

Reproductive patterns of roe deer in Central Spain

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Abstract. Reproductive patterns of roe deer (*Capreolus capreolus*) were studied in a population of Central Spain, in relation to environmental conditions. The birth period started earlier and was longer than for most European populations, which could be interpreted as a consequence of the mild climate that allows earlier births and higher reproductive asynchrony. Litter size was smaller than for northern populations, which is consistent with the pattern of increasing litter sizes with latitude. Our data suggest that habitat features and quality are related to intrapopulational differences in fecundity and litter size, high quality habitats being associated with higher fecundity rates and the production of larger litters, probably due to the better condition or older age of females using those habitats.

Key words: *Capreolus capreolus*, Roe deer, fecundity, litter size, sex ratio.

Resumen. *Pautas reproductivas del corzo en el centro de España.* Se estudian algunos parámetros reproductivos del corzo (*Capreolus capreolus*) en las Villuercas (Cáceres, España), en relación con las condiciones medioambientales. Los resultados reflejan que el período de partos comienza antes y es de mayor duración que para la mayor parte de las poblaciones europeas, lo cual puede ser consecuencia del clima más templado que hace que la época favorable tenga mayor duración que en otras áreas y permite adelantar el nacimiento de las crías. El tamaño de camada encontrado es menor que en otras poblaciones más norteñas, en consistencia con el patrón esperado de aumento en el tamaño de camada con la latitud. Dentro de nuestra área de estudio, los datos sugieren que las características del hábitat están relacionadas con diferencias intrapoblacionales en fecundidad y tamaño de camada, de modo que hábitats de mejor calidad se relacionan con mayor proporción de hembras en reproducción y camadas mayores, probablemente debido al uso de esos hábitats por hembras de mejor condición o de mayor edad.

Introduction

Mammalian reproductive strategies are largely shaped by environmental conditions (e.g. May & Rubenstein, 1985). The timing and duration of the mating period, the fertility rates, the number of offspring per litter (May & Rubenstein, 1985) and the sex ratio at birth (Clutton-Brock & Iason, 1986), are examples of reproductive features commonly reported to be dependent on the environment.

Different environmental factors may affect the reproductive patterns. For instance, food availability may affect the body condition of the females and hence the age at first reproduction, as well as the litter size and the sex ratio of the progeny (Langvatn et al., 1996; Hardy, 1997). But also, the seasonality of food availability affects the reproductive phenology, either by determining the moment when females reach the condition threshold, the peak of food availability for offspring, or a compromise between both (Follet,

1985). Habitat features may affect social living, the mating system, sexual dimorphism and finally and the number of offspring per litter (Carranza, 1996).

The roe deer (*Capreolus capreolus*) is a cervid species with several characteristics that make it a good candidate for contributing to our understanding of these kind of relationships: i.e. large distribution area, high variability in habitat and social organization, variation in litter size and sex ratio at birth, and embryonic diapause which may allow plasticity in the timing of the mating period with respect to birth season (e.g. Prior, 1995; Danilkin, 1996; Hewison, 1996; Hewison & Gaillard, 1996).

Reproductive features of Iberian roe deer populations are poorly known. Iberian roe deer is characterized by its distribution in forested areas where they live in very small social units (Pereira & Pereira, 1977; Tellería & Sáez-Royuela, 1986; Costa, 1992) contrasting to the open areas and larger groups found in some other parts of its distribution range (Danilkin,

1996).

The aim of this study was to provide information on reproductive features of a roe deer population in Central Spain, which is near the south-western limit of the world distribution of the species.

Study area and Methods

The study area is located in the Villuercas mountains, a chain of low-height mountain ranges (maximum height 1,601 metres above sea level) in the south-east of Cáceres province (central Spain). Observations were concentrated in an area of about 1,500 hectares, covered by three main kinds of forests characterized by the dominant overstorey species: pine (*Pinus nigra*), oak (*Quercus pyrenaica*) and chestnut (*Castanea sativa*). Main understorey genus were *Cistus* and *Erica*, which occurred at variable densities in all forest types. A qualitative rank of these three habitats according to food availability, water sources, and shrub cover as shelter, could be in decreasing order of quality: the chestnut forest, the oak forest, and finally the pine forest (Mateos-Quesada, unpubl. data).

