Short-term response of the canopy arthropod community to fire in a Portuguese olive grove

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Abstract

In the Mediterranean region, fires have been an ecosystem modeling force for centuries. Low-mobile or small sized fauna such as arthropods are strongly affected by these periodic disturbances. Arthropods represent a hyperdiverse group and are present in all the ecosystems occupying the totality of available niches. In agroecosystems, shifts on arthropod communities are of especial relevance when the natural enemies of pests are significantly affected. The aim of this work was to assess the short-term effect on the canopy arthropod community of an unintentional fire occurred in an olive grove in Cedães-Mirandela (Portugal). Samples of arboreal entomofauna were collected in the burnt olive grove by shaking olive branches as well as in an adjacent grove (used as control area). In each olive grove, samples were collected in two areas (one adjacent and one distant) relatively to the nearest shrubland. Total arthropod abundance and the most abundant groups were compared between burnt and non-burnt groves. The effect of sample position (adjacent to shrubland vs. central area) was assessed. A total of 1318 arthropods were captured. Both the total and each dominant group abundances were significantly higher in the non-burnt grove. The fire drastically reduced the abundance of arthropods in the olive tree canopy; however, the dominant groups were almost the same is the two groves. The abundance pattern was, in general, the opposite when considering the sample position, relatively to the shrubland areas. We suggest that the colonization ability of different groups of arboreal arthropods through flight can be involved in the restoration of the community after disturbance instead the presence of semi-natural surrounding areas.

Keywords: arthropods, shrubland, colonization, Trás-os-Montes, wind.

Respuesta a corto plazo de la comunidad de artrópodos al incendio de un olivar en Portugal

Resúmen

En la región mediterránea, los incendios han modelado los ecosistemas durante siglos. La fauna de pequeño tamaño, como los artrópodos, se ve fuertemente afectada por estas perturbaciones periódicas. Los artrópodos representan un grupo muy diverso, estando presentes en todos los ecosistemas y ocupando la totalidad de los nichos disponibles. En los agro-ecosistemas, los cambios en las comunidades de artrópodos son de especial relevancia cuando se producen alteraciones en las poblaciones de enemigos naturales de las plagas. El objetivo de este trabajo fue evaluar el efecto a corto plazo de un incendio no intencionado sobre la comunidad de artrópodos de un olivar ocurrido el 19 de julio de 2016 en Cedães, Mirandela (Portugal). Se recogieron muestras de entomofauna arbórea en el olivar quemado y en un olivar adyacente no quemado (utilizado como control). En cada olivar se recogieron muestras en dos zonas, una adyacente y otra distante, respecto a un matorral cercano. La abundancia total de artrópodos y de los grupos más abundantes se comparó entre los dos olivares, quemado y no quemado. El fuego redujo drásticamente la abundancia de artrópodos en el olivar quemado, siendo los grupos dominantes semejantes en los dos olivares. En general, el patrón de abundancia

fue contrario a la posición de la muestra, en relación a las áreas de matorral. Esto puede deberse a que la capacidad de colonización de los diferentes grupos de artrópodos arbóreos voladores de la zona afectada esta influencia por la presencia de áreas semi-naturales en los alrededores.

Palabras clave: artrópodos, matorral, colonización, Trás-os-Montes, viento.

1. Introduction

Fire is a natural ecosystem process that has been repeatedly used in the Mediterranean region for centuries. Fires are used to control the masses of natural scrub in order to increase the available grass biomass for livestock or to burn stubble (Urones and Majadas, 2002). Historically, during summer in the Mediterranean ecosystem is frequent the natural fire to which the vegetation is adapted.

Low-mobile or small sized fauna such as arthropods may be strongly affected by these periodic disturbances (Kral et al., 2017). Arthropods represent a hyperdiverse group and are present in all the ecosystems occupying the totality of available niches (Benson et al., 2007)

The dynamics of arthropod communities reflect changes in plant structure as a consequence of the development of cyclical succession processes caused by fires. The effect of fire may be especially strong in managed areas such as agroecosystems were overall landscape complexity is often reduced (Johnson et al., 2008). In this context, shifts on arthropod communities are of especial relevance when natural enemies of pests are significantly affected (Chaplin-Kramer et al., 2011). The aim of this work was to assess the short-term effect on the canopy arthropod community of an unintentional fire occurred on the 19th July 2016 in an olive grove in Cedães-Mirandela (Portugal).

