

Allometric growth in the Spanish ibex, *Capra pyrenaica*

We would like to dedicate this work to the memory of a great friend and colleague, Dr. Ruiz-Martínez, who died a few years ago in a fatal accident.

José E. GRANADOS¹, Paulino FANDOS², Francisco J. MARQUEZ³, Ramón C. SORIGUER⁴, Manuel CHIROSA⁵ and Jesús M. PEREZ³

¹ Sierra Nevada National Park, Carretera de Pinos Genil, Km. 7, E-18071 Granada, Spain; e-mail: pn.snevada@cma.junta-andalucia.es

² Environmental Adequation, Almadén 15, 3^o-4, E-28014 Madrid, Spain; e-mail: pfandos@navegalia.com

³ Department of Animal and Plant Biology, and Ecology, Jaen University, Paraje Las Lagunillas S.N., E-23071 Jaén, Spain; e-mail: jperez@ujaen.es

⁴ Doñana Biological Estation (Council of Scientific Research), P.O. Box 1056, E-41080 Sevilla, Spain; e-mail: soriguer@ebd03.ebd.csic.es

⁵ Department of Environment, Government of Andalusia, Marqués de la Ensenada 1, E-18003 Granada, Spain; e-mail: Sv.E.Gr@cma.junta-andalucia.es

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Abstract. The growth of Spanish ibex from the Sierra Nevada National Park was studied by analyzing ten biometric parameters. The results obtained show faster growth in females, and this asymptotic values obtained in this study are lower than those reported for other Spanish ibex populations. Males do not reach stable or definitive values for body weight and horn length, but show asymptotic values for horn perimeter at 8 years. Females reach asymptotic values for the three parameters selected between 3 and 4 years of age.

Key words: age, allometry, Caprinae, Sierra Nevada, Spain

Introduction

Wild populations are frequently limited by the availability of food resources, which effect growth, fecundity and survival (Houston et al. 1989). Individuals differ both at the intra and inter-specific levels in features such as body size, or age of maturity (Reiss 1989). Various studies on wild ungulates (Nievergelt 1966, Bunnell 1978, Fandos et al. 1989) have shown a relationship between body weight and horn length, however animal. Body weights often fluctuate seasonally because of intrinsic factors (Mitchell et al. 1976, Solberg & Saether 1994). The analysis of growth curves in wild populations can reflect the overall health of such populations (Fendley & Brisbin 1977), and external morpho-biometric parameters may be used as indicators of environment quality for management activities. This bit is a little unclear the aim of our study was to been analyze the growth rate of a Spanish ibex population from the Sierra Nevada National Park and to compare it with data obtained from other ibex populations.

Materials and Methods

The Sierra Nevada National Park is located in the southeast of the Iberian Peninsula and occupies an extent of 850 km² (36°55'–37°10' N, 2°34'–3°40' E) and contains the highest

peak in the peninsula (Mulhacén: 3481 m a.s.l.). All bioclimatic stages described for the Mediterranean region are present (a more detailed account can be obtained from M o l e r o et al. 1992).

In this study, a total of 651 ibexes (435 males and 216 females) were sampled. Animal weights and measurements were obtained by means of live-trapping (using corral-traps; P é r e z et al. 1997) and by selective hunting for management purposes within the Sierra Nevada National Game Reserve. The ages of animals were established following the criteria of F a n d o s (1991). The biometric parameters analyzed were: body weight (BW), horn length (HL), horn basal circumference (HBC), horn spread : tip to tip (HS), body height (BH), body length (BL), chest girth (CG), femur length (FL), tail length (TL) and ear length (EL). These were chosen both to study growth and to allow comparisons between the sexes. We also compared our data with those obtained from other ibex populations. Relationships between age and other parameters were analyzed through a correlation matrix using log-transformed data. The variables studied were fitted to the three most frequently used growth models: logistic, Gompertz and Von Bertalanffy, which respectively progressively longer and more gradual approaches to asymptotic values (F e n d l e y & B r i s b i n 1977). The logistic model fits the equation $y = A / (1 + e^{-K(x-1)})$, where y is the value for the time variable, A is the asymptotic value and K and x are coefficients describing growth. The Von Bertalanffy model corresponds to a function $y = A (1 - e^{-b(x-1)})$. The Gompertz model is represented by the equation $y = A (e^{-e^{-K(x-1)}})$.

