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Feeding strategies of Spanish Wild Goat in the Cazorla Sierra (Spain)

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WILD GOAT
CAPRA PYRENAICA
HABITAT
FEEDING STRATEGIES
SPAIN

ABSTRACT – Spanish wild goat (*Capra pyrenaica*) diet has been determined in three areas of Cazorla Sierra wich has different vegetation and herbivore density. Diets were determined in three seasons of the year in order to know the habitat, available vegetation, herbivore density and seasonality influences in diet selection.

We have selected three study areas :

1 La Cañada area is situated at 1300 m height and extends over 0.87 km^2, potential vegetation belongs to the supramediterranean betican basophilous series of *Quercus faginea*, mean animal density is 69 indiv./km^2,

2 La Nava area is situated at 1300 m height and extends over 2 km^2, potential vegetation belongs to the supramediterranean betican basophilous series of *Quercus rotundifolia*, mean animal density is 210 is 210 indiv./km^2,

3 Linarejos area is situated at 1000 m height and extends over 0.72 km^2, potential vegetation belongs to the mesomediterranean betican basophilous series of *Quercus rotundifolia* and mean animal density is of 40 indiv./km^2.

Herbaceous vegetation available to the herbivores was determined by a "point-quadrat" modified method, and ligneous vegetation both by cover and line-intercept methods. Wild goat diets were estimated by micrographic analysis of fresh feces and animal censuses were carried out. Kulzynski's similarity indeces were used to compare herbivore diets. Also, Ivlev's and niche-breadth indices were calculated.

Results show that Spanish wild goat is broadly browser with seasonal variations in his diet. Holm oak (*Quercus rotundifolia*) was the most selected plant species in all study areas. Diet variations between La Nava and Linarejos areas were the most significatives, because of the differences both in vegetation and herbivore density. In winter, Spanish wild goat reduces its diet niche breadth and diets are more similar in the three areas. In this work we will discuss how the environmental conditions determine feeding strategies of wild goat.

INTRODUCTION

Many authors agree that herbivore diets, and especially those of generalist herbivores, are far more complex than those of other consumers. Herbivores often eat low quality food and their problem may be more to do with choosing a balanced diet than with maximising the gain energy rate (Crawley, 1983).

Various authors have discussed feeding behaviour among large herbivores in limited food environments from a theoretical point of view. Westoby (1974) and Belovsky (1978) suggest that herbivore diet specialization could happen when there is resource abundance and that generalisation takes place when these is scarcity. Nudds (1980) suggests that a change in feeding strategy from specialist to generalist occurs when food is scarce.

In this paper we will analyse trophic adaptations in the Spanish wild goat to the seasons of the year, to different habitats and to animal density. We will test the hypothesis that a reduction in food availability could make the wild goat's diet more generalised, as proposed by Brown & Doucet (1991) for white-tailed deer, increasing the diversity of the diet.

STUDY AREA

The study was carried out in Sierra de Cazorla Natural Park which is 214.000 ha large. It is situated in the east of Jaen province. The geological substratum is limestone and the average rainfall is 1060 mm.

We chose three areas inhabited by the mountain goat with varying ungulate densities. One of the areas contains different vegetation from the other two.These areas were :

1 Nava de San Pedro (NSP). Area : 2 km^2. Situated between 1.300 and 1.400 m altitude. Vegetation belongs to the supra-mesomediterraenean betican basofilous series of the *Quercus*

faginea (Gomez-Mercado 1989). Average animal density was 211 indiv./km^2.

2 Cañada de las Fuentes. Area : 0.9 km^2. Situated between 1.300 and 1.400 m. altitude. The vegetation belongs to the supra-mediterraenean betican basofilous series of the *Quercus ilex* and density was 69 indiv./km^2.

3 Linarejos. Area : 0.77 km^2. Situated at 1.000 m altitude. Vegetation belonging to meso-mediterraenean betican basofilous series of *Quercus ilex*. Density was 40 indiv./km^2.

METHODS

Plant sampling

Herbaceous vegetation was determined by an adaptation of the "point-quadrat" method. Ligneous vegetation was determined with the "cover" and "line-intercept" methods (Cuartas & Garcia-Gonzalez, in press).

