughout the year (Figure 1).

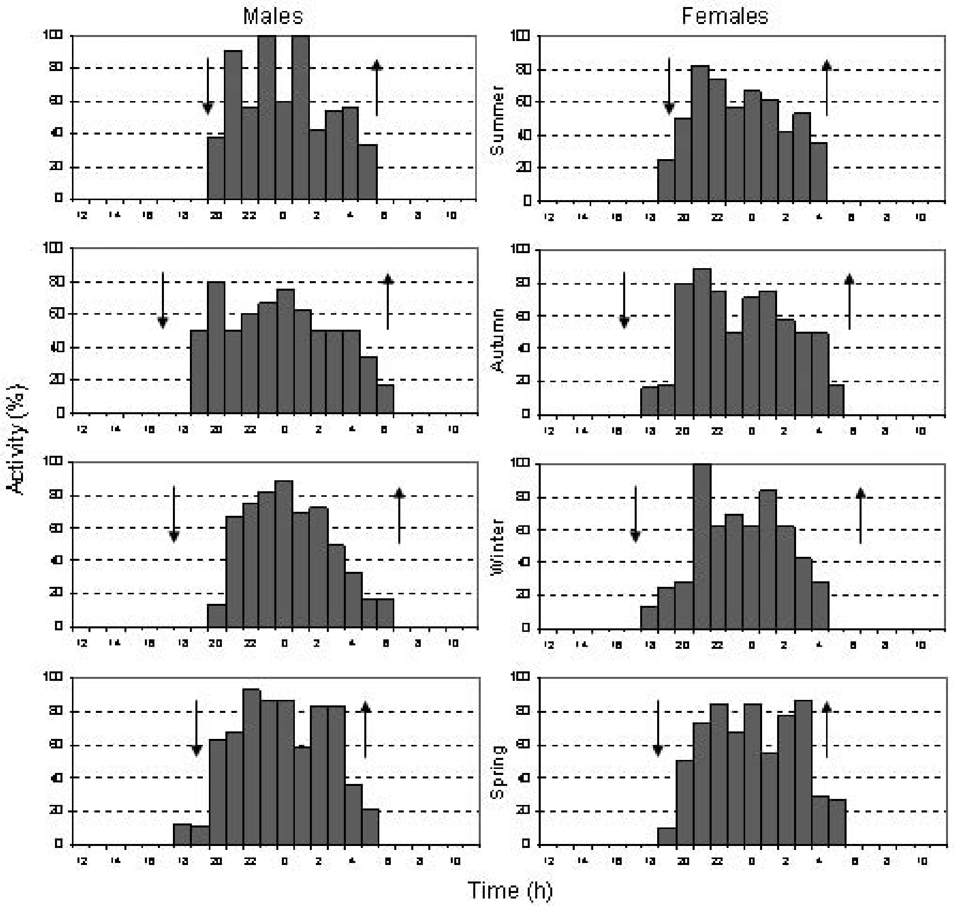

Figure 1. The seasonal activity pattern of the 9 common genets studied (4 males and 5 females). Sampling was carried out at all times of the day, both diurnal (x= 8 fix/hour and season) and nocturnal (x= 20 fix/hour and season). The arrows indicate the approximate time of sunset and sunrise for each season. (The number of fixes and animals of each sex studied in each season are shown in Table 2).

Patrón de actividad estacional de las 9 ginetas estudiadas (4 machos y 5 hembras). Se ha muestreado todas las horas del día, tanto diurnas (x= 8 localizaciones / hora y estación) como nocturnas (x= 20 localizaciones / hora y estación). Las flechas indican la hora aproximada de puesta y salida del sol para cada estación. (El número de localizaciones y los animales de cada sexo estudiados en cada estación se muestran en la Tabla 2).

Activity was higher in males than in females (F= 4.545; df= 1; P= 0.046), and vary with the seasons (F= 20.759; df= 3; P< 0.001), but there was no interaction between sexes and seasons (F= 0.224; df= 3; P= 0.879) (Table 2), nor with any of the climatological variables studied (P> 0.05). The percentage of nocturnal activity was positively correlated with the individual's body weight (r_s= 0.700, n= 9, P= 0.036; Figure 2).

At night (sunset – sunrise) the common genets were active on average 55.7% (± 11.8%) of the time, a value that varied depending on the season (Table 2). The maximum values of the percentage of nocturnal activity, however, occurred in spring and summer, when the night is shorter. Of the 426 fixes carried out during the daytime (sunrise – sunset), activity was only registered in daylight in 12 cases (2.8%). This activity occurred mainly in spring and summer, in males and females, coinciding with twilight hours, both dusk and dawn. Over the whole year, the common genets were active on average 26.0% (± 7.4%) of the entire day.

