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Global change and radiation in Mediterranean forest ecosystems: a meeting point for ecology and management

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ABSTRACT: Quantitative information on understory light is crucial to understand many aspects of forest ecology and dynamics. However, only scant information is available for Mediterranean shrublands and forests despite its increasing importance with land abandonment in Southern Europe. The increased shade that accompanies the abandonment of Mediterranean woody ecosystems together with the predicted global dimming is likely to result in a decreased spatial heterogeneity of light and a gradual disappearance of the characteristic high-light shrub communities, which in turn could lead to impoverished, hollow forests with only a herbaceous understory layer. There is information to simulate future climatic scenarios and changes in land use in the Mediterranean basin, but we do not know enough for equivalent predictions of the responses of Mediterranean forests to dim and homogeneous understories in conjunction with increased temperatures and droughts. Here I present pieces of evidence of how is understory light and how it can be affected by abandonment of traditional practices coupled with the expected increased drought in Holm and cork oak forests in Central and Southern Spain. The results are interpreted in view of the limited ecophysiological information of plant responses to the combination of drought and shade, which indicate that, counter intuitively, photoinhibition and drought can be more severe in the shade, drastically affecting plant recruitment and natural forest regeneration. Since management of forests is to a large extent the management of light, the combination of results and predictions from studies on forest plant ecophysiology, light heterogeneity and dynamics, and global change represents a meeting point for ecology and management, particularly challenging for Mediterranean ecosystems where crucial information to this respect is notably insufficient.

1 INTRODUCTION

Quantitative information on understory light is crucial to understand many aspects of forest ecology and dynamics. However, only scant information is available for Mediterranean shrublands and forests despite its increasing importance with land abandonment in Southern Europe. Many studies have shown that high levels of species diversity can be maintained by the light heterogeneity generated via treefall gaps, Schnitzer and Carson (2001), which suggests that a forest management enhancing spatial heterogeneity of light may lead to an enhanced biodiversity. But many uncertainties to this respect still remain, particularly in heavily managed forest ecosystems such as those in the Mediterranean region, where the number of studies describing understory light is remarkably lower than that of non-Mediterranean temperate and tropical forests, Valladares (2003). There is informa-

tion to simulate future climatic scenarios and changes in land use in the Mediterranean basin, but we do not know enough for equivalent predictions of the responses of Mediterranean forests to dim and homogeneous understories in conjunction with increased temperatures and droughts. Here I present pieces of evidence of how is understory light and how it can be affected by abandonment of traditional practices coupled with the expected increased drought in Holm and cork oak forests in Central and Southern Spain.

2 MATERIALS AND METHODS

Understory light of an abandoned Holm oak (*Quercus ilex* L.) woodland was studied in a 0.1 ha plot in central Spain by means of hemispherical photography and geostatistics. Vegetation in the plot was on average 2.4 m height, with one zone dominated by individual Holm oak trees of up to 9 m height and another zone dominated by shrubby Holm oaks and rockroses. Light was estimated in a 30 x 30 grid of 1-m^2 points. Data from this study, Valladares and Guzman-Asenjo (2003), are combined with unpublished results from studies in cork oak (*Quercus suber* L.) forests in Southern Spain (Los Alcornocales Natural Park, Cadiz) to produce a simple model of shrubland-forest succession in a global change scenario.

3 RESULTS

The understory of the abandoned Holm oak forest studied was rather bright receiving on average 50% of the irradiance in the open. Understory light exhibited a remarkable temporal and spatial heterogeneity (Fig. 1). Sunflecks contributed with half of the total daily radiation available in the understory and they were intense and long. Spatial heterogeneity of light was lower in an abandoned cork oak forest in Southern Spain, where the more humid conditions facilitated extensive growth of both the canopy and the understory and climbing plants.

