



Flowering phenology and plant-pollinator interactions in a grassland community of Southern Brazil



Suiane Santos Oleques^{a,*}, Gerhard Ernst Overbeck^b, Rubem Samuel de Avia Jr.^c

^a Programa de Pós-graduação em Botânica, Laboratório de Estudos em Vegetação Campestre (LEVCamp), Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil

^b Departamento de Botânica, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil

^c Laboratório de Estudos em Biodiversidade Pampiana (LEBIP), Universidade Federal do Pampa, Campus São Gabriel, RS, Brazil

ARTICLE INFO

Article history:

Received 30 November 2016

Received in revised form 21 February 2017

Accepted 22 February 2017

Edited by Fei-Hai Yu

Available online 27 February 2017

Keywords:

Biotic interactions

Competition

Phenological pattern

Synchrony

ABSTRACT

Synchrony of phenological events at the community level is a critical aspect for plants. Distinct phenological patterns, such as aggregated and segregated, act in the establishment of plant-pollinator interactions and can play a fundamental role in plant community structure. Working in grazed subtropical grasslands in southern Brazil, our goals were to describe the plant-pollinator interactions in the grassland community and investigate the phenological patterns. The study was performed in a grassland community of Southern Brazil. In 12 sample plots (100 m² each) all flowering plant species with visually attractive flowers were recorded monthly during the period of six months. We used the Pianka index to estimate the flowering overlap, by comparison with 1000 pseudo-communities and a synchrony index to evaluate the phenological community pattern. All 82 flowering species present in the 12 study plots were observed monthly between six months. We observed that the community presented aggregated and non-synchronized flowering periods, which should reduce pollinator competition. We found no significant relationship between flowering synchrony and similarity of pollinators, that is, plant species that flower for a long time or together with many species did not share more pollinators than plants that flower for short time and alone. Some guilds of flowers visitors preferred flowers with a particular color, which indicated the important role of visual traits in plant-pollinator interactions. This study reports that flowering phenology could be structured by biotic components more than by random processes in these species-rich South Brazilian grasslands.

© 2017 Elsevier GmbH. All rights reserved.

1. Introduction

Time plays a fundamental role in plant reproduction, both for the dispersion of propagules and in the pollination process (Encinas-Viso et al., 2012). The reproductive phenology of plant species is an important factor for structuring biotic interactions with pollinators and, ultimately, for shaping evolutionary processes (Olesen et al., 2008). Plant species co-existence could be determined by flowering pattern and it is driven by functional differentiation of species that could be filtered by environmental conditions, disturbance, plant competition by resources and plant pollinator interactions (Catorci et al., 2012). The relationship between flowering phenology and functional traits of species has been well documented

(Morales et al., 2005; Ansquer et al., 2009; Catorci et al., 2012). However, few studies have focused on functional traits important to a pollinator perspective, such as color, floral resource availability and morphology. Even though many studies have focused on the role of abiotic factors and phylogenetic constraints on phenological patterns (Kochmer and Handel, 1986), biotic interactions may have considerable importance in determining phenological features (Stiles, 1977; Newstrom et al., 1994; Elzinga et al., 2007; Fantinato et al., 2016).

Most plant species depend completely or partially on pollinators for reproduction (Faegri and Van Der Pijl, 1979). The timing of the exposition of a plant's reproductive structures is of fundamental importance for the respective group of potential pollinators which can be directly associated with reproductive success of the plant. Plants can present many flowering individuals over a short period of time ("big-bang") or can flower for a long period in low intensities ("steady-state") (*sensu* Gentry, 1974). These patterns are

* Correspondence author.

E-mail address: suiane.bio@gmail.com (S.S. Oleques).

extremes of a gradient of flowering strategies defined by flowering intensity and flowering synchrony among individual plants at the population level or among plant species at the community level. This variation leads to different phenological patterns in the plant community. For instance, a concentration of flowering species in time results in an aggregated phenological pattern. In contrast, long and steady flowering of smaller numbers of individuals results in a scenario where species change their reproductive phases and present low flowering synchrony with others, resulting in segregated phenological pattern. If we consider pollinators to be a resource 'used' by plants and essential elements for the fitness of plants along evolutionary time, the patterns in the plant community should be expressed and at the same time determined by plant-pollinator interactions. However, interspecific interactions, such as competition (e.g. Stiles, 1977) or facilitation (e.g. Rathcke and Lacey, 1985; Feldman et al., 2004) among plant species and functional traits (Catorci et al., 2012) may also contribute in shaping phenological patterns. Non-overlapping flowering periods could be advantageous as they decrease the competition effects. However, a high flowering time overlap not always indicates a competitive scenario. Rathcke and Lacey (1985) and Feldman et al. (2004) suggested that facilitation interactions could be observed in some aggregated pattern of flowering time, resulting in an optimization of pollinator attraction by higher display of flowering species at a given time. This kind of facilitation could lead to the convergence of phenological time in plant communities (Elzinga et al., 2007). Díaz et al. (1994), working in mountain grassland of Argentina, found no evidence that suggested the existence of systematic ecological forces leading to divergence in phenologies. However, most studies conducted on the community level (72% of communities studies according Feinsinger et al., 1986) found that flowering periods were distributed over time with a minimum interspecific overlap which support the competition-pollinator hypothesis (Aizen and Rovere, 2010).