Table 2
Percentage of seasonal nocturnal activity relative to the length of the night (% night) and the whole day (% daily) for both sexes. For each season, the average duration of the night, the number of common genets studied (N), the number of total fixes (total fixes), the number of nocturnal fixes (noct. fixes), and the number of nocturnal fixes in which the common genets were active (active fixes) are indicated.

Porcentaje de actividad nocturna estacional en relación a la duración de la noche (% night) y del día entero (% daily) para ambos sexos. Para cada estación, se indica la duración media de la noche, el número de ginetas estudiadas (N), el número total de localizaciones (total fixes), el número de localizaciones nocturnas (noct. fixes) y el número de éstas en las que las ginetas estaban activas (active fixes).

		Males						Females					
	Night duration	N	total fixes	noct. fixes	active fixes	% night	% daily	N	total fixes	noct. fixes	active fixes	% night	% daily
Summer	9h 44m	2	99	78	49	62.8±5.9	25.5±2.4	4	202	154	86	55.8±2.5	22.6±1.0
Autumn	13h 44m	2	117	65	35	53.8±5.7	30.3±3.2	4	207	113	58	51.3±3.1	29.5±1.8
Winter	13h 49m	4	161	103	59	57.3±6.1	32.9±3.5	4	168	106	56	52.8±4.1	30.4±2.4
Spring	9h 25m	4	218	166	103	62.0±9.6	24.3±3.8	4	173	134	76	56.7±2.6	22.3±1.0

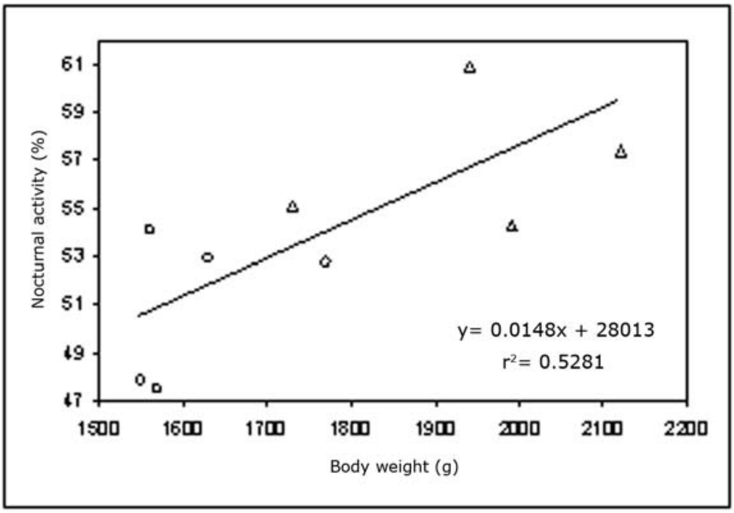

Figure 2. Relationship between weight and nocturnal activity of males (triangles) and females (circles). The result of a regression is showed.

Relación entre la masa corporal y la actividad nocturna de machos (triángulos) y hembras (círculos). Se muestra el resultado de la regresión.

In all seasons, the beginning and the end of the activity were more or less synchronized with sunrise and sunset respectively, mainly coinciding with dusk and dawn, although at these times the activity was minimal (Figure 1). Nevertheless, differences were found between seasons in the activity displayed in the two hours after sunset, both in the males (χ^2= 4.57, df= 3, P= 0.033) and the females (χ^2= 47.41, df= 3, P< 0.001), whilst in the two hours before sunrise, differences were only found in the males (χ^2= 55.26, df= 3, P< 0.001). In summer, autumn and winter, the activity displayed during the two hours after sunset was almost always higher in the males (df= 1: summer, χ^2= 3.88, P= 0.049; autumn, χ^2= 11.27, P= 0.001; winter, χ^2= 4.50, P= 0.034) and also in the two hours before sunrise (df= 1: summer, χ^2= 6.87, P= 0.009; autumn, χ^2= 7.36, P= 0.007; winter, χ^2= 7.36, P= 0.007). In spring, on the other hand, no differences were found between sexes at the start or at the end of the activity. Thus, the activity period extends from dusk to dawn, depending on the length of the night in each season (Figure 1).