2. Material and Methods

2.1. Study area

The study area was located in one olive grove in Cedães (Mirandela, Portugal) (41°29´15´´N, 7°07´41´´W). The olive grove included a burnt and a non-burnt area, serving as control, and covered an area of 3 ha. Both areas of the grove are adjacent to a seminatural area (shrubland).

2.2. Sampling and identification of arthropods

On the 1st August 2016, 13 days after the fire has occurred, 12 samples of arboreal entomofauna were collected in the burnt olive grove and other 12 samples in an adjacent non-burnt grove. Each sample consisted in shaking two branches per tree in a total of four trees. In each grove, samples were grouped in adjacent to the nearest shrubland and distant to it. The captured individuals were preserved in 70% ethanol in situ, transported to the laboratory, sorted, counted and identified till class, order or family taxonomic groups.

2.3. Data analysis

The mean and standard error were calculated for total abundance in each grove and area (adjacent to shurbland vs. central area) within the grove. Total arthropod abundance and the most abundant groups were compared between burnt and non-burnt areas using the Wilcoxon rank test as well as the effect of sample position (adjacent to shrubland vs. central area). Due to the low number of samples per area, the means were used to simulate a pool of 100 samples from a Poisson distribution for total abundance and each arthropod group. Simulations and contrasts were conducted in R (R Core Team, 2014).

3. Results

A total of 1318 arthropods were captured encompassing the groups Araneae, Chrysopidae, Coleoptera, Diptera, Formicidae, Hemiptera, Hymenoptera, Lepidoptera, Orthoptera, Psocoptera and Thysanoptera (Table 1). Hemiptera, Araneae, Formicidae, Psocoptera and Coleoptera were the most abundant groups (Table 1). Both the total and each dominant group abundance were significantly higher in the non-burnt grove (Table 2) (Fig. 1). Also, the total and Hemiptera, Araneae and Formicidae abundance were significantly higher in the area adjacent to the shrubland in the non-burnt grove (Fig. 2A). On the contrary, total and Araneae, Coleoptera, Hemiptera and Psocoptera abundance was significantly higher in the central area within the burnt grove (Fig. 2B). The fire drastically reduced the abundance of arthropods in the olive canopy, however, the dominant groups were almost the same in the two groves. The abundance pattern was, in general, the opposite when considering the sample position.

Table 1. Abundance (mean ± standard error) of each arthropod group captured in the non-burnt and burnt olive groves.

	Non-burnt (Mean ± SE)	Burnt (Mean ± SE)
Araneae	22.08 ± 4.78	5.67 ± 0.75
Chrysopidae	0.33 ± 0.14	-
Coleoptera	4.66 ± 0.95	0.50 ± 0.19
Diptera	0.16 ± 0.11	-
Formicidae	21.33 ± 3.86	0.25 ± 0.13
Hemiptera	48.58 ± 5.44	0.08 ± 0.08
Hymenoptera	0.33 ± 0.13	0.25 ± 0.13
Lepidoptera	0.08 ± 0.08	-
Ortoptera	0.08 ± 0.08	-
Psocoptera	5.08 ± 1.46	0.08 ± 0.08
Thysanoptera	0.08 ± 0.08	0.25 ± 0.13
Total	102.75 ± 8.01	7.08 ± 0.91

Table 2. Results of the Wilcoxon tests for the abundance of arthropod groups between adjacent to shrublands and central areas, and non-burnt and burnt olive groves (Simulated data).

