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Body size and reproductive parameters in the wild boar *Sus scrofa*

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Parameters involved in the reproductive performance of wild boar *Sus scrofa* Linnaeus, 1758, such as fertility rates and litter size, show considerable intrapopulational variability. In this work we analyze a total of 198 females, culled by hunting in the Villuercas region (Cáceres, Spain), in an area with food suplementary throughout the year. The 31% of the total number of females examined, and the 47% of the female above 44 kg body weight, were in breeding condition (either gestating or lactating). There were no differences among four central months throughout the breeding period in the proportion of breeding females. Mean litter size was positively influenced by physical features of the female such as body size and weight. The month of the year (within the central breeding period) did not affect litter size. These findings indicate that reproductive decisions of females, ie whether or not to start gestation and the number of offspring in the litter, are mainly determined by their physical features.

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Introduction

The wild boar *Sus scrofa* Linnaeus, 1758 is at the moment the most widely distributed ungulate in the Iberian penninsula having expanded the areas which it occupies as well as increasing its numbers in those areas where it already lived (Sáez-Royuela and Tellería 1986). Knowledge of the reproductive characteristics of the population present in the Iberian penninsula has given an explanation for this present situation, the studies by Vericad (1983), Sáez-Royuela (1987) or Abaigar (1990) being outstanding. The study of the different populations has also discovered differences in the reproductive characteristics such as fertility of the females or size of the litter.

These two aspects of the reproductive biology of the wild boar are, apparently, conditioned to a great degree by the physical characteristics of the female (Sáez-Royuela 1987, Abaigar 1990), although there are also other factors to be taken into account such as density of population (Aumaitre *et al.* 1982), the periods of light (photo-periods) (Mauget *et al.* 1980) or the quantity and moment of available food (Aumaitre *et al.* 1982).

The aim of the present paper is to analyse the influence of certain physical parameters (weight, physical condition, total length, height and body length) and seasonality (in the four months where there are hunts which we can consider as the central reproductive months) of the wild boar.

Study area

The study was made in the Villuercas region, in the centre-west of the Iberian penninsula. The wild boar came from several estates of a total extension of about 3500 hectares, mostly devoted to game hunting. As well as wild boar, and only referring to ungulates, there is a large population of red deer *Cervus elaphus*, roe deer *Capreolus capreolus* and in recent years fallow deer *Dama dama* have also been introduced.

The local vegetation is abundant mediterranean forest composed principally of holm oak *Quercus ilex*, cork trees *Quercus suber* and oak *Quercus pyrenaica*, which together make up for 80% of the area under study. There are also pine forests *Pinus halepensis*, and also about 100 hectares of chestnut trees *Castanea sativa* which are grown for their nuts. Between the months of February and October, and very specially during the summer months, a food supplement is provided of about 15000 kilogrammes of fruit and corn.

Material and methods

Totally, 198 females from the hunts were examined, being this hunting activity a widely used way of obtaining data in the areas where the wild boar is commonly hunted (Galliard *et al.* 1987, Sáez-Royuela and Tellera 1988, Abaigar 1990, Badia *et al.* 1991). Data were collected during the hunting seasons of 1994–1995, 1995–1996 and 1996–1997. Due to the fact that the wild boar analyzed were dead animals from hunting they reflect the situation between the months of October and February (the official hunting season), both inclusive.

The following data were taken from the females: date of death, reproductive state, weight, total length, height, body length. In the case of pregnant females, the weight considered was that of the mother subtracting the weight of the unborn foetuses it carried. With reference to the reproductive state, all of the females were included in one of these two categories: in reproduction, without reproduction. Refering to the first group, two more types were defined: pregnant females carring foetuses, and female with milk in their mammary glands. When comparisons were made this was only between females which had mostly or completely finished their development, we have taken into account females weighing 45 kilogrammes or more, this being the accepted weight of several authors (see Sáez-Royuela 1987, Spitz *et al.* 1990). Physical condition was also calculated using a relationship between logarithm of length, in our case height, and logarithm of weight, being the physical condition the residual values of this relation (Andersson 1992). The number of embryos or foetuses in pregnant females was also registered.

