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Wildfire effects on species composition and nutritive value in different thermo-Mediterranean vegetation types

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Abstract. Wildfires have an important impact on species composition and moreover on forage production and its nutritive value in the arid Mediterranean rangelands. The present study was conducted in the East Aegean island of Oinoussa, in which a wildfire occurred in summer of 2012. Three different phryganic communities were identified in the field in burned and adjacent unburned areas at the middle of May 2013 (one year after the fire): *Sarcopoterium spinosum* phrygana, *Cistus creticus* vegetation type covering inclined slopes and *Cistus creticus* vegetation type covering abandoned terraces. Species composition and its chemical composition (herbaceous and woody species separately) were determined in each one of the three plant communities. Species composition was differentiated between burned and unburned areas as wildfire resulted in an increase of herbaceous species and in a decrease of woody ones. *C. creticus* only in terraces had similar recovery with *S. spinosum* after fire only. The nutritive value of herbaceous vegetation in terms of fiber and CP content was slightly higher in the burned areas of *C. creticus* and lower the ones of *S. spinosum*, while among the tested woody species *Cistus creticus* had the higher nutritive value.

Keywords. Revegetation – Burning – *Cistus creticus* formation – *Sarcopoterium spinosum* formation.

Effets d'un incendie sur la composition en espèces végétales et sur la valeur nutritive dans les différents types de végétation thermo-méditerranéens

Résumé. Les feux de forêt ont un impact important sur la composition en espèces et aussi sur la production de fourrage et la valeur nutritive des parcours méditerranéens arides. La présente étude a été menée dans l'île de l'Egée d'Oinoussa, dans lequel un incendie survenu à l'été 2012. Trois communautés phryganiennes différentes ont été identifiées dans les zones brûlées et non brûlées adjacentes à la mi-mai 2013 (un an après l'incendie) : *Sarcopoterium spinosum* de la phrygana, des communautés de *Cistus creticus* couvrant les pentes inclinées et des communautés de *Cistus creticus* couvrant les terrasses abandonnées. La composition en espèces végétales et la composition chimique des espèces herbacées et ligneuses séparément ont été déterminées dans chacune des trois communautés végétales. La composition en espèces est différente entre les superficies brûlées et non brûlées, l'incendie ayant entraîné une augmentation des espèces herbacées et une diminution des espèces ligneuses. Seul *C. creticus* sur les terrasses a eu une récupération similaire à celle de *S. spinosum* après l'incendie. La valeur nutritive de la végétation herbacée sur la base des teneurs en fibres et en protéines était légèrement plus élevée dans les zones brûlées de type *C. creticus* et plus faible dans les zones de type de *S. spinosum*, tandis que pour les espèces ligneuses *Cistus creticus* avait valeur nutritive la plus élevée.

Mots-clés. Végétalisation – Combustion – Formations de *Cistus creticus* – Formations de *Sarcopoterium spinosum*.

I – Introduction

Sclerophyllous shrublands are common components of the Mediterranean vegetation and an important forage resource for the grazing animals in the Mediterranean basin (Perevolotsky *et al.*, 1998). Additionally, they are among the major fire-prone biomes of the world (Bond *et al.*, 2005). The recovery of these ecosystems after fire is differentiated among shrub species. As consequent, the vegetation structure and dynamics of sclerophyllous shrublands are controlled by both wildfires and grazing (Naveh and Dan 1973).

The reduced livestock grazing results in an increase of fire risk in these ecosystems. On the other hand, the decline of shrub cover by grazing reduces fire risk and serves hydrological purposes as well as aesthetic values (Moreira *et al.*, 2009). Moreover, the reduction of shrub cover in favor of herbaceous vegetation improves the foraging conditions (Perevolotsky *et al.*, 2002). Although illegal in Greece, fire is a traditional method, used by shepherds in order to increase the available herbage production in shrublands and to improve its feed quality (Nastis and Tsiouvaras, 2009). Thus, the aim of the present study was the comparative evaluation of species composition and their nutritive value in burned and unburned areas of different thermo-Mediterranean vegetation types one year after the fire.

II – Materials and methods

The study was conducted in Oinoussa Island, northeastern of Chios Island in East Aegean, one year after a wildfire that occurred in the northwest part of the island in 2012. The bioclimate of the area is classified as sub-humid with mild winters (Panitsa *et al.*, 1994). The mean air temperature is 16°C and the mean annual rainfall 600 mm. The vegetation types that were indentified in the study area were: (1) *Sarcopoterium spinosum* phrygana in the north-west part of the Island, (2) *Cistus creticus* vegetation type covering inclined slopes and (3) *Cistus creticus* (Ter) vegetation type covering abandoned terraces in the north-east part of the island.

Five transects of 20 m long were used in each vegetation type in burned and adjacent unburned areas along the contour lines. The plant cover was measured by using the line-point method (Cook and Stubbendieck, 1986) in May 2013, and the floristic composition was calculated. Contacts were obtained every 20 cm. The sampling of above ground biomass was carried out in two 0.5 X0.5 m quadrats in the 1st, 3rd and 5th transect in each time. The samples from the unburned areas were separated in shrubs and herbaceous vegetation. All samples were oven dried at 50°C for 48 h and weighed. Nitrogen content was measured by the Kjeldahl method (AOAC, 1990) and crude protein (CP) was calculated by multiplying N by 6.25. Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Acid Detergent Lignin (ADL) were measured using the procedure described by Van Soest *et al.* (1991).

