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Body Weight and Horn Length in Relation to Age of the Spanish Wild Goat

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Growth in body weight and horn length was studied in two Spanish wild goat populations (*Capra pyrenaica* Schinz, 1838) in Sierra de Gredos and Sierra de Cazorla. The males of both populations and from all age classes had greater mean weights and horn lengths than females. The growth rate of horns and body weight of females was more rapid and the asymptotic value for males was higher. When compared to the Cazorla population, the Gredos animals attained significantly greater body weights and hornsheath length in adults of both sexes.

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1. INTRODUCTION

The lack of basic data and growth studies of most ungulate species may be due to the difficulty in obtaining representative samples and the lack of reliable methods for age determination (Blood *et al.*, 1970; Bunnell & Olsen, 1976; Grobler, 1980).

There are only a few descriptive studies of the endemic Spanish wild goat *Capra pyrenaica* Schinz, 1838 (Cabrera, 1911; Couturier, 1962). The purpose of our study was to examine the relationship between body weight and horn-sheath length, and age. Our objectives were to observe growth in this species and compare our findings with other populations. Our data can also be used for later correlation studies with primary production (Bunnell, 1978) or energy flow between trophic levels (Dzięciołowski, 1970).

2. STUDY AREA

We studied specimens from the two largest Spanish wild goat populations in the Iberian Peninsula (de la Cerda & de la Peña, 1971). The first population *C.p. victoriae* Cabrera, 1911, came from a national game reserve in the Sierra de

Gredos ("SG") (40°11′ and 40°26′N). The second population, *C.p. hispanica* Schimper, 1848, was from the Sierra de Cazorla ("SC") within a natural park (37°48′ and 38°10′N).

The climatic differences between sites are shown by the plant species found in different vegetation strata (Allue & Andrade, 1966). The supermediterranean stratum at "SC", found at intermediate altitudes, is characterized by two species of trees: evergreen oak (*Quercus rotundifolia* Lam.) and muricated oak (*Q. faginea* Lam.). White oak (*Q. pyrenaica* Willd.) predominates in "SG".

The oromediterranean stratum is found at the highest altitudes in "SC" and is characterized by Austrian pine (*Pinus nigra* L.). In "SG", the dominant species of this stratum is broom (*Cytisus purgans* L.).

The cryomediterranean stratum is only present in the "SG" and has no arboreal or shrub layer, consisting mainly of alpine meadows and areas of *Nardus stricta* L.

3. MATERIAL AND METHODS

We collected a total of 177 shot specimens of Spanish wild goat, 90 from "SG" and the rest from "SC". Data from goats shot, throughout 1980 to 1984, were pooled, in order to create samples of approximately equal size for each season of the year.

Whole animals were weighed using a spring scale with an accuracy of ±0.1 kg. Horn length was determined by using a thick string closely applied to the irregularities of the anterior crest of the sheath and then measuring the string, a method that has an accuracy ±1 mm. Specimen age was calculated on the basis of the number of horn growth rings and capture date (Fandos *et al.*, in press).

Student *t*-test was used to calculate the significance of the differences between mean weights and horn length in adult specimens of the two populations.

The Von Bertalanffy equation was used to analyse weight and horn length in relation to specimen age for each sex. This equation was chosen because of its biological relevance (Schroeder & Redlich, 1977; García González, 1980) and because it is commonly used in such studies (Ricklefs, 1967; Sinclair, 1977; Kingsley, 1979). The equation for evaluating weight gain was:

$$W = P_1 ((1 - \exp (P_2 (t - P_3)))^3)$$

and the equation for horn sheath length was:

$$L = P_1 (1 - \exp (P_2 (t - P_3)))$$

(W=weight, L=length, t=specimen age in year and P_1=asymptotic value, P_2=growth rate and P_3=constant related to size at birth).

4. RESULTS

The males of both populations and from all age classes had greater mean weights and horn lengths than females. Males and females from the "SG" sample were heavier and had larger horns than the adult "SC" animals. The differences in the two variables between populations were significant in both sexes (Table 1).

Male weights increased rapidly until the animals were five or six years old and reached the maximum value at about nine years of age. Females showed marked weight gain in the first four years of life with slight differences after this age (Fig. 1).

Table 1.

Statistical description and significance of the differences in the two variables studied for two *C. pyrenaica* populations, by sex. Results of Student *t*-test. SG — Sierra de Gredos, SC — Sierra de Cazorla.

	Weight (kg)				Length of horn (mm)			
	Males (>5 yrs)		Females (>4 yrs)		Males (>9 yrs)		Females (>8 yrs)	
	SG	SC	SG	SC	SG	SC	SG	SC
Mean	58.08	50.93	36.11	30.11	745.00	671.13	242.50	161.22
SD	8.08	8.95	4.54	4.37	33.89	37.21	37.91	19.64
n	23	45	17	29	4	8	12	18
t	3.22		4.37		3.19		7.29	
p<	0.01		0.001		0.01		0.001	

