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Abstract. Silvopastoral systems in Greece are mainly utilized by domestic animals but they also provide many other goods and services. Direct observations were carried out on a mixed flock of sheep and goats grazing on deciduous rangelands dominated by oak and beech trees in northern Greece. Diet samples were collected by hand plucking and were categorized into woody, grass, forb species and leaf litter. Grazing activities (feeding, moving, lying, standing and ruminating) were also recorded. Mean forage cover (%) of grass, forbs, woody species and leaf litter was 51.5, 15.3, 5.5 and 23.2 respectively. Bare ground and rock-gravel represented 4% and 0.6% of the cover respectively. Grasses and forbs were the main components of sheep diet (96.4%), while browse made up only 3.6% of their diet. On the contrary, browse was the most important forage class for goats (57.9%), followed by grasses and forbs (40%) and leaf litter (2.1%). Sheep behaved as typical grazers, exclusively selecting herbaceous species, while goats exhibited considerable flexibility selecting forage from all forage categories. Feeding was the main activity of both animal species, followed by moving, standing and ruminating.

Keywords. Wooded rangelands – Grazing activities – Diet selection – Small ruminants.

Comportement alimentaire des ovins et des caprins en pâturage dans des systèmes sylvopastoraux du Nord de la Grèce

Résumé. *En Grèce, le système sylvopastoral est exploité par les animaux domestiques tout en fournissant plusieurs autres revenus aux éleveurs. Afin de déterminer le régime alimentaire des animaux, des observations directes ont été effectuées dans des parcours dominés par des chênes et des hêtres, et pâturés par des troupeaux ovins et caprins dans le nord de la Grèce. Le poids des coups de dents a été simulé par prélèvements manuels des principaux ligneux, graminées, et autres plantes, ainsi que de la litière. Les comportements tels que pâturer, se déplacer, se reposer, se tenir debout et ruminer ont également été enregistrés. La biomasse végétale était respectivement composée de 51,5, 15,3, 5,5 et 23,2% de graminées, forbs (plantes herbacées dicotylédones), espèces ligneuses et litière. La surface sans végétation et la roche-mère couvraient 4% et 0,6% du parcours. Les constituants les plus importants du régime alimentaire des moutons étaient les graminées et les forbs (96,4%) avec seulement 3,6% du régime constitué par les ligneux. Par contre, les ligneux sont majoritaires (57,9%) dans le régime alimentaire des chèvres. Herbacées et forbs représentent 40% de leur régime et la litière 2,1%. Les ovins ont donc eu un comportement typique de pâturage, alors qu'une très grande variabilité du régime a été observée chez les chèvres, qui ingèrent une plus large gamme d'espèces fourragères. Le comportement de pâture était le plus fréquent suivi des actions de se déplacer, de se tenir debout et de ruminer.*

Mots-clés. *Parcours ligneux – Activités de pâturage – Régime alimentaire – Petits ruminants.*

I – Introduction

Wooded rangelands of deciduous oak and beech trees occupy about 44% of the forests' total area in Greece (Ministry of Agriculture, 1992). These areas are mainly utilized by domestic and wild animals whereas they provide also many other goods and services such as timber, fuelwood, charcoal, mushrooms, biodiversity, recreation, etc. Vegetation in such environments is characterized as highly heterogeneous in terms of species richness, plant size and forms, and nutrient content. Sheep and goats grazing in this heterogeneous environment come across

extremely diverse vegetation (deciduous trees and shrubs, evergreen shrubs, grasses, legumes and forbs) which can motivate their feeding behaviour (Baumont *et al.*, 2000). In a single day, each member of a flock should decide to distribute thousands of bites over hundreds of plants and plant parts, which are usually highly contrasted, i.e. from a tiny grass regrowth to a large mature leaf branch.

Interspecific dietary differences between sheep and goats grazing on various conditions and environments of the Mediterranean area have been described in several studies (Leouffre *et al.,* 1989; Cuartas and García-González, 1992; Papachristou and Nastis, 1993; Bartolomé *et al.,* 1998; Yiakoulaki *et al.*, 1999; Yiakoulaki and Papanastasis, 2005). However, little information is available on how sheep and goats grazing in a mixed flock select their diets from wooded rangelands of deciduous oak and beech trees. Such information is important for integrating grazing into management schemes of these areas as well as for determining the environmental impact on animal production systems.

