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Role of various plant groups in the sustained use of mountainous Mediterranean rangelands

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RESUME – *"Rôle de plusieurs groupes végétaux pour l'utilisation soutenue de parcours montagneux méditerranéens". Dans les parcours méditerranéens, la période favorable pour la croissance végétale se limite à la période hivernale. Cependant plusieurs groupes végétaux ont développé des adaptations spéciales telles que le caractère pérenne ou un dimorphisme saisonnier qui leur permet de survivre pendant la saison chaude et sèche également. Ces adaptations sont cruciales pour permettre au bétail un approvisionnement en fourrage pendant cette période critique de l'année. Dans les parcours méditerranéens du Mont Psiloritis en Crète, la croissance saisonnière des plantes herbacées, des phryganes, des arbustes à feuillage persistant et caduc, a été mesurée dans deux parcelles adjacentes, protégées et pâturées librement par ovins et caprins, pendant toute l'année. On a observé que les plantes herbacées étaient pâturées principalement en automne et au printemps, les phryganes (p.e.* Genista acanthoclada*) principalement en hiver et au printemps, les sclérophylles pérennes (p.e.* Quercus coccifera*) principalement au printemps et en été, et les arbustes caducs (e.g.* Acer creticum*) principalement en été et au printemps. Cet article discute l'importance de combiner des groupes végétaux ayant différents types de croissance pour une utilisation soutenue des parcours des montagnes méditerranéennes.*

Mots-clés : *Arbustes à feuillage persistant, arbustes caducs, herbacées, parcours des montagnes méditerranéennes, phryganes, Crète.*

Introduction

In Mediterranean rangelands, the favorable period for plant growth is confined to the cool and wet season of the late autumn, winter and early spring months. During the hot and dry summer period, on the contrary, herbaceous plants are dormant thus resulting in a feed gap that has serious implications to animal nutrition and survival (Papanastasis and Mansat, 1996). For this reason, combination of additional forage resources which offer flexibility in grazing management is needed (Talamucci *et al*., 1996), including transhumance (Kyriakakis and Papanastasis, 1999).

Woody species have developed special mechanisms to cope with drought and survive through the summer period. These mechanisms are: evergreeness involving small, leathery, evergreen leaves with thick cuticles and sunken stomata exemplified by evergreen sclerophyllous shrubs; and seasonal dimorphism involving replacement of the large winter leaves with smaller ones in the summer to reduce the transpiring surface exemplified by phrygana (Margaris, 1981). On mountainous areas though deciduous woody species also grow which shed their leaves during the wet but cold winter instead of the summer period.

The various growth adaptations to Mediterranean climate result in differentiating plant species into groups or functional types (Lavorel *et al*., 1997). In this paper, the seasonal forage production of several plant groups was studied in mountainous Mediterranean rangelands and its implication to their sustained use is discussed.

Materials and methods

The research was carried out on the rangelands of Psilorites mountain in Crete (35^{o} 08´ - 35^{o} 18´ N, 24^{o} 54´ - 25^{o} 18´ E). The area has a humid Mediterranean climate with rainy and mild to cold

winters and dry and hot summers. Mean precipitation exceeds 800 mm and falls in the form of snow on the high altitudes. The dominant bedrock is undivided limestone of the “platy series” resulting in shallow, mostly red soils. Vegetation is dominated by phrygana which are dwarf shrubs, spiny or aromatic, and seasonally dimorphic. In addition, several shrubby species are found, evergreen at the lower altitudes but also deciduous as the elevation increases, while herbaceous species are grown among the woody plants (Kebaili, 1997). Rangelands are communally grazed by sheep and goats at an average stocking rate of 4.6 sheep equivalents/ha/year (Menjli, 1994).