The age of the foetuses (t) was determined using the Huggett and Widdas formula (1951), which had already been applied to the wild boar (Vericad 1983),

$$t = \frac{\sqrt[3]{Pm}}{0.097} + 24.1$$

where Pm is the average weight of the foetus of the litter.

The statistics employed are parametrical since in all the variables the Kolomogorov-Smirnov Normality Test has been applied, with the result $p > 0.05$ in all cases.

Results

Of 198 females analysed, 137 (69.2%) were not in reproduction, and 61 (30.8%) were in reproduction, of which 52 were pregnant and 9 were lactating. Those in reproduction had the greatest weight (ANOVA $F = 33.84$, df = 1,195, $p < 0.001$), as well as a greater total length (ANOVA $F = 28.69$, df = 1,195, $p < 0.001$) and height (ANOVA $F = 27.13$, df = 1,195, $p < 0.001$).There were no differences in the length of tarsus (ANOVA $F = 3.60$, df = 1,195, $p = 0.06$) nor in physical condition (ANOVA $F = 0.99$, df = 1,195, $p = 0.321$).

To determine the influence of weight on reproductive state, the females were placed in 6 size groups. The results indicate (Fig. 1) that the percentage of reproductive females was low among small females and high among large females ($\chi^2 = 25.85$, df 10, $p = 0.004$).

On the other hand, there were no differences ($\chi^2 = 0.56$, df = 1, $p = 0.450$) in the percentage of females in reproduction in the two seasons studied, winter (33.4%) and autumn (28.5%). The result was the same ($\chi^2 = 0.474$, df = 1, $p = 0.493$) when only adult growing females (34–44 kg) were analysed, although the percentage of pregnant females in autumn (24.3%) was slightly greater than in winter (18.2%).

The months when most of the females got pregnant was in August (43%) and September (31%) (Fig. 2), although there were conceptions from June to October. The months when most of the births took place were in December (42%) and January (35%).

The size of the litter was 3.58 ± 1.33 (average ± standard deviation) and varied between 1 and 7 (Fig. 3). No differences were observed during the seasons analysed (ANOVA $F = 0.07$, df = 1,63, $p = 0.793$), neither were there any differences between years (ANOVA $F = 0.058$, df = 2, 59, $p = 0.994$). Litter size correlated positively with several body measurements: weight ($r = 0.392$, $p = 0.001$), total length ($r = 0.33$, $p = 0.008$), and height ($r = 0.267$, $p = 0.033$), while no correlations physical condition ($r = 0.108$, $p = 0.3940$) and tarsus ($r = 0.011$, $p = 0.933$).

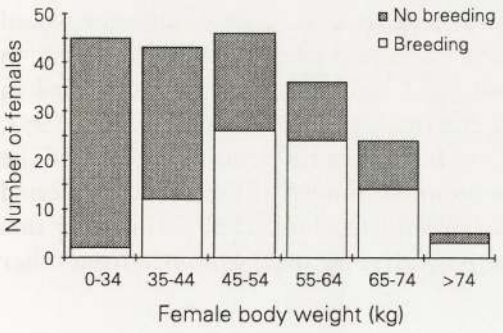

Fig. 1. Relationship between female body weight and breeding condition.

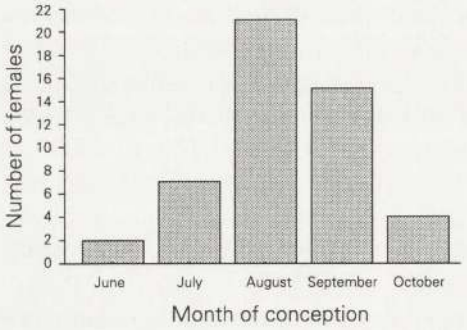

Fig. 2. Monthly frequency of conceptions, estimated on the basis of litter weights from females culled between October and January.