II – Materials and methods

The research was conducted at the Municipal Department of Ossa in Lagadas county of Thessaloniki, northern Greece, in October 2002 (late autumn). Mean annual precipitation is 635 mm and mean minimum temperature of the coldest month below 1°C, indicating a semi-arid Mediterranean climate with cold winters (Le Houerou, 1981). Soils, which are mainly derived from metamorphic rocks (Fockel and Mollat, 1979), are shallow and acid (pH 5.2-6.4), poor in nitrogen, phosphorus and organic matter and have a sandy-loam texture. Oaks (*Quercus pubescens* Willd., and *Quercus fraineto* Ten.) and beech (*Fagus moesiaca* K. Maly) were the dominant tree species in the study area resulting in an overstory crown density of less than 30%. The understory vegetation was composed of both shrubby and herbaceous species. *Quercus coccifera* L., *Carpinus orientalis* L., *Pyrus amygdaliformis* Vill. and *Rosa canina* L. were the main shrub species, while *Dichanthium ischaenum* L., *Chrysopogon gryllus* L. Trin., *Thymus sibthorpii* Benth., *Dactylis glomerata* L. and *Poa bulbosa* L. were the dominant herbaceous species. The stocking rate in the Municipal District of Ossa for 2002 was 0.98 sheep equivalents/ha/year (Yiakoulaki *et al.*, 2006).

A mixed flock of 50 goats and 70 sheep, both composed of local breeds, was used for the experiment. By using a GPS, the area covered by this flock during a grazing day was found to be about 45 ha. In this particular area, five randomly selected plots, 30 x 30 m each in size, were used to measure ground cover by using the loop method (Cook and Stubbendieck, 1986). Only understory vegetation (up to 1.50 m) was recorded and categorized into grasses, forbs and woody species. A direct observation and simulation method (Altman, 1974) was applied in order to determine the diet selected by sheep and goats and to obtain representative samples. Four 2 years-old female animals (two sheep and two goats) were selected as experimental animals and were marked, using sprays of different colours, with large numbers on their sides for identification purposes. The animals were followed continuously by two observers for two consecutive days. Specifically, each experimental animal was observed for a 30 min period and from a certain distance to the animals in order not to affect their foraging behaviour. The animals grazed for more than eight hours per day during each experimental grazing day (Yiakoulaki *et al.*, 2003). A total of 32 individual observation periods of 30 min were obtained. The animals were allowed to get settled for 30 min before observations started. Grazing activities were determined by using the focal sampling technique (Altman, 1974) for four consecutive grazing days. Two observers were trained just prior to the beginning of these measurements in order to avoid discrepancies between their recordings. Observations were made to the same four animals that were used for the determination of diet selection. Every observation hour was divided in 12 observation periods of 5 minutes each. Animals' activities were recorded every 15 seconds during the 5 minutes observation period and converted into percentages of the total grazing time. A total of 192 individual recordings of 5 minutes were obtained. Activities were defined as follows: (i) feeding time – the time that animals spent grazing and browsing; (ii) moving time – the time that animals spent walking or running from one place to another; (iii) standing time – the time that animals ceased all their activities and stood

inactive; (iv) laying time – the time that animals laid down to rest; and (v) ruminating time – the time that animals spent for rumination. All measurements were subjected to an analysis of variance (Steel and Torrie, 1980). The LSD test was used for detecting mean statistical differences ($P \leq 0.05$).

III – Results and discussion

Mean forage cover (%) of herbaceous plants (grasses and forbs) and woody species is presented in Table 1. Herbaceous vegetation covered most of the soil surface, while woody species represented a small percentage of vegetation available to the animals. Bare ground and rocks were also represented by small proportions. By contrast, litter which included past year's vegetation growth as well as fallen oak or beech leaves was making an important component of ground cover.

Table 1. Mean forage cover (%) of grass, forbs and woody species

Categories	Percentage (%)
Grasses	51.5
Forbs	15.3
Woody species	5.5
Litter	23.2
Rocks, gravel	0.5
Bare ground	4.0
Total	100.0

Feeding was the predominant activity of sheep and goats during the grazing day followed by moving, standing, ruminating and laying (Table 2). Sheep spent 8.6% more time feeding than did goats, while goats spent 6.5% and 3.9% greater time moving and standing, respectively, than sheep. However, there were no significant differences ($P \leq 0.05$) between animal species for these grazing activities. Ruminating time was very short during the observation period, while the activity of laying was not recorded. This was probably due to the normal practice of the farmers to pen their animals during the night hours. Therefore, animals have long imposed opportunities for rumination and laying but not for foraging.

