Acta Oecologica 49 (2013) 64–70

Contents lists available at SciVerse ScienceDirect

Acta Oecologica

journal homepage: www.elsevier.com/locate/actoec

Original article

Is evenness altered by fire in natural assemblages of soil arthropods?

Monica Pitzalis [a,*], Marco A. Bologna [a], Luca Luiselli [b,c]

[a] Dipartimento di Scienze, Università Roma Tre, Viale G. Marconi 446, 00146 Roma, Italy
[b] Institute of Environmental Studies, DEMETRA, Via Olona 7, I-00198 Rome, Italy
[c] ENI s.p.a., Environmental Department, Nigerian Agip Oil Company Ltd., Via Lovanio 32, I-00198 Roma, Italy

ARTICLE INFO

Article history:
Received 14 November 2012
Accepted 7 March 2013
Available online 9 April 2013

Keywords:
Soil arthropods
Fire ecology
Management
Evenness
Species richness
Italy

ABSTRACT

We studied evenness and species richness in two assemblages of soil arthropods at six contiguous study plots in Mediterranean ecosystems of central Italy, three of these plots being burnt and three unburnt. We analysed these aspects of community structure by diversity–dominance diagrams comparisons made through analysis of covariance on respective slopes and ordinate intercepts. We observed consistent patterns in both Collembola and Oniscidea assemblages, either in burnt and unburnt plots. Evenness did not change among study plots and across habitats, either before or after fire, whereas species' composition was significantly altered by fire. Results from our study implied that evenness and species diversity are clearly affected in a different and independent way by fire. Hence, it is not acceptable to focus on only the evenness when looking at the effects of controlled fires for environmental management reasons.

1. Introduction

Evenness and species diversity are common descriptors for natural communities (Whittaker, 1965; Tokeshi, 1993; Schuler et al., 1994; Magurran, 2004), but their values can be considerably affected by human-induced or naturally occurring stochastic and/or deterministic stressors (Magurran, 2004; Magurran and McGill, 2011). For instance, dominance tends to be higher in stressed communities and evenness is consequently reduced (Guo and Rundel, 1997; Magurran, 2004). Then, it is important to search for changes in evenness to understand the eventual disturbances on a given community (Battisti et al., 2008).

Fire is considered as one of the main threats for conservation target in the general IUCN threat list (Salafsky et al., 2002, 2008). Controlled fire is among the most used practices for management of natural and semi-natural wooded areas, especially in Australia (Collet and Neumann, 1995; Collett, 1998; Richards et al., 1999; York, 1999) and California (Force, 1981; Keeley and Fotheringham, 2001). Nonetheless, also in European countries the use of fire as a management tool has recently increased considerably because it did not affect significantly community diversity and evenness (Piñol et al., 2005, 2007).

In this study, we analyse the evenness and species richness patterns of soil arthropod communities (Isopoda Oniscidea and Collembola) in a few contiguous study plots in Mediterranean central Italy, some of them affected by fire and some of them used as control. These two groups have been demonstrated to be good indicator of environmental stress in altered versus pristine scenarios (Paoletti and Hassol, 1999; Pitzalis et al., 2005, 2010).

More specifically, we test the following key questions: (i) Are there any changes in evenness and species richness patterns in burnt versus unburnt plots? (ii) If so, is the direction of the changes consistent between evenness and species richness? that is: do evenness and species richness change as a response to fire in a same predictable matter? (iii) If not so, is the evenness a reliable indicator of the community stability and, hence, level of stress of that community? (iv) Is it possible that evenness may not be profoundly altered whilst species richness is? (v) What are the main management implications emerging from evenness versus richness evaluations? In order to test these key questions, we used diversity–dominance diagrams (Whittaker, 1965; Battisti et al., 2008) with comparisons made through analysis of covariance on respective slopes and ordinate intercepts. Diversity–dominance diagrams have been demonstrated to be valuable instruments to detect and quantify stress levels in ecological communities (Tokeshi, 1993; Grant and Loneragan, 2003; Magurran, 2004; Battisti et al., 2008).

* Corresponding author.
E-mail addresses: monica.pitzalis@uniroma3.it, monicapitz@fastwebnet.it (M. Pitzalis), marcoalberto.bologna@uniroma3.it (M.A. Bologna), lucamlu@tin.it (L. Luiselli).

1146-609X/$ – see front matter © 2013 Elsevier Masson SAS. All rights reserved.
http://dx.doi.org/10.1016/j.actao.2013.03.001

2. Materials and methods

2.1. Study area

The research was carried out at a coastal pinewood ("Pineta di Castelfusano", 5 e 25 m a.s.l.; 41°440 N, 12°190 E) situated in the middle-southern area of Latium (central Italy), about 25 km SW of Rome. This area has a typical Mediterranean climate, belonging to the xerotheric bioclimatic region (thermo-Mediterranean/meso-Mediterranean subregion; Blasi, 1994). Two main soil types can be recognised (Gisotti and Collamarini, 1982): (i) a soil type represented by the Late Pleistocenic dunes, presently covered by a pineforest (*Pinus pinea*), planted in the last two centuries, and by *Quercus ilex* woods and Mediterranean shrublands; (ii) a soil type, occurring on the ancient dune slacks, that is represented by fragments of the wetland vegetation (characterised by a *Populus alba* and *Quercus robur* association), which covered a vast area before an extensive water drainage had occurred in the early 900. On July 2, 2000 a large fire stroke the Castelfusano pinewood in the inner side of the forest devastating about 340 of the total 1000 ha of the forest. More details of the study area and the impact of fire on it are given in Ukmar et al. (2007).