On the whole, the common genets displayed an apparently unimodal activity pattern, with the maximum peaks of activity being generally displayed in the first half of the night (Figure 1), although in many cases it was found that the individuals interrupted their nocturnal activity and then became active again later on. This is illustrated by the intensive monitoring carried out with two individuals during the same activity period. Whilst the male displayed a continuous, unimodal activity pattern for 6 hours 45 minutes (%night: 70.0; %day: 29.1), the female's pattern was bimodal, with a total activity period of 4 hours 45 minutes (%night: 51.3; %day: 19.8), with an interruption lasting 1 hour 30 minutes when the female remained on a resting site.

Discussion

The almost exclusively nocturnal activity pattern, delimited by sunset and sunrise, coincides with the pattern described for two females in the north of the Iberian Peninsula (J. Ruiz-Olmo, pers. comm.), and also in the south (Palomares and Delibes 1994), both in young individuals and adults. However, Palomares and Delibes (1988) describe a high diurnal activity rate in a young female. The activity data obtained in our study only refer to adult individuals; therefore, the activity patterns of different age classes cannot be compared. The average daily activity was also similar to that described by Palomares and Delibes (1994), around one quarter of the day.

Other species of genets studied in Africa also display mainly nocturnal activity, but with significant diurnal activity (Ikeda *et al.* 1982, 1983, Fuller *et al.* 1990, Maddock and Perrin 1993). In this and other studies of *G. genetta*, adult individuals display very sporadic diurnal activity. In some cases, this activity may be a result of the animals being disturbed by the presence of the observers near the genets' resting areas (Palomares and Delibes 1994). In our study, it is unlikely that this was the cause of the scarce diurnal activity recorded, given the distance between the observer and the animal when the activity was detected. This diurnal activity mainly occurred at dusk and dawn in spring and summer, in the seasons when the night is shorter. This could cause the animals to begin the activity earlier and end it later, in order to take full advantage of the hours due to the shorter duration of the night. These differences occur because the duration of the night changes throughout the seasons.

Moreover, in spring common genets use larger home ranges, probably due to their biological cycle (Camps and Llimona 2004), and thus this would mean they would be active for longer. In our study area, the length of the night does not affect the common genets' activity percentage, but it does affect the times when the activity begins and ends. This variability in the beginning and ending of the activity period has already been described in different species of carnivores (Kavanau and Ramos 1972).

The duality of the unimodal and bimodal pattern, with two main periods of activity, is typical of carnivores and varies depending on the species (Palomares and Delibes 1994, Lodé 1995, Ruiz-Olmo 1995, Zalewski 2001, Theuerkauf *et al.* 2003), interrupting their activity on a resting site (Livet and Roeder 1987). Small seasonal changes discovered in this pattern may be due to differences in the availability of food throughout the year (Lode 1995), physiological factors such as the breeding period (Debrot and Mermod 1983, Arthur and Krohn 1991, Lodé 1995), changes in their prey's activity (Kruuk 1995) or in the variation of climatological factors (Ewer 1983, Schmidt-Nielsen 1983). Indeed, many species of carnivores reduce their activity at times when climatic conditions are very harsh, especially in northern latitudes (Ewer 1973, Pulliainen and Heikkinen 1980, Buskirk *et al.* 1988, Marchesi 1989). In the case of the common genet, climatological factors such as snowfall, rainfall or temperature could even affect the species' distribution (Virgós *et al.* 2001), but the climatological conditions of our study area are not critical enough to affect it.

The activity depends on the individual's weight, probably for energetic reasons. Heavier individuals have greater energy requirements to cover their physiological needs. This could cause them to be active for longer and have fewer rest periods in order to obtain more food to satisfy their greater energy requirements (Peters 1983, Bunnell and Harestad 1990). Moreover, this is probably the main reason why males are generally more active than females. Males are significantly heavier than females and, consequently, also have greater energy requirements. Furthermore, males have larger home ranges than females (Camps and Llimona 2004), most probably because of their greater weight. This also means they need to be active for longer periods in order to maintain their larger home ranges (McNab 1963, Gittleman and Harvey 1982). In addition, the males have to defend larger territories and, at least during one period of the year, they have to devote additional time to looking for receptive females with which to breed (Camps and Llimona 2004). All these factors lengthen the males' activity period.

It can be concluded that the common genet's activity pattern in our study area is affected by factors such as the animal's sex, its body condition, its biological cycle and the length of the night. Other factors, however, not revealed in this study, may well also affect this pattern. In fact, it is highly likely that a mixture of all these factors determines the common genets' activity patterns.

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