Table 2. Percentage (%) of time spent by sheep and goats on various activities during each experimental grazing day on deciduous oak and beech trees in northern Greece

Grazing activities	Sheep ± SE	Goat ± SE
Feeding	61.4 a ± 5.7	52.8 a ± 6.7
Moving	32.7 a ± 4.6	39.2 a ± 4.7
Standing	3.0 a ± 2.5	6.9 a ± 4.7
Ruminating	2.9 a ± 2.0	1.1 a ± 0.7
Laying	0.0	0.0

a: Means within the same row followed by a common letter were not significantly different ($P \leq 0.05$).

Herbaceous species were the main components of sheep diet (96.4 %) while browse made up only a small proportion of their diet (Table 3). On the contrary, browse was the most important forage class for goats (57.9%), followed by herbaceous species (40%). They also consumed small proportions of the fallen leaves of the deciduous woody species (2.1%). Considerable consumption of leaf litter by goats' grazing in the tropical deciduous woodlands of Brazil during autumn has been

also reported by Schacht and Malecheck (1990). In the present study, sheep exclusively used the herbaceous layer while goats, being more opportunistic consumers with respect to the vegetation classes (Kronberg and Malechek, 1997), selected their diet from all forage categories.

Table 3. Percentage (%) of grasses, forbs and woody species in sheep' and goats' diet grazing on deciduous oak and beech trees in northern Greece

Forage category	Sheep	Goat
Woody species	3.6 a	57.9 b
Quercus coccifera	–	37.3
Rubus idaeus	–	9.2
Quercus pubescens (green+yellow leaves)	–	5.1
Rosa canina	–	3.2
Solanum nigrum	–	0.9
Ligustrum vulgare	–	0.8
Cistus sp.	3.3	–
Quercus coccifera acorns	0.3	1.4
Grasses	63.9 b	23.7 a
Poa bulbosa	18.3	6.3
Dactylis glomerata	5.8	6.8
Phleum phleoides	4.8	0.4
Cynodon dactylon	9.2	1.4
Bromus squarosus	0.8	0.7
Fectuca valesiaca	10.2	1.0
Dichanthium ischaemum (dry leaves)	–	1.2
Dichanthium ischaemum (green leaves)	4.9	–
Cynosurus echinatus	1.8	0.9
Taeniatherum caput-medusae	6.4	4.6
Aegilops ovata	0.9	–
Eragrostis minor	0.8	0.4
Forbs	32.5 a	16.3 a
Lamium sp.	–	0.9
Berteroa incana	–	0.6
Verbascum sp.	–	1.0
Circium vulgare	–	0.9
Xanthium spinosum	–	2.3
Phomis samia	–	0.5
Chichorium intybus	0.7	0.6
Stachys cretica	–	0.6
Geranium rotundifolium	0.5	0.5
Sanguisorba minor	0.8	0.3
Cardus sp.	0.4	3.6
Thymus sibthorpii	2.8	–
Achillea millefolium	2.4	–
Hieracium pillosela	0.9	–
Centaurea sp.	0.3	–
Teucrium polium	0.9	–
Erodium sp.	0.8	–
Trifolium subterraneum	16.0	1.5
Vicia cracca	–	1.7
Astragalus sp.	6.0	1.3
Leaf litter	–	2.1
Total	100	100

a, b: Means of forage categories within the same row followed by a common letter are not significantly different ($P \leq 0.05$).

Goats selected higher amounts ($P \leq 0.05$) of woody species compared to sheep. *Quercus coccifera* was the dominant woody species selected by goats followed by *Rubus idaeus*, *Quercus pubescens* (green + yellow leaves) and *Rosa canina. Solanum nigrum* and *Ligustrum vulgare* contributed to less than 1% to goat's diet. On the contrary, woody species were a negligible component of sheep' diet, *Cistus* sp. and *Quercus coccifera* acorns being the only selected woody components. Acorns that were available during the study period contributed 1.4% to goats diet, but constituted a small proportion of sheep' diet. Similar results are reported by Taylor and Kothmann (1990) who found that acorns contributed to 2% of Angora goat diets during autumn.

A total of 39 species were present in the two diets, 25 of which were consumed by sheep and 30 by goats. Two woody, nine grass and five forb species occurred in both sheep and goats diet. Oak species, including *Quercus coccifera* acorns, comprised the majority of woody species consumed by goats (43.8%).

IV – Conclusions

Faced with similar opportunities for choice during grazing on wooded rangelands of deciduous oak and beech trees in the autumn, sheep and goats selected significantly different proportions of woody species and grasses. Confirming earlier studies, sheep behaved as typical grazers selecting exclusively the herbaceous layer, while goats exhibited a more opportunistic foraging behaviour, selecting feed from all forage categories.

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