2.2. Protocol

As in most research on wildfire effects on biological communities, this study is necessarily retrospective in nature. Unlike empirical trials of designed studies, treatments cannot be randomly assigned and true controls do not exist. Thus, as in similar studies (e.g., Fernandez and Salgado, 2002; Santalla et al., 2002), we used unburnt habitats as representative of pre-fire conditions. In order to do this, we selected six sites, corresponding to the different main habitats occurring in the study area, to compare the effect of fire in different habitats. Three of these sites were unaffected by fire, and three were affected by fire. The six sampling sites were chosen in the core of the burned or unburned areas and at least 200 m from their edges, in order to minimize the capture of individuals coming from other ecosystems, such as adjacent maquis and garrigue. Overall, the vegetation structure of the burnt sites resembled, before fire, that of unburnt sites in our experiments. More in detail, the vegetation characteristics of the study sites were as follows (Fig. 1):

BP1: a burnt pinewood area of ca. 2 ha, located at a distance from adjacent unburnt pinewood of 164–322 m;
BP2: a burnt pinewood area of ca. 2 ha, located at a distance of 0–158 m from adjacent unburnt pinewood areas;
BH: a burnt forest area of ca. 1.5 ha, dominated by holm-oak (*Quercus ilex*), and located at 200–300 m from the most adjacent unburnt mixed pine and holm-oak woodland, and about 600 m from the nearest unburnt holm-oak forest area (UH);
UP: an unburnt pinewood area of ca. 2 ha, continuous with BP2 and BH;
UH: an unburnt holm-oak forest area of ca. 2 ha;
UW: an unburnt moist forest area (ca. 2 ha) with fragments of the original vegetation formerly distributed on the dune slacks in the study area before pines, were planted. This area corresponds to the climax vegetation condition for the study area, together with UH.

As for the burnt sites, BP1 and BP2 have a similar type of fire (canopy fire), and BH was poorly damaged by fire, which affected only superficially the site without destroying pine trees.

The unburnt sites were representative of the conditions of the respective wildfire sites (i.e. UP for BP1 and BP2, and UH for BH) before the fire. In addition, the unburnt sites were similar to burnt correspondent sites also in terms of elevation, slope, topography, tree species composition, plant association, soil types, and past management practices. We compared only one site for each vegetation type because the fire, although devastating in terms of its effects (Pitzalis, 2002; Pitzalis et al., 2005; Ukmar et al., 2007; Trucchi et al., 2009), was not extended in space enough to allow for comparisons of multiple sites that are independent each another (Pitzalis et al., 2005, 2010; Trucchi et al., 2009). Moreover studies

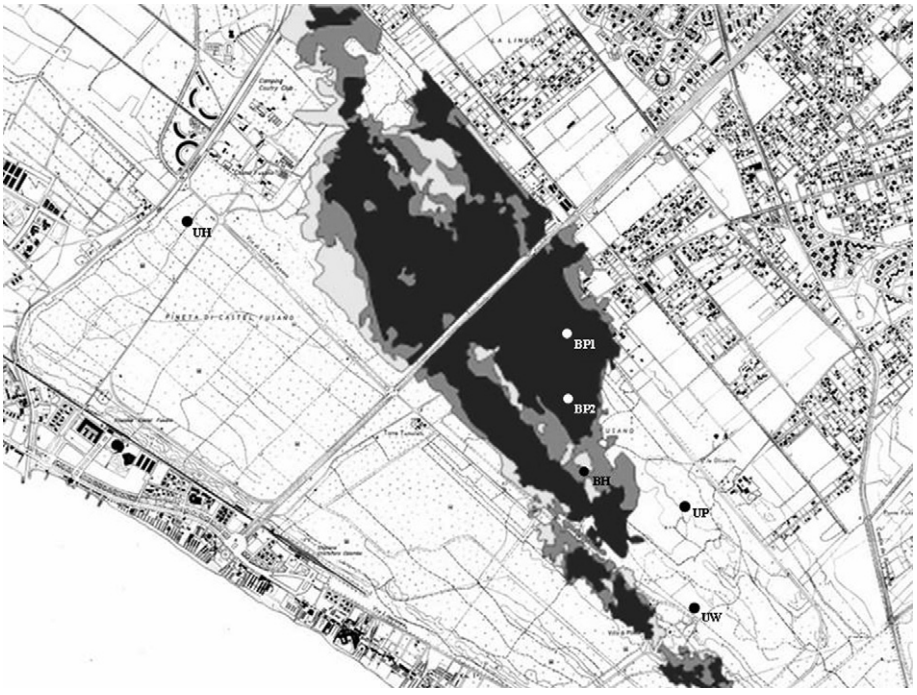

Fig. 1. Map of the study area with indicated the six study plots. For more details, see the text.