



Relationship between land-use types and functional diversity of epigeic Collembola in Southern Brazil



Bruna Raquel Winck^{a,*}, Enilson Luiz Saccol de Sá^a, Vitor Mateus Rigotti^a,
Matthieu Chauvat^b

^a Programa de Pós Graduação em Ciência do Solo, Departamento de Solo, Universidade Federal do Rio Grande do Sul, Av. Bento Gonçalves, 7712, 91540-000, Porto Alegre - RS, Brazil

^b Normandie Univ., UNIROUEN, IRSTEA, ECODIV, 76000 Rouen, France

ARTICLE INFO

Article history:

Received 22 February 2016

Received in revised form 29 September 2016

Accepted 30 September 2016

Available online xxx

Keywords:

Environmental filtering

Biotic interactions

Trait-divergence

Trait-convergence

Functional diversity

Land-use

ABSTRACT

Land-use change has been identified, among global changes, as the main threat causing biodiversity loss, locally and regionally. This is especially true in Southern Brazil with the two main biomes (Pampa and Atlantic forest) facing high conversion rate into agricultural land to meet increasing demand for food and fuel. Within this region, we focused on epigeic biota across three land-use types (forest, grassland and *Eucalyptus* plantation). We used both a taxonomical and a trait-based approach to depict the changes of Epigeic Collembola assemblages across land-use types. Furthermore, we tested trait-convergence and trait-divergence across land-use types to infer how the environmental filtering and biotic interactions can affect assembly rules and collembolan community composition. Results differed according to the approach used (either taxonomical or trait-based). In general, diversity indices based on the taxonomical approach did not significantly differ between forest and grassland, whereas *Eucalyptus* plantation showed significantly lower values. Functional diversity was significantly higher in forest and similar between grassland and *Eucalyptus* plantation. Furthermore, we found both convergence and divergence of subsets of traits related to the land-use types. The trait-convergence tended to be higher in grassland sites and rather linked to sensorial traits (number of ocelli, antenna length, and trichobothria), drought tolerance traits (body size) and habitat preference traits (pigmentation level, furca development, scale, number of ocelli, antenna length, and body size). On the opposite, Trait-divergence was only linked to sensorial traits (antenna length and postantennal organ) and greatest in forest sites. Our findings showed that a trait-based approach associated with a taxonomic one provides a better understanding of the collembolan community structuring in response to biotic and abiotic changes across different land-use types.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

Worldwide, in order to optimize productivity to meet the increasing demand for food, biofuel and fiber, native grasslands and forests have been replaced by intensively managed agricultural lands (Overbeck et al., 2007; Dahms et al., 2010). Land-use change has been identified, among global changes, as one of the main threat causing biodiversity loss, locally and regionally (Sala et al., 2000; Ponge et al., 2003; Vandewalle et al., 2010; de Vries et al., 2013; Isbell et al., 2015). This is especially true in Southern Brazil with the two main biomes, Atlantic forest and pampas,

facing high conversion into agricultural land with a decrease of their areas over the last century of about 88% and 25%, respectively (Overbeck et al., 2007; Ribeiro et al., 2009; Pillar and Lange, 2015). Basically, the natural vegetation in Southern Brazil has been either used for grazing activities or replaced by plantations of *Eucalyptus* ssp., soybean, wheat, and corn (Nabinger et al., 2000; Pillar et al., 2012).

At the ecosystem level, it is now recognized that the belowground compartment plays an essential role in maintaining ecosystem structure and functioning. Soils support a wide array of ecological functions (i.e., soil organic matter decomposition, carbon and nutrient cycles, food web interactions) leading to several ecosystem services such as C storage, food production and climate mitigation (Lavelle et al., 2006; Barrios, 2007; de Vries et al., 2013). As land-use type partly determines abiotic and biotic soil properties (Sousa et al.,

* Corresponding author.

E-mail address: bru.winck@gmail.com (B.R. Winck).

2006; Vandewalle et al., 2010; Liiri et al., 2012), land-use conversion has an important impact on several soil processes and thereby on ecosystem functioning (Grandy and Robertson, 2007; Dahms et al., 2010; de Vries et al., 2013).

Within the soil, fauna plays fundamental roles in belowground key processes such as carbon and nitrogen cycling (Chamberlain et al., 2006a,b; Lenoir et al., 2006; Eisenhauer et al., 2009). Among soil organisms, Collembola are abundant invertebrates, with numerous species (Hopkin, 1997) affecting decomposition and mineralization processes by feeding on a wide range of micro-organisms and organic sources (Lenoir et al., 2006; Tordoff et al., 2008). Therefore, the study of soil Collembola responses related to soil changes along land-use conversion is of great interest (Hopkin, 1997; Silva et al., 2016; Sousa et al., 2006; Salmon et al., 2014).

In order to evaluate responses of collembolan communities to environmental changes and describe their structure and composition, several studies have integrated both taxonomic and functional approaches (Parisi et al., 2005; Makkonen et al., 2011; Salmon and Ponge, 2012; Salmon et al., 2014; Santorufu et al., 2015; Silva et al., 2016). Diversity indices based only on taxonomic identification (i.e., Richness, Simpson and Shannon diversity indices) are not sufficient to describe communities of organisms, because these indices do not consider the functional variability between species (Moretti et al., 2009), i.e., they consider each species as unique in its response to the environment and in its functionality, and cannot explain the mechanisms that link changes in species composition to environmental changes (Mouillot et al., 2013). To obviate this, recent studies have highlighted the role of a trait-based approach (functional traits) to evaluate the functional composition of a given community and investigate mechanisms related to assembly processes (Keddy, 1992; Lavorel and Garnier, 2002; Chase, 2003; McGill et al., 2006; Pillar et al., 2009).