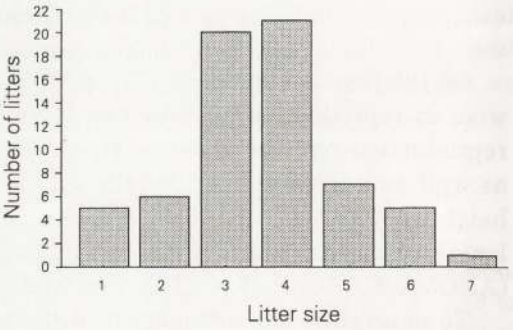

Fig. 3. The distribution of litter size.

Discussion

The population of wild boar studied is not different from that of other studies (see Mauget and Pépin 1987 or Sáez-Royuela 1987) with respect to physical characteristics of breeding females and their reproductive phenology. Because breeding females are larger than non-breeding ones, this presumably indicates that the amount of resources available for reproduction increases once body development has reached its peak (Tuomi 1980, Gerard *et al.* 1991, Ahmad *et al.* 1995). The proportion of breeding females is about the same in autumn and winter, and gestation frequency is highest in the winter (Abaigar 1990). This fact, which is due to the advanced period of conception of the wild boar in our study (mainly in August and September), differs from earlier studies in other parts of Europe (Aumaitre *et al.* 1982, Mauget *et al.* 1984) or even in other parts of the Iberian penninsula (Sáez-Royuela 1987, Abaigar 1990, Fernández-Llario 1996) where the maximum number of conceptions takes place in November or December.

We believe that this behaviour could be due to the large amounts of food which is supplied artificially during the summer and which enables the females to reach the necessary physical requirements, which control the beginning at the reproductive cycle (Massei *et al.* 1996). The advancement of the period of heat would be, then, a direct consequence of this type of care, and would lead us to question the accepted idea the periods of increasing light have an implicit rest period in wild boar reproduction (Mauget 1980, Aumaitre *et al.* 1982, Sáez-Royuela 1987, Abaigar 1990, Fernández-Llario 1996). This has been referred to as one of the most important determining factors in the commencement of the breeding period in the wild boar (Ahmad *et al.* 1995, Barber and Coblenz 1987). However this subject must be studied in greater depth specifically, we need evidence from other

populations with similar feeding conditions to those in this study and where gestations in August and September is not observed (Mauget 1980).

With reference to the size of the litter, 3.58 piglets per female is lower than in other penninsular populations, such as 4.04 in Doñana (Fernández Llario 1996), 4.2 for the wild boar in the province of Burgos (northern Spain) (Sáez-Royuela 1987), and 4.1 in Almería (east of Spain) (Abaigar 1990). The values obtained in more distant places are even larger, eg France 4.44 (Dardaillon 1988) and 4.75 (Aumaitre *et al.* 1982), Italy with values between 2.8 and 4.5 (Massei *et al.* 1996), Germany with more than 5 (Stubbe and Stubbe 1977) or 5.2 piglets in Poland (Dzięciołowski 1991). This divergence could, in part, be due to Bergmanns rule (see Vericad 1983, Sáez-Royuela 1987); that is the more northern populations, tend to have an increased size of litter (Stearns 1992). The rule has been also confirmed for other species of mammals (Cockburn *et al.* 1983, Conway *et al.* 1974, Fleming and Rauscher 1978).

This litter size could also be a result of heavy hunting activity within the area. Therefore, in this type of peninsular zone the mean age of the population, and as such of the females, is quite low (Sáez-Royuela 1987). This in turn leads to a large part of the reproducing females being very young, which contributes to the fact that the litter sizes are low (Sáez-Royuela 1987, Dzięciołowski *et al.* 1992, Ahmad *et al.* 1995).

Finally, one must also take in account the possible influence that the way food is supplied could have. The fact that it is administered in very specific areas leads to very high population densities at conception, and this in another condition which could contribute to lower litter sizes (Dawkins 1980, Massei *et al.* 1996).

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