Results

The correlation indices best predicting age were: horn length (0.795), chest girth (0.739) and horn spread (0.715) (males) and horn length (0.944), horn spread (0.917) and body weight (0.889) (females). Chest girth was also highly correlated with body weight (0.922), horn circumference (0.906) and body height (0.864) in males, and with body weight (0.928), horn circumference (0.928) and horn length (0.893) in females. R^2 values for different parameters for fitting the variables considered (BW, HL and HBC) to the three growth models are generally high (> 0.96) and more or less similar between models. Asymptotic values for different parameters obtained from different growth curves are also similar, except in the case of horn length in males. As expected, males reached the highest body weight values in all age groups considered, when compared to females. Male BW increased rapidly until 5 years of age, but increased continuously throughout their lives. The maximum theoretical weight reached by males was close 69 kg. Females increased their body weight even more rapidly during their three first years, reaching around 32 kg at five years. Fig. 1 (a-b) represents the growth curves generated by fitting the values obtained to the logistic function giving the best correlation indexes for both males ($R^2 = 0.97$) and females ($R^2 = 0.98$). In both sexes, the logistic model best fitted the increase in horn length ($R^2 = 0.97$ in males and $R^2 = 0.97$ in females) with estimated growth rates (B) of 1.78 and 0.52, respectively. Asymptotic values (around 16.4 cm) were attained by females after their three first years of life. Males showed a continuous increase in HL, reaching an expected maximum of 74.15 cm. Fig. 1 (c-d) shows growth curves for HL in males and females. Basal horn circumference also fitted a logistic function, with a higher growth rate in males ($B = 0.61$) than females ($B = 0.24$). The average maximum values expected for males was 21.92 cm and 9.72 cm for females. Growth curves generated for HBC are shown in Fig. 1 (e-f).