Diet Analysis

To estimate wild goat diet the microhistological analysis (recognition of indigestible fragments in animal faeces) was used (Garcia-Gonzalez & Cuartas, 1989).

Animal Censuses

Animal abundance was determined by a combination of fixed point observation method and the systematic survey method (Escos & Alados, 1988).

Data processing

Kulzynski Similarity Index was used in comparing the wild goat diets among habitats and seasons.

$$K.S.I. = \frac{2C}{a+b} \times 100$$

C is the lowest percentage of a species among the plant species common to two herbivores, and a + b is the total of percentages for all the studied plant species.

Diet diversity of wild goat was determined by the index :

$A = e^{H'}$ (H' being Shannon-Weaver's index), which is a mesure of the number of species in the sample where each species is weighted by its abundance (Ludwig & Reynolds, 1988).

RESULTS

The Spanish mountain goat consumes a yearly average of 72.39 % ligneous species, 8.45% forbs and 19.15% graminoids. There are some seasonal variations and some habitat variations (fig. 1). Thus, in May, holm-oak (*Q. ilex*) consumption is very low, and the consumption of *Erinacea anthyllis* (28%) and *Pinus nigra* (24.4%) is very high. In September consumption of ligneous species goes up (specially of holm-oak) all the way through to February. The highest consumption of forbs takes place in May, altough without clear species preference. Consumption of geophytes is especially important in September.

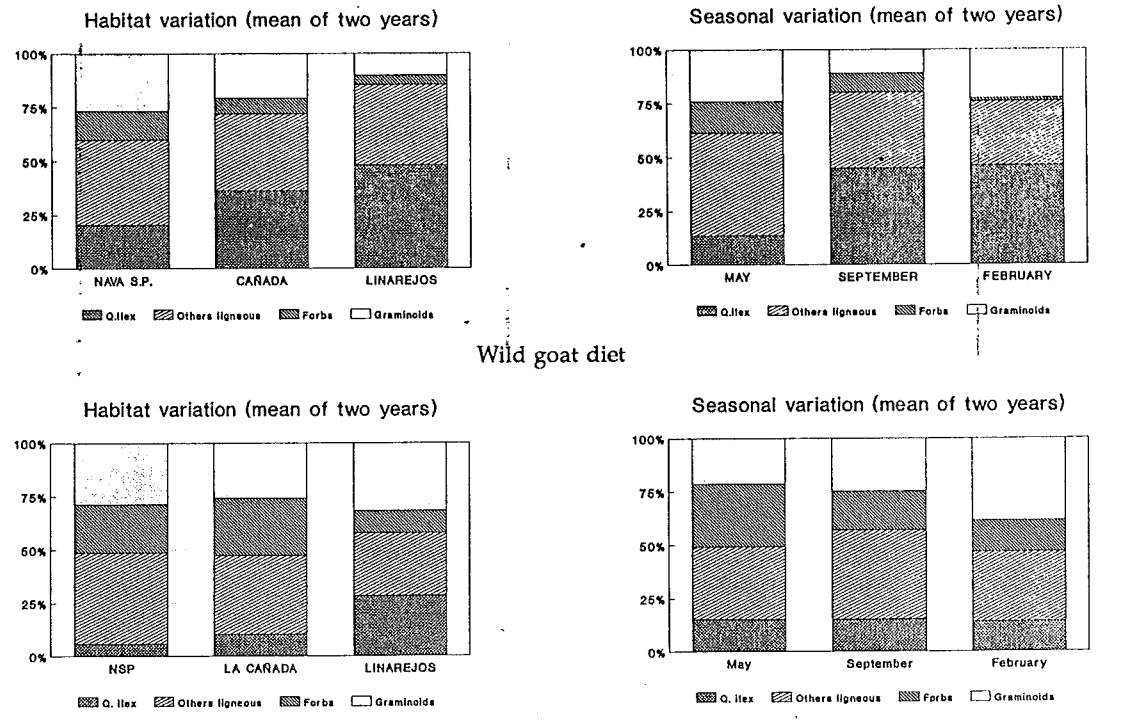

Figure 1 : Habitat and seasonal variation of Spanish wild goat diet and available vegetation in the study area (Diet : % in faeces ; Veget. : % plant abundance frequencies)

The consumption of graminoids in May and September does not show clear species preference, but in February these is a special interest in *Helictotrichon filifolium* (16%). The diet diversity index was grater in May and similar in September and February. Species number consumption was intermediate between February and May (table 1).