During the birth seasons of 1994 and 1995, the whole area was extensively covered by transects on foot (typically two per day, so that any location in the study area was covered at least every 5 days), and all observed females and new-born offspring recorded, together with their location in the study area and the habitat type. The birth period was defined as the period between the first and the last record of females with newborn fawns. This period was defined in 1995 but not in 1994 because some newborn fawns were seen in the first days of observation in 1994, so we could not pinpoint the onset of the period. Double counting was prevented by considering only those fawns within the few first days of life (less than four days, before the ears were completely extended), and with the help of the location of previous records due to the low mobility of the newborn roe deer during the first days. When possible, we took advantage of natural marks for individual recognition of the mother. Every family group remained within an area of about 23 hectares of rather exclusive use (Mateos-Quesada, 1998), so it was possible to follow the same family group over a long period of time. All family ranges within an inner area of about 900 hectares, included in the 1,500 hectares study area, were intensively monitored by daily itineraries on foot. The sex of fawns was identified when they aged about three months, and the first button antlers can be observed in males (Sáez de Buruaga et al., 1991).

Data are from the whole study area except when they concerned the following of family units for a certain period of time and then they were from the inner area only, hence the differences in sample size between analyses.

Results

Females followed by newborn fawns were recorded from April 8th until May 28th in 1995. The estimated

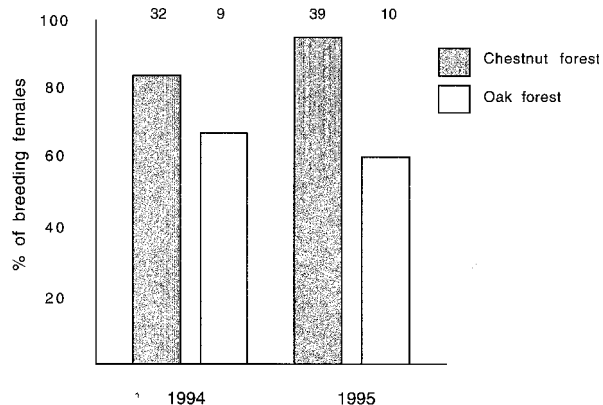


Figure 1.- Proportion of breeding females in both habitat types for the two years of study. Sample size (number of monitored females) is shown above bars.

length for the birth season was therefore about 50 days. The proportion of breeding females was 82.9% (N=41) in 1994 and 79.6% (N=49) in 1995 ($\chi^2=0.162$, d.f.=1, $p=0.687$). Roe deer in the study area was found in three different forest communities, differing in the overstorey dominant species: i.e. pines, oaks and chestnut trees. Although some animals were occasionally seen in pine forests, no family ranges were found placed predominantly in this habitat, hence there were no reproduction recorded for these forests. The proportion of breeding females in both habitats is shown in figure 1.

The common tendency for both years was for the chestnut forest to show a higher proportion of breeding females, although the difference between habitats was only significant for 1995 (1994: $\chi^2=0.216$, d.f.=1, $p=0.642$; 1995: $\chi^2=9.007$, d.f.=1, $p=0.003$).

Litter size varied from one to three in both years. Mean number of offspring per litter was $1.47 \pm 0.50SD$ (N=62) in 1994 and it was $1.45 \pm 0.58SD$ (N=51) in 1995. In 1994, mean litter size was 1.17 ± 0.38 (N=7) in oak forests and 1.40 ± 0.51 (N=27) in chestnut forests (Man-Whitney U-test, $z=1.442$, d.f.=32, $p=0.149$). In 1995, all females in oak forests produced 1 offspring per litter (N=6) while females in chestnut forest

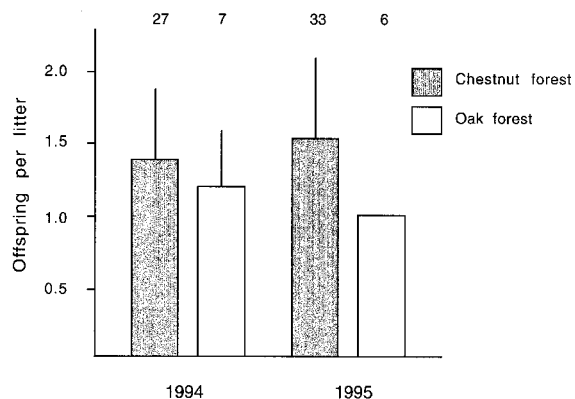


Figure 2.- Litter size for females breeding in chestnut- and oak forests in the two years of study. Sample size (number of litters) is shown above bars.