The obtained data were tested for normality using the Kolmogorov-Smirnov test and Log data transformations were performed for the non-normally distributed data. One-way ANOVA was used to analyse the effect of fire on coverage of plant functional groups and nutritive value among the vegetation types with IBM SPSS 21 for Windows. The LSD at the 0.05 probability level was used to detect the differences among means.

III – Results and discussion

Wildfire resulted in a significant decrease of the coverage of woody species in all vegetation types, but the relatively lowest reestablishment of them one year after fire was observed in *C. creticus* formations in inclined slopes (Table 1). This could be attributed to the combined resprouting and seeding regenerative strategy of *S. spinosum* that promotes its recovery and competitive ability (Seligman and Henkin, 2003). On the other hand, the recovery of the obligate seeder *C.*

creticus depends on seed bank and on the degree of germination stimulation (Roy and Sonie, 1992). The more favorable germination conditions in abandoned terraces probably contributed to the better recovery of *C. creticus* there. The coverage of grasses in burned areas was significantly reduced in *C. creticus* (Ter), increased in *S. spinosum* and not affected in *C. creticus* formations in inclined slopes. The coverage of legumes was increased only in burned areas of *C. creticus* (Ter) while the forbs were not affected in all cases (Table 1).

Table 1. Coverage percentage (%) of the plant functional groups in unburned and burned areas of the three vegetation types

Vegetation types	Woody (%)		Grasses (%)		Legumes (%)		Forbs (%)	
	No-Fire	Fire	No-Fire	Fire	No-Fire	Fire	No-Fire	Fire
<i>C. creticus</i>	63 ± 5a	12 ± 2b	15 ± 2a	18 ± 2a	3 ± 0.8a	4 ± 1a	7 ± 3a	13 ± 2a
<i>C. creticus</i> (Ter)	53 ± 8a	32 ± 3b	21 ± 5a	6 ± 1b	3 ± 0.4b	7 ± 2a	12 ± 3a	2 ± 1a
<i>S. spinosum</i>	77 ± 3a	34 ± 4b	9 ± 2b	24 ± 5a	3 ± 1a	3 ± 2a	6 ± 2a	12 ± 3a

Means followed by the same letter in the same row for the same functional group are not significant different ($P \geq 0.05$).

S. spinosum had significantly higher NDF concentration compared to *C. creticus* in the unburned areas, while *C. creticus* had the highest CP concentration in unburned areas of abandoned terraces (Table 2). Similarly, Parlak *et al.* (2011) have reported for the same period of the year higher fiber content for *S. spinosum* compared to *C. creticus* in Turkey.

Table 2. Chemical composition (g.kg⁻¹) (Means±S.E.) of the dominant shrubs, *C. creticus* and *S. spinosum* in unburned areas of the three vegetation types

Vegetation types	NDF(g.kg ⁻¹)	ADF(g.kg ⁻¹)	ADL(g.kg ⁻¹)	CP(g.kg ⁻¹)
<i>C. creticus</i>	356 ± 16a*	362 ± 24a	135 ± 11a	80 ± 12b
<i>C. creticus</i> (Ter)	339 ± 11a	351 ± 19a	122 ± 4a	116 ± 7a
<i>S. spinosum</i>	540 ± 10b	370 ± 12a	110 ± 7a	74 ± 8b

Means in the same column followed by the same letter are not significantly different ($P \geq 0.05$).

The NDF and ADF concentration of the herbaceous vegetation was significantly reduced in *C. creticus* formation, while it was increased in *S. spinosum* (Table 3). The ADL concentration was increased in all cases. The CP concentration was reduced in *S. spinosum* formation and was not affected in *C. creticus* (Table 3). The nutritive value of herbaceous vegetation in terms of fiber and CP content was slightly increased and decreased after fire in *C. creticus* and *S. spinosum* respectively. This divergent result could be attributed to differences in species composition and in stages of maturity among plant species (Huyghe *et al.*, 2008) among the vegetation types.

Table 3. Chemical composition (g.kg⁻¹) (means ± S.E.) of the herbaceous vegetation in unburned and burned areas of the three vegetation types

	NDF(g.kg ⁻¹)		ADF(g.kg ⁻¹)		ADL(g.kg ⁻¹)		CP(g.kg ⁻¹)	
	No-Fire	Fire	No-Fire	Fire	No-Fire	Fire	No-Fire	Fire
<i>C. cr.</i>	648 ± 16a [†]	473 ± 43b	385 ± 11a	340 ± 18b	60 ± 5b	98 ± 1a	110 ± 2a	103 ± 5a
<i>C. cr</i> (Ter)	620 ± 12a	414 ± 24b	403 ± 11a	310 ± 5b	71 ± 1b	91 ± 6a	83 ± 7a	93 ± 5a
<i>S. sp.</i>	541 ± 12b	600 ± 9a	347 ± 6b	399 ± 10a	70 ± 4b	96 ± 5a	91 ± 3a	76 ± 1b

[†] Means followed by the same letter in the same row for the same functional group are not significant different ($P \geq 0.05$) (*C.cr.*: *Cistus creticus*, *S.sp.*: *Sarcopoterium spinosum*).

IV – Conclusions

Species composition was differentiated between burned and unburned areas as wildfire resulted in an increase of herbaceous species mainly grasses and in a decrease of woody ones. The post-fire recovery of obligate seeder *C. creticus* was similar with that of the resprouter *S. spinosum* only in abandoned terraces. The nutritive value in terms of fiber and CP content was positively affected by fire in *C. creticus* vegetation type but negatively in *S. spinosum*.

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