Functional traits refer to morphological and physiological characteristics of an organism that strongly influence its performance in the environment and have demonstrable links to the organism's functions (Hooper et al., 2005; McGill et al., 2006; Violle et al., 2007). According to de Bello et al. (2009) and Pillar et al. (2009), functional traits also allow to analyze and infer mechanisms involved in assembly processes (assembly rules) in communities. Understanding those mechanisms is crucial to predict responses of communities to environmental changes (i.e., land-use types) and then be able to predict consequences on ecosystem functioning (Lavorel and Garnier, 2002; Hooper et al., 2005; Violle et al., 2007; Pillar et al., 2009). The concept of "assembly rules" assumes that local communities are made by species assembled according to their functional traits from a regional pool (McGill et al., 2006; Violle et al., 2007), resulting from two assembly processes: environmental filtering and biotic interactions (MacArthur and Levins, 1967; Keddy, 1992; Stubbs and Wilson, 2004; Pillar et al., 2009; de Bello, 2012).

Environmental filtering assumes that local habitat conditions act to constrain certain traits within limits and may lead to trait-convergence assembly patterns (TCAP). The result is an assemblage of organisms that share similar functional traits and ecological requirements (MacArthur and Levins, 1967; Mason et al., 2005; Grime, 2006; de Bello et al., 2009; Pillar et al., 2009). For example, Makkonen et al. (2011) observed that Collembola in similar conditions of moisture and temperature shared similar body size and habitat preference. Likewise, Abgrall et al. (2016) showed that changes in vegetation may also act as an environmental filter for soil fauna. It was observed that under highly-productive plant communities, collembolan communities were dominated by species with low pigmentation and a high capacity for chemical perception (high post-antennal organ lobes), probably due to the high quantity and quality of litter.

As a contrary force, biotic interactions within the communities (i.e., competitive exclusion) are expected to cause trait-divergence assembly patterns (TDAP), resulting in an assemblage in which organisms are dissimilar to each other with respect to their functional traits, allowing their coexistence by limiting their similarity (Pillar et al., 2009; de Bello, 2012). Trait divergence, one of the mechanisms of ecological niche differentiation, leads to an increase in functional diversity in a given community (MacArthur and Levins, 1967; Mason et al., 2005; de Bello et al., 2009; Pillar et al., 2009). Several studies reported that habitat heterogeneity is one of the main factors that allows the trait-divergence by promoting the co-occurrence of species with different ecological requirements (Pacala and Tilman, 1994). Podgaiski et al. (2013) showed that spider traits (i.e., body, chelicerae and eye sizes) were more divergent under more functionally diverse plant communities. They suggested that under a diverse plant community, the habitat heterogeneity increased supporting a larger number of ecological niches and possibility of trophic resources.

Since both mechanisms (convergence and divergence) occur within communities and are responsible for the taxonomic and functional composition, there is a need to elucidate the contribution of each mechanism in structuring collembolan assemblages. In Brazil, some studies addressing taxonomic composition, functional traits, and assembly process have been carried out on plants (Müller et al., 2007; Pillar and Duarte, 2010; Joner et al., 2011; Carlucci et al., 2012) and spiders (Podgaiski et al., 2013) in the face of disturbance, but no study was carried out so far on belowground fauna. In this context, we aimed at 1) assessing the structure and composition of collembolan communities from both a taxonomic and a functional approach in three different land-use types predominant in Southern Brazil; and 2) exploring trait-convergence and trait-divergence across those different land-use types to evaluate and partition how environmental filtering and biotic interactions are driving assembly processes in Collembola communities. We hypothesized that different intensity of trait-convergence (environmental filtering) and trait-divergence (biotic interaction) assembly patterns can explain differences in collembolan community structure and composition among different land-use types.

2. Materials and methods

2.1. Site description

The study was carried out at 12 sites ($n=12$) located at the Agronomic Experimental Station of UFRGS (30°5'S, 51°39'W at 46 m a.s.l.), Eldorado do Sul municipality, Rio Grande do Sul, Brazil. All soils were classified as Aluminic Acrisol (IUSS, 2006). The climate was classified by Köppen as Cfa (a transitional zone between tropical and temperate climates), in which annual precipitation is about 1445 mm and mean temperature ranges from 9 °C in winter to 25 °C in summer with an annual temperature of about 18.8 °C (Bergamaschi et al., 2013). Sites were distributed across three different land-use types: natural gallery forest "Forest" ($n=4$), grassland ($n=4$) and *Eucalyptus* plantation ($n=4$). Natural gallery forest and grassland are natural biomes in Southern Brazil that are being progressively replaced by other land-uses (i.e. *Eucalyptus* plantation) or have been used intensively for grazing.

Forest sites have a canopy formed by trees of medium height, between 7 and 15 m, associated with vascular epiphytes. The arboreal component is distributed into 27 families and 60 species (Shannon index is 3.339), with Myrtaceae species being the most abundant, especially *Myrcia multiflora*, *Luehea divaricata*, and *Myrciaria cuspidate*. The vascular epiphytes are distributed into 15 families and 57 species (Shannon index is 3.39), with Orchidaceae, Bromeliaceae, and Polypodiaceae showing higher species

Download English Version:

<https://daneshyari.com/en/article/4381769>

Download Persian Version:

<https://daneshyari.com/article/4381769>

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