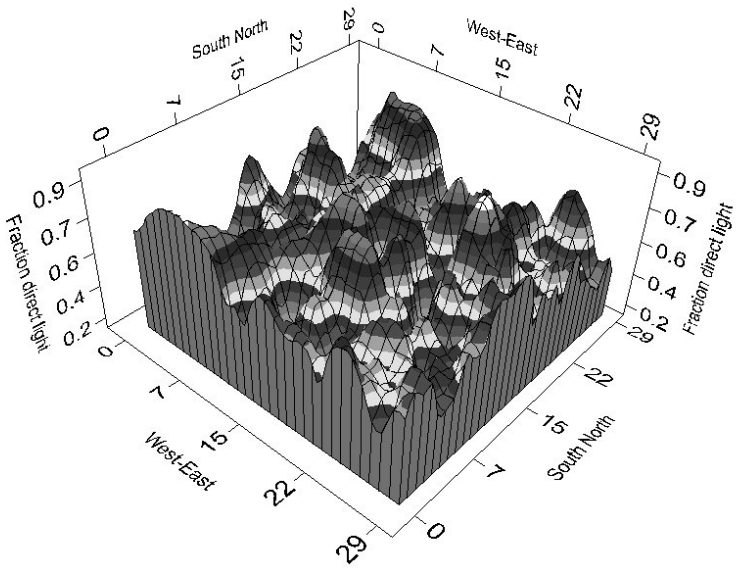

Figure 1. Interpolated map of the direct radiation (expressed as fraction of the direct light available in the open) in the understory of an abandoned Holm-oak forest in Madrid (Spain) estimated with hemispherical photography. X and Y axes are in meters. Photographs were taken at 1 m above the ground.

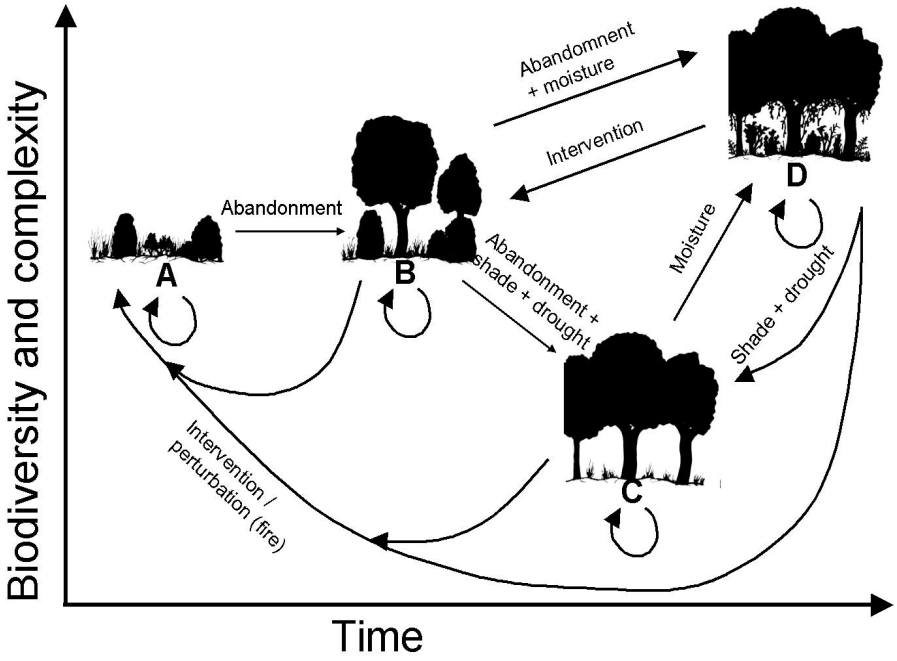

Figure 2. Conceptual model for the time evolution of the typical Mediterranean shrublands (A) with the abandonment of traditional practices (i.e. coppicing, pasturage, ordinary fires) leading initially to a mosaic of woodlands and shrublands (B). If abandonment takes place in moist regions, forests become complex and dense, with dark understories, abundant climbing plants and specialized nemoral species (D). If abandonment takes place under dry conditions, the combined scarcity of water and light leads to empty forests (C), which are poor in species, particularly in the understory and exhibit a very limited capacity for self-regeneration. Intense, catastrophic fires or resumed human intervention can abruptly change the evolution of the system.

4 CONCLUSIONS

The increased shade that accompanies the abandonment of Mediterranean woody ecosystems together with the predicted global dimming, Stanhill and Cohen (2001), is likely to result in a decreased spatial heterogeneity of light and a gradual disappearance of the characteristic high-light shrub communities, which in turn could lead to impoverished, hollow forests with only a herbaceous understory layer (Fig. 2). The combination of drought and shade leads counter intuitively to an enhanced photoinhibition and drought in the shade than in the sun, Valladares and Pearcy (2002), drastically affecting plant recruitment and natural forest regeneration. Global change in Mediterranean ecosystems involves abandonment plus increased drought, Grove and Rackham (2001), so low diversity, empty forests can be expected to become more frequent unless appropriate, corrective management is enforced. Since management of forests is to a large extent the management of light, the combination of results and predictions from studies on forest plant ecophysiology, light heterogeneity and dynamics, and global change represents a meeting point for ecology and management, particularly challenging for Mediterranean ecosystems where crucial information to this respect is notably insufficient.

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