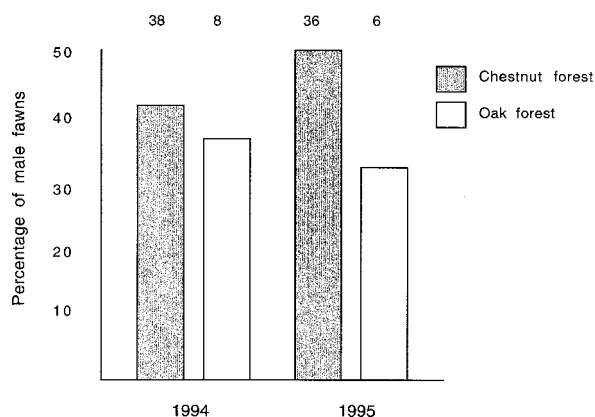


Figure 3.- Sex ratio (proportion of male fawns) according to habitat, for the two years of study. Sample size (number of offspring) is shown above bars.

produced 1.51 ± 0.57 ($N=33$) calves per birth (Mann-Whitney U-test, $z=2.174$, $d.f.=37$, $p=0.029$) (Figure 2).

A slightly higher percentage of female fawns (55.7%, $N=79$) than male fawns was born in 1994 as well as in 1995 (54.55%, $N=55$), although sex ratios at birth were not significantly different from 1:1 (Chi-square one group: 1994: $\chi^2=1.025$, $d.f.=1$, $p=0.311$; 1995: $\chi^2=0.455$, $d.f.=1$, $p=0.500$). Females in chestnut forests gave birth to a slightly higher proportion of male fawns than those in oak forests, although the sample size for oak forests was too small to draw firm conclusions (1994: $\chi^2=0.058$, $d.f.=1$, $p=0.810$; 1995: $\chi^2=0.573$, $d.f.=1$, $p=0.449$; Figure 3).

Discussion

Our record for the onset of the birth season (April 8th) is the earliest one ever reported for roe deer, several days before than the April 14th reported by Szedergei & Szedergei (1971). Such dates for most populations are in May and June, and the case for our population is in concordance with the pattern of earlier birth periods in warmer climates (Gaillard et al., 1993). In the same way, the mild climate may influence the asynchrony of births. The duration of the birth season is almost two months in our population, similar to that reported by Costa (1992) for another Spanish population situated about 400 km north, and much longer than that of 43.7 days reported as maximum duration by Danilkin (1996), or the more frequently reported 30 days (Borg, 1970; Perco & Perco, 1979; Sempere, 1982; Danilkin, 1996).

Mean litter size in our population is smaller than those reported for northern populations, where average litter sizes are commonly over 1.5 (Haafte, 1968; Kurt, 1968; Tarello, 1991; Boisaubert & Boutin, 1993; Andersen et al., 1998). Hewison (1996) reported an interpopulational positive relationship between body weight and mean litter size for roe deer in Britain. Body weight of roe deer in our population (25.3 Kg on average, Mateos-Quesada 1998) is at the top of the range provided by Hewison (1996), however litter size in our

population is only 1.46 on average, far below the size predicted by such a relationship (over 1.8). The result of a low litter size relative to body weight may be in concordance with the tendency for increasing litter size with latitude (Conaway et al., 1974). Habitat quality may also influence litter size, either because different habitats have different nutritional quality (Duncan et al., 1998), or because age and condition of females may be different according to habitats as a result of intrapopulational competition, and fecundity is largely affected by such female features (Hewison, 1996). Our data suggest that oak and chestnut forests may produce differences in litter size. In fact, the tendency of higher fecundity of females in the chestnut forest would be according to the habitat selection in favour of this habitat by the roe deer in our area (Mateos-Quesada, 1998). However, the number of litters found in the oak forests was too small to draw firm conclusions. Among the three populations of roe deer so far studied in Spain, two of them are in deciduous forests (Costa, 1992; this study) and show higher litter size than the other one living in a more xeric Mediterranean habitat (Braza et al., 1994).

Environmental factors may also affect the sex ratio at birth (Clutton-Brock & Iason, 1986). Competing theories for sex ratio adjustment rely on sex differences in variance of reproductive success (Trivers & Willard, 1973) or on sex differences in local resource competition (Clark, 1978; Silk, 1983). Data for roe deer are contradictory (see review in Hewison et al., 1999). Our data suggest that mothers in high quality habitat would produce more sons, although the sex ratio differences were not significant due to the very small sample size for the poor quality habitat. Despite the low degree of polygyny in this species, the variance in male reproductive success is higher than that of the female (Gaillard et al., 1998; Liberg et al., 1998). On the other hand, although females may be more philopatric than males (Vincent et al., 1983), all juveniles may tend to disperse because of the territorial behaviour of adults, especially in forested habitats (Danilkin, 1996; Mateos-Quesada, 1998). This might explain a sex ratio adjustment more in concordance with Trivers-Willard predictions.

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