At the end of summer of 1995, two paired plots 5x10 m each in size were established, one at 800 m and the other at 1200 m altitude. Half of each plot was fenced and the other half was left free for grazing. Forage production was measured by hand clipping the plant growth on quadrats 50 x 50 cm each, randomly placed along three transects within each half-plot. For woody species, it was judged that animals could not eat more than 6 cm down to the canopy surface and the growth measured reflected the available browse. For herbaceous plants, all the aboveground biomass was considered available and the clipping was done to the ground surface. In the laboratory, samples were hand separated into edible (leaves and twigs) and non-edible parts before ovendrying at 70ºC and weighing. Only the edible part is reported in this paper.

Browse and herbage measurements were repeated at the end of each season (autumn, winter, spring and summer) during the growing season 1995-96 but in different transects and quadrats each season in every half-plot. Forage production data were lumped into four plant groups, namely evergreen shrubs, deciduous shrubs, phrygana, and herbs, both inside the protected and in the freely grazed half-plots and the utilization percentages were calculated. Analysis of variance was carried out only for the edible dry matter (EDM) data.

In addition, the nutritive value of the edible part of each plant group was determined by analyzing for neutral detergent fiber (NDF), the acid detergent lignin (ADF) and the crude protein (CP) contents. These analyses were carried out only in the samples of the protected half-plots.

Results and discussion

Total forage production (edible dry matter) was significantly higher in the lower than in the upper altitude. Among seasons, it was highest in spring and lowest in summer and winter for the lower and upper altitudes respectively (Table 1). Also, its percentage utilization was highest in the spring in both altitudes. Its lowest value however was in the autumn in the lower altitude and in the winter season in the higher one reflecting the role of altitude in conditioning the grazing pressure on rangelands of Psilorites mountain.

Individual plant groups responded differently than total production. In the lower altitude, phrygana were making the bulk of production in spring, autumn and winter, while in the summer season the most productive group were the evergreen shrubs. Herbaceous species were the third group in terms of production, mainly available in spring and autumn while deciduous shrubs were making no more than 1% of the total production in any season except in the winter when it was nil (Table 1). In the higher altitude, the relative importance of the various groups changed. Phrygana were also making the bulk of production but only in spring, while herbs were the most important group in all the other seasons. Deciduous shrubs were much more important than evergreen shrubs in spring and summer but the opposite occurred in the other two seasons (Table 1).

Based on the percentage utilization of the individual plant groups it comes out that evergreen species were mainly grazed in spring as well as in summer, when their nutritive value was higher than of herbaceous species (Table 2). The deciduous shrubs were grazed in spring but mainly in summer when their nutritive value was much higher than of the other plant groups (Table 2), while they provided no forage during winter due to shedding of their leaves. Phrygana were grazed during winter and spring when nutritionally they were quite attractive (Table 2) while in the other two seasons they produced very little and were practically not grazed at all. Herbaceous species, finally, were highly preferred in all seasons except summer, when the nutritive value was the lowest (Table 2).

Table 1. Mean edible dry matter (EDM) (kg/ha) and utilization percentage (UP) (%) of plant groups at two altitudes over the four seasons

Plant group	Autumn		Winter		Spring		Summer	
	EDM	UP	EDM	UP	EDM	UP	EDM	UP
	Lower altitude (800 m)							
Evergreen shrubs [1]	823a[5]	16	491b	9	1054a	41	685a	38
Deciduous shrubs [2]	23c	34	0	0	26c	38	22c	53
Phrygana [2]	897a	5	725a	47	1224a	33	127b	4
Herbs[4]	228b	83	133c	79	346b	79	84bc	66
Total	1971	19	1409	37	2650	42	988	34
	Higher altitude (1200 m)							
Evergreen shrubs	125b	39	112a	10	283c	57	183b	49
Deciduous shrubs	21c	32	0	0	319bc	42	204ab	34
Phrygana	96b	3	143a	13	485a	40	0	10
Herbs	235a	47	151a	47	361b	52	292a	42
Total	476	36	406	25	1448	47	770	44

[1] *Quercus coccifera, Phamnus oleoides, Phillyrea latifolia, Olea oleaster.*
[2] *Acer creticum, Berberis cretica.*
[3] *Genista acantoclada, Euphorbia acanthothamnus, Phlomis fruticosa.*
[4] *Bromus mollis, Poa bulbosa, Dactylis glomerata, Trifolium campestre,* etc.
[5] EDM means of the same season and altitude with the same letter are statistically insignificant (P>0,05).

