



Does flowering synchrony contribute to the sustainment of dry grassland biodiversity?



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ARTICLE INFO

Article history:

Received 20 January 2016

Received in revised form 1 April 2016

Accepted 7 April 2016

Edited by Fei-Hai Yu

Available online 11 April 2016

Keywords:

Co-flowering index

Generalists and specialists species

Pollinator sharing

Rare species

Species interactions

ABSTRACT

Phenological relationships among entomophilous species for pollination may play an important role in structuring natural plant communities.

The main aim of this work was to test whether in dry grassland communities there is a non-random flowering pattern and if the pattern influences the species richness, and the richness of subordinate and common species.

Field sampling was carried out in temperate dry grasslands in NE Italy. Species composition and the flowering phenology were monitored in 45 2 m × 2 m plots randomly placed over dry grasslands.

To quantify the degree to which insect-pollinated species overlap in their flowering time we developed a “co-flowering index” (CF-index). The significance of the observed flowering pattern was tested using a null model.

A positive correlation was found between the synchronic flowering and the number of subordinate species. Subordinate species showed shorter flowering length than the common species and a mostly specialized pollination system.

Our findings suggest that flowering synchrony might be a key characteristic which may contribute to shape dry grassland composition by favouring the long lasting maintenance of rare species populations within the community.

The comprehension of such functional relationships between species of different trophic levels is of great importance for the conservation of dry grasslands and the maintenance of the ecosystem services that pollination provides.

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1. Introduction

Biotic interactions have long been investigated as a possible mechanism governing and maintaining species richness within a community (Brooker et al., 2008; Bonanomi et al., 2011; Hallett et al., 2014). Among the wide variety of biotic interactions, phenological relationships among entomophilous species for pollination have been hypothesized as playing an important role in structuring natural plant communities (Feldman et al., 2004; Moeller, 2004; Ghazoul, 2006; Callaway, 2007; Brooker et al., 2008). Polli-

nators are assumed to exert comparable selection pressures, thus generating correlations among floral traits (e.g., color, long and narrow corolla tubes, or particular nectar quantities and concentrations) (Armbruster et al., 1999, 2000; Fenster et al., 2004). Although generalist pollination systems are frequent on a global scale, also specialization is common and is assumed to have been integral to angiosperm diversification (Johnson and Steiner, 2000). Most angiosperms produce recognizable suites of convergent floral traits and reward sources that recur in flowers of different evolutionary origin but that share similar pollinators (Rodríguez-Gironés and Santamaría, 2004; Thomson and Wilson, 2008; Willmer, 2011; Sonkoly et al., 2016). In this way, plant-plant relationships may have been modified in order to ensure and/or enhance the visitation rate, eventually influencing community structure and dynamics. Especially, the sharing of the same temporal niche (synchronous flowering periods) by different plant species increases the abundance of floral resources. This in turn could enhance the possibility

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Fig. 1. Study area. Euganean Hills are enclosed within the black square.

of pollinator sharing and ensure the survival of rare and extremely selective entomophilous species (Lavery, 1992; Johnson et al., 2003; Ghazoul, 2006).

The phenological synchronization of flowering and fruiting is supposed to affect inter-specific patterns at several scales, from population to community and landscape (Frankie et al., 1974; Ollerton and Lack, 1992, 1998; Bronstein, 1995; Vilela et al., 2014; Borchert et al., 2005). For example, asynchronous ripening of fruits among certain species in a community was interpreted as a mechanism for avoiding competition for seed dispersers (Wheelwright, 1985). Conversely, flowering synchrony of individuals in a given population has been proved to influence both the quantity and genetic quality of their offspring, by affecting the number of potential mates and the foraging efficiency of pollinators (Schemske, 1977). At a different scale of observation, Dante et al. (2013) revealed how relationships among co-flowering entomophilous species drive species assemblage and distribution within an old-field plant community, highlighting the importance of pollination interactions in influencing ecosystem structure and functioning.

During the last decade, there has been a consensus in ecological and environmental sciences about the interdependence between species richness and ecosystem functioning (Sachs et al., 2009; Hooper et al., 2005), although with contrasting views. Schwartz et al. (2000) proposed that this relationship generally follows an asymptotic trend, suggesting that only few species are needed to

sustain most processes and functions. Accordingly, increased attention was paid to processes involving relatively dominant species (Schwartz et al., 2000; Lawler et al., 2001; Cardinale et al., 2006). Recently, however, several authors have emphasized the role of the whole diversity, comprising less common species, in assuring ecosystem stability and functioning across time (Allan et al., 2011; Mouillot et al., 2013).

According to Tilman (2004), the abundance of a species is proportional to the amount of the habitat that has the environmental conditions that match the species requirements. Thus, less common species are those better adapted to less common environmental conditions in a habitat and are likely to possess functional traits distinct from those of common species. Indeed, rare or subordinate species have been recognized as increasing both species richness (Wellstein et al., 2014) and the functional diversity of communities (Richardson et al., 2012); they are also expected to support ecosystem functioning under future environmental conditions (Mouillot et al., 2013). At the same time, in the majority of ecological communities, rare species are expected to be at higher risk of extinction than dominant ones (Purvis et al., 2000). Therefore, the identification of patterns related to the maintenance of species diversity and, in particular, of the rare or subordinate species in ecological communities should be mandatory when investigating ecosystem functioning (Allan et al., 2011; Mouillot et al., 2013).

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