Distinct phenological patterns of plants with different flower colors (Warren and Billington, 2005) are indicators of the importance of specific interactions between pollinators and plants. It is known that pollinator diversity or the number of interactions established by a plant species are defined by different characteristics of the plant that act together, such as resource availability (quantity of nectar, pollen or oil), morphological traits (color, size and shape of flowers) and flowering time (Bosch et al., 1997). Robertson (1924) showed that species with greenish flower colors bloom before others along the year. Similarly, Warren and Billington (2005) found a significant association between flower color and flowering phenology. Besides, according to the concept of pollination syndromes, plants have characteristics that reflect their primary pollinators and flower color is a determinant trait in the range of pollinators groups (Faegri and Van Der Pijl, 1979; Fenster et al., 2004).

Because of their high species richness (Overbeck et al., 2007), subtropical grasslands in southern Brazil are interesting systems for the understanding of phenological patterns and their relation to pollination. The goal of our study was to answer the following questions: i) Does a grassland community under seasonal subtropical climate present a clear phenological pattern in time? Our hypothesis is that the high seasonality found in South Brazilian grassland promotes a short time period to flowering and temporal displacement in flowering events decreasing a potential pollinator competition of individual species. ii) Does overlapping of flowering phases among plant species lead to higher similarity of their flower visitors? We hypothesized that flowering overlap could lead to highest sharing flower visitors. iii) Do plants with different flower colors exhibit particular flowering phenological pattern? We expected that the species' phenology is independent on flower

color and that species with distinct flowers colors presented the same pattern at the community as a whole.

2. Material and methods

2.1. Study area

The study was performed at the UFRGS Experimental Agro-nomic Station (EEA) in Eldorado do Sul, Rio Grande do Sul state, Brazil (30°06'08.68" S, 51°40'54.92" W), from September 2014 to February 2015. The area is part of the Brazilian Pampa biome that presents subtropical climate and the landscape is characterized by dominance of grassland vegetation (Overbeck et al., 2007) with high diversity of grasses (Poaceae), legumes (Fabaceae) and shrubs (Asteraceae). Livestock ranching is one of the main economic activities in the region and have an important role in the maintenance of grasslands and conservation of the associated biodiversity (Nabinger et al., 2000). We concentrated our study on the spring and summer months when flowering are much more intense than during the other half of the year (Pinheiro et al., 2008).

2.2. Flowering phenology and floral visitors monitoring

In 12 sample plots (100 m² each) all flowering plant species with visually attractive flowers (i.e., species from the Poaceae, Cyperaceae and Juncaceae were not considered) were recorded monthly during the period of six months. For each plant species, we noted abundance (number of individual blooming), flowering period (flower presence or absence) and flower visitors for each plant species. Per plot, each flowering species was observed for 15 minutes during three periods of day (9–12 h, 12–14 h and 15–17 h). In addition to identification of all plants, specimen of all pollinators (when flower visitors contacted the flower reproductive structures) were collected and identified by help of the literature or by specialists on the group in question.

2.3. Statistical analysis

The data were organized in a matrix where each plant species represented a row (*i*), each month a column (*j*) and flowering intensity (relative abundance of each species per month) in cells (*ji*). We evaluated the existence of community flowering phenology pattern, aggregation or segregation of flowering phenology events, using a niche overlap index (Pianka). Statistical significance was determined by comparison with 1000 pseudo-communities that calculated mean values of a null model. We used the RA3 algorithm that reshuffles the row values and retains the observed niche breadth of each species. This analysis was performed in EcoSim 7.00 (Gotelli and Entsminger, 2005). When observed values were higher than generated values, aggregated phenology pattern occur, and lower than observed values indicate segregated phenology pattern (Gotelli and Graves, 1996).

In order to evaluate the importance of flowering synchrony in the community, we calculated the Synchrony index (used as "S" at the community level and "di" in species level) (Freitas and Bolmgren, 2008). The synchrony index was calculated also for groups of species with the same flower's color (yellow, white, pink and purple). This index was used because it allows us to estimate the level of synchronization for each specie "i" in relation to the community of censured species "j". The objective of this index is to merge the overlap between two individuals from the perspective of both individuals and the intensity component of synchronization (Freitas and Bolmgren, 2008). This trait is not observed in Pianka index. Therefore, the Pianka index would make the analysis of synchronization between species and pollinator similarity impossible and the synchronization index proposed by Freitas and Bolmgren

Download English Version:

<https://daneshyari.com/en/article/5532365>

Download Persian Version:

<https://daneshyari.com/article/5532365>

[Daneshyari.com](https://daneshyari.com)