Table 2. Nutritive value of the edible dry matter of the various plant groups at two altitudes over the four seasons on Psilorites mountain

Nutritional characteristic	Plant group	Lower altitude (800 m)				Higher altitude (1200 m)			
		Autum	Winter	Spring	Summer	Autumn	Winter	Spring	Summer
NDF (%)	Evergreen shrubs	47.7	46.7	49.7	43.0	69.3	56.9	54.7	50.4
	Deciduous shrubs	61.1	0.0	56.0	42.6	49.0	0.0	39.7	32.6
	Phrygana	55.8	44.4	50.5	50.7	49.1	25.4	34.4	55.0
	Herbs	69.9	50.6	60.0	65.0	60.0	66.8	54.2	63.0
ADL (%)	Evergreen shrubs	19.1	16.0	17.0	18.5	21.8	18.6	15.0	17.8
	Deciduous shrubs	22.1	0.0	22.0	21.6	18.2	0.0	12.7	10.9
	Phrygana	16.9	15.3	11.1	13.2	23.0	8.6	8.6	13.0
	Herbs	19.3	19.0	21.7	22.0	16.0	16.3	10.7	12.0
CP (%)	Evergreen shrubs	8.8	8.4	10.0	8.1	8.8	8.2	8.9	8.1
	Deciduous shrubs	5.2	0.0	6.9	10.1	10.1	0.0	15.0	11.5
	Phrygana	9.0	10.3	12.0	11.3	10.9	13.3	10.8	8.0
	Herbs	13.0	19.1	16.4	5.0	12.8	19.8	11.3	7.0

It seems that combining these four groups of species in the same feeding calendar can ensure a continuous forage supply throughout the year (Fig. 1) but their relative contribution depends on their availability. This availability is very much affected by the altitude. As elevation increases deciduous shrubs increase their presence at the expense of evergreen shrubs and herbaceous species become more available in the summer than in the winter period (Kebaili, 1997). On the other hand, availability can be modified by proper vegetation and grazing management, which is a real challenge in communally used Mediterranean rangelands.

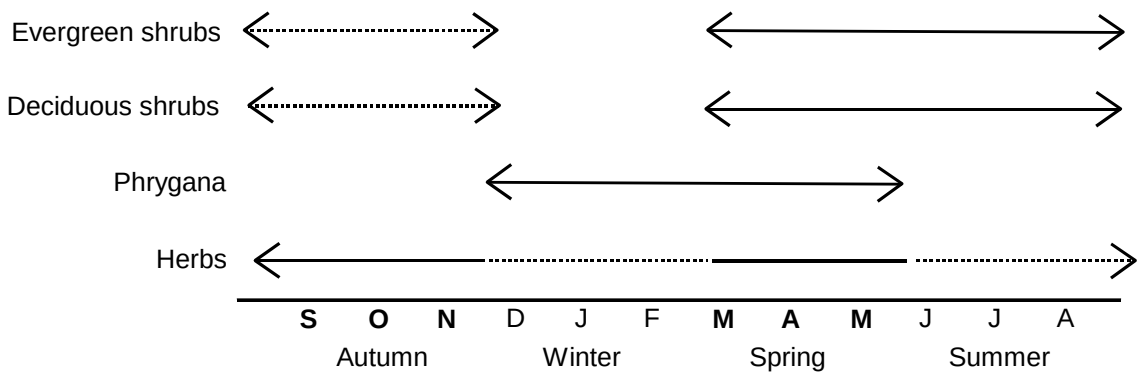

Fig.1. Grazing calendar of the various plant groups on rangelands of Psilorites mountain (solid lines indicate fixed periods of use while broken lines tentative ones dictated by altitude).

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