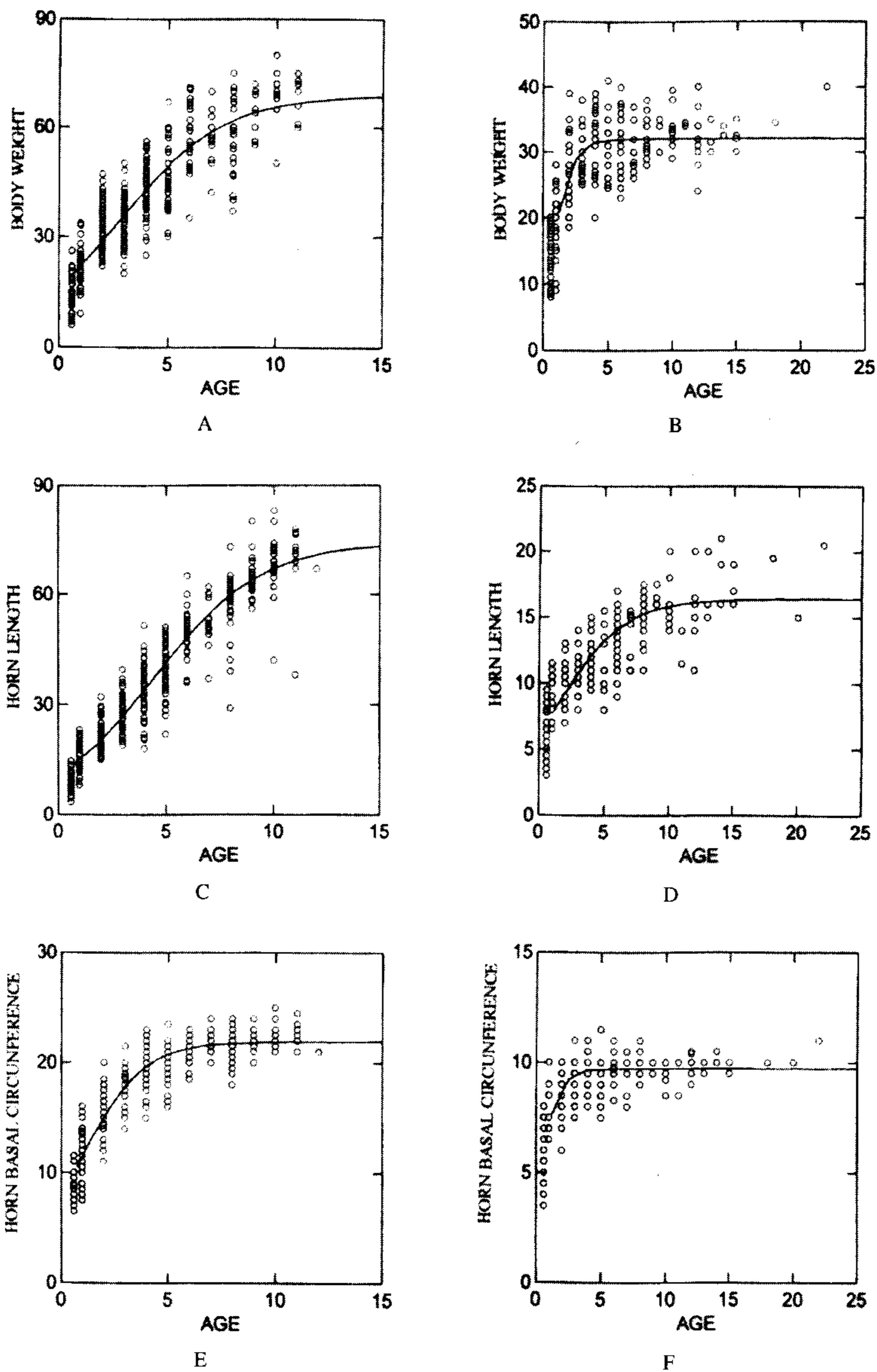


Fig. 1. Male (a) and female (b) weight growth curves, fitted to a logistic function. Male (c) and female (d) horn length growing curves, fitted to a logistic function. Male (e) and female (f) horn basal circumference growing curves, fitted to a logistic function.

Discussion

Our data show marked sexual dimorphism in asymptotic values and growth rates for the three parameters analyzed. This has been reported previously by Couturier (1962), Nievergelt (1966), Schaller (1977), Bunnell (1978, 1980), Gray & Simpson (1979), Jarman (1983), Fandos & Vigal (1988), Fandos et al. (1989) and Fandos (1991). Granados et al. (1997) report smaller sizes in ibex from

southern populations and, when comparing growth rates from different Spanish ibex populations, we observed asymptotic values to be reached earlier in animals from Sierra Nevada than from Cazorla and the Gredos Mountain Range (Fandos et al. 1989, Fandos 1991). Females in their third year reach asymptotic BW and HL values and, in general, adult size, when they are 3-4 years old. On the contrary, average values for each parameter in older male age classes are usually smaller than asymptotic values. This hypothesis must be confirmed by histological analysis of the genitalia, however, our data support the hypothesis that females from southern populations become adult earlier. Individual regressions are necessary for each population and for both sexes (Fandos et al. 1989). In our opinion, the biometric differences observed amongst ibex populations are probably related to both intrinsic and environmental factors (Nievergelt 1966, Bunnell 1978, Fandos & Vigal 1988, Fandos 1991). These reflect habitat quality to a greater or lesser extent, but have no taxonomic implications, even if we consider populations from Cazorla and Sierra Nevada to belong to the same subspecies (Cabrera 1911).

Data obtained in this study suggest that the game management regime presently operated for Sierra Nevada ibex is inadequate because animals are hunted prior to fully completing growth. This is also considered to represent a source of genetic impoverishment (Hartl 1992). Moreover, in recent times old males have become more and more scarce. Increasing the minimum age of the animals to be hunted may have a positive effect on population structure, and on future trophy quality.

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