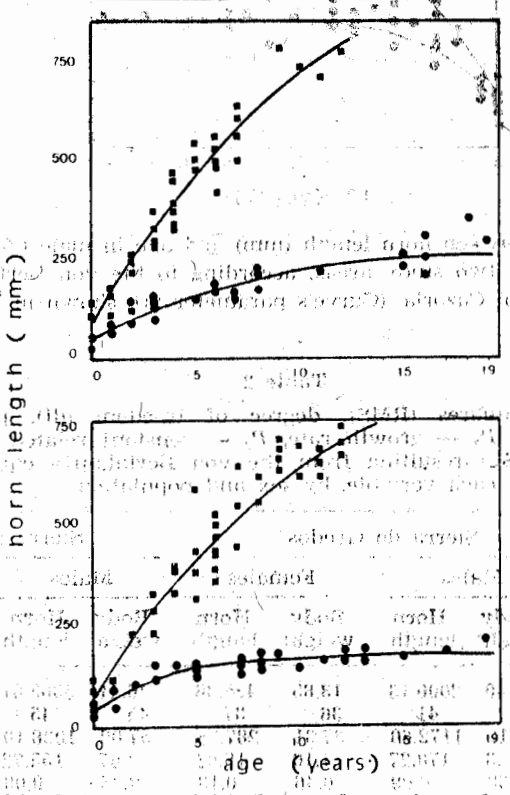

Fig. 1. Relationship between weight (kg) and age in males (■) and females (●) of *C. pyrenaica* from the two study areas, according to the von Bertalanffy equation. (a) Gredos, (b) Cazorla. (Curve's parameter are shown in Table 2).

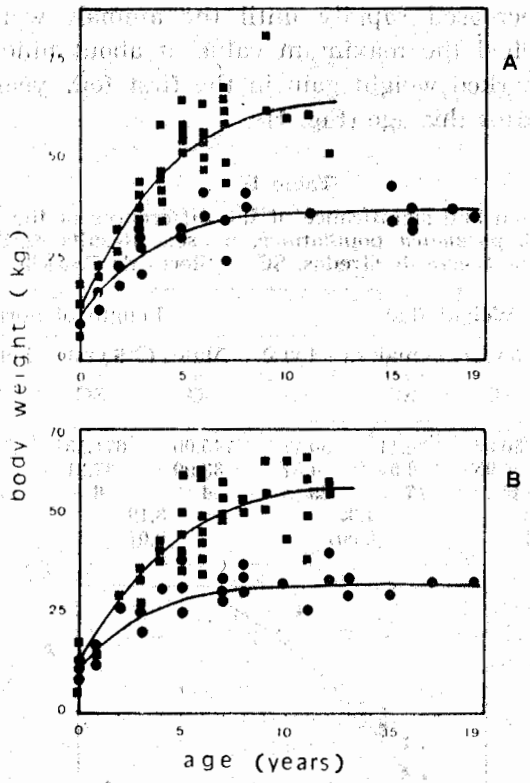

Fig. 2. Relationship between horn length (mm) and age in male (■) and female (●) *C. pyrenaica* from the two study areas, according to the von Bertalanffy equation. (a) Gredos, (b) Cazorla. (Curve's parameter are shown in Table 2).

Table 2

Residual minimum squares (RMS), degree of freedom (df), parameter values (P_1=asymptotic value, P_2 — growth rate, P_3 — constant related to size at birth) and standard error (SE) resulting from the von Bertalanffy equation fitting for each variable, by sex and population.

Variable	Sierra de Gredos				Sierra de Cazorla			
	Males		Females		Males		Females	
	Body weight	Horn length	Body weight	Horn length	Body weight	Horn length	Body weight	Horn length
RMS	46.40	2006.13	13.85	425.38	46.41	3365.01	12.63	254.13
df	47	41	36	37	45	45	36	35
Paramt. P_1	65.18	1172.60	37.31	287.26	57.09	1028.10	31.60	171.37
S.E.	3.23	178.27	1.10	18.03	2.67	155.72	0.91	5.38
Paramt. P_2	0.38	0.09	0.46	0.13	0.33	0.09	0.49	0.34
S.E.	0.06	0.02	0.06	0.02	0.06	0.02	0.08	0.05
Paramt. P_3	—1.05	0.21	—1.24	—0.68	—1.59	0.24	—1.13	0.26
S.E.	0.49	0.26	0.43	0.44	0.77	0.39	0.49	0.21

Horn length increased (Fig. 2) longer during the animal's life than body weight. Females attained adult values at earlier ages because of their more rapid relative growth rates — P_2 — (Table 2) and earlier attainment of adult body size.

5. DISCUSSION

The clearest finding of our study was the presence of marked sexual dimorphism in asymptotic values and growth rate of two variables studied, as has been indicated in Caprines by other authors (Couturier, 1962; Nievergelt, 1966; Schaller, 1977; Bunnell, 1978, 1980; Gray & Simpson, 1979).

The correlations between age-weight and age-horn length were stronger in females from both populations (Table 2). This may indicate that annual environmental variations affect males more than females, as Bunnell (1978) has noted in the horn growth of Dall's sheep. However, Gray & Simpson (1979) observed a greater variability in female Barbary sheep, attributing it to the stress of gestation and suckling.

Only the heaviest males with the biggest horns take part in the reproductive process. Natural selection probably favors the males' continuous growth rate in horn length and body weight as part of the reproductive strategy (Geist, 1971; Fandos, 1986).

Our results indicate that there are certain differences between the subspecies, although these variables should not have taxonomic significance since body size and horn-sheath length are directly influenced by the availability of food and environmental factors (rainfall *ect.*) (Nievergelt, 1966; Bunnell, 1978; Fandos, 1986).

The data given here differ from those given by other authors such as Couturier (1962), who gives weight of adult male of 70—80 kg in "SC", with a mean of 65 kg for the largest specimens of the "SC" population. Couturier does not mention sample size or age at which animals were considered to be adults.

Our mean horn-sheath lengths for the "SG" male specimens were slightly greater (Table 1) than data given by Cabrera (1911): ($x = 704.1 \pm 63.5$ mm ($n = 10$)) or by Couturier (1962): ($x = 260 \pm 46.22$ mm ($n = 4$)).

C. pyrenaica is intermediate in body weight within the genus *Capra;* the heaviest species being *C. ibex walia* Ruppell, 1835, and the lightest, *C. aegagrus* Erxleben, 1977 of Crete (Schaller, 1977).

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