	Non-burnt		Burnt		Non-burnt vs. Burnt	
	W	**P**	**W**	**P**	**W**	**P**
Araneae	8893.00	<0.01	1724.50	<0.01	138.50	<0.01
Coleoptera	5421.50	0.30	3797.00	<0.01	134.50	<0.01
Hemiptera	9777.50	<0.01	4300.00	<0.01	124.00	<0.01
Formicidae	7979.50	<0.01	4320.00	0.02	144.00	<0.01
Psocoptera	2631.00	<0.01	4200.00	<0.01	144.00	<0.01
Total	9710.00	<0.01	1294.00	<0.01	144.00	<0.01

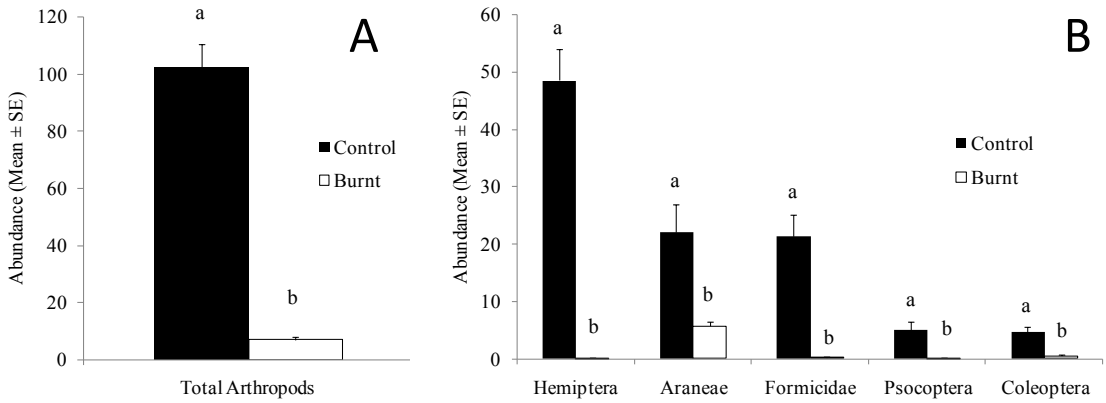

Figure 1. A: Total arthropod abundance (mean ± standard error – SE) in the non-burnt grove and burnt olive groves and B: dominant arthropod groups abundance (mean ± standard error – SE) in the control grove and burnt olive groves. Different letters above each pair of bars indicate significant differences between groves (p<0.01).

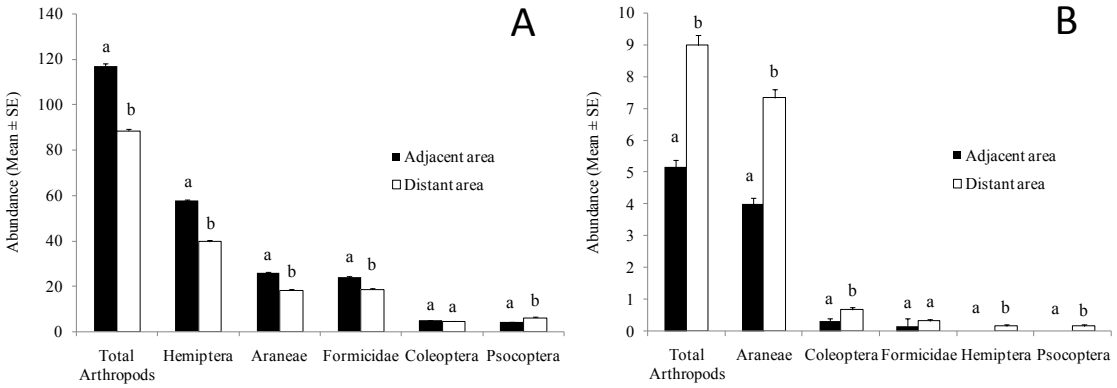

Figure 2. Total arthropod abundance and abundance of the dominant groups (mean ± standard error) in the pool of samples adjacent to the shrubland area and distant to it. A: Non-burnt grove and B: Burnt grove. Different letters above each pair of bars indicate significant differences between areas (p<0.01).

4. Conclusion

Since the shurbland areas are located on the opposite grove side in each case, we suggest that the flying colonization ability of different arthropod groups are involved in how the canopy community is restored after the disturbance more than the presence of semi-natural surrounding areas. For example, in the case of spiders, aerial dispersion (ballooning) depends on wind direction (Bianchi et al., 2017) and the dominant wind along the study area could be the most important driver controlling the incoming population to the grove.

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