Table 1 : Seasonal variation of Spanish wild goat diet diversity (N = species number ; $A = e^{H'}$ where H' is Shannon-Weaver index)

	May	Sept.	Feb.
N	30	27	23
A	13.89	6.44	6.08

As for habitats, Linarejos has the greatest ligneous plant abundance (57.8%) (fig. 1) and is where the highest quantity of ligneous species is consumed (85.11%). In NSP and La Cañada, where botanic composition and plant species abundance are similar (62% in common, table 2), the diet is also similar at 59% in common (table 3).

Table 2 : Kulzynski's similarity indexes between wild goat (*Capra pyrenaica*) diets and available vegetation in the different habitats

	Goat diet	Available vegetation
NSP - Cañada	59	62
NSP - Linarejos	30	24
Cañada - Linarejos	52	34

The number of species consumed in all habitats was 35. Diet diversity was greater in NSP than in La Cañada and in La Cañada greater than in Linarejos (table 3).

Table 3 : Variation of Spanish wild goat diet diversity and ungulate density in the different habitats (N and A as in table 1)

	NSP	Cañada	Linarejos	Total
N	24	26	20	35
A	11.44	6.87	3.91	9.95
D (ind./km^2)	211	73	40	

DISCUSSION

By comparing mountain goat diets at three different stages of the year (May, September, February) we can see that there is no generalization of diet when resources are scarce, and what's more there is a particular selection of certain species. This can be explained by remembering that herbivores do not have a wide choice of food in winter and wild goat's feeding strategy could be to reduce the trophic niche, reducing diet diversity and causing greater impact on vegetation, particularly *Q. ilex* which is the most consumed species (Cuartas & Garcia-Gonzalez, in press). In this case the initial hypothesis which presupposes that mountain goats generalise their diet when resources are scarce, should be rejected.

Diet variations due to habitat are related to vegetation availability and to density of animals sharing the area. Mountain goat diet, therefore, is different in botanic composition of species (adapting to the available vegetation in each habitat), but with regard to ligneous, forb or graminoid species there is only a significantive difference between NSP and Linarejos ($X^2 = 16.14$; d.f. = 2 ; $p < 0.05$), where plant abundance most differs and where animal density is most contrasted (211 indiv./km^2 in NSP and 40 indiv./km^2 in Linarejos, fig. 2).

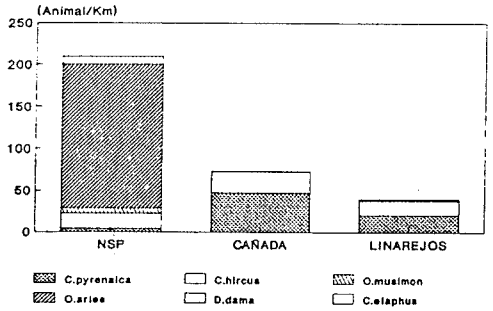

Figure 2 : Variations of ungulate density in the three study habitats

Furthermore, diet diversity values are maximum for NSP where ligneous availability is lower and ungulate density is higher (table 3). In this situation the wild goat would seem to change the trophic niche incrasing diet diversity so as to avoid competition from other herbivores. This agrees with the initial hypothesis which presupposed a change in feeding strategy towards generalisation when resources are limited.

Therefore, contradictory results has been obtained with regard to the initial hypothesis, according to whether resource scarcity is produced by high ungulate density or because of seasonal variations in the primary production. In our opinion, under study conditions, density would seem to have a greater influence than seasonal variations. Sampling undertaken in order to evaluate available vegetation indicates that although there are qualitative seasonal changes in floristic composition, the total plant cover (below 2 metres) does not experience wide seasonal variations. (Cuartas & Garcia-Gonzalez, in press). The increase in diet diversity values in May could be explained by a wider availability of species and by a nutrient balancing strategy.

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