



Original Research Article

Structural breakdown of specialized plant-herbivore interaction networks in tropical forest edges

Bruno Ximenes Pinho ^{a, *}, Wesley Dáttilo ^b, Inara R. Leal ^a^a Departamento de Botânica, Universidade Federal de Pernambuco, Av. Prof Moraes Rego, s/ no. 50.670-901, Recife, PE, Brazil^b Red de Ecoetología, Instituto de Ecología A.C., Carretera Antigua a Coatepec 351, El Haya, CP 91070, Xalapa, Veracruz, Mexico

ARTICLE INFO

Article history:

Received 27 June 2017

Received in revised form 14 August 2017

Accepted 14 August 2017

Keywords:

Edge effects

Herbivory

Human-disturbance

Forest fragmentation

Network modularity

ABSTRACT

Plant-herbivore relationships are essential for ecosystem functioning, typically forming an ecological network with a compartmentalized (i.e. modular) structure characterized by highly specialized interactions. Human disturbances can favor habitat generalist species and thus cause the collapse of this modular structure, but its effects are rarely assessed using a network-based approach. We investigate how edge proximity alters plant-insect herbivore networks by comparing forest edge and interior in a large remnant (3,500 ha) of the Brazilian Atlantic forest. Given the typical dominance of pioneer plants and generalist herbivores in edge-affected habitats, we test the hypothesis that the specialized structure of plant-herbivore networks collapse in forest edges, resulting in lower modularity and herbivore specialization. Despite no differences in the number of species and interactions, the network structure presented marked differences between forest edges and interior. Herbivore specialization, modularity and number of modules were significantly higher in forest interior than edge-affected habitats. When compared to a random null model, two (22.2%) and eight (88.8%) networks were significantly modular in forest edge and interior, respectively. The loss of specificity and modularity in plant-herbivore networks in forest edges may be related to the loss of important functions, such as density-dependent control of superior plant competitors, which is ultimately responsible for the maintenance of biodiversity and ecosystem functions. Our results support previous warnings that focusing on traditional community measures only (e.g. species diversity) may overlook important modifications in species interactions and ecosystem functioning.

© 2017 Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Plants and insects interact with each other both in mutualistic and antagonistic ways throughout their life-cycles (Bronstein et al., 2006; Schoonhoven et al., 2005). Plant-herbivore interactions are fundamental for the functioning of terrestrial ecosystems, as they are the main driver of energy flows to higher trophic levels (Futuyma and Agrawal, 2009). The removal of plant tissues by insect herbivores can limit plant population growth rates as a consequence of reallocation of resources that would have been destined for reproduction or plant growth (Coley et al., 1985; Fine et al., 2004). Furthermore, specialist herbivores may constrain plant growth of superior competitors, thus promoting species coexistence in tropical

* Corresponding author.

E-mail address: bxpinho@hotmail.com (B. Ximenes Pinho).

forests (Fine et al., 2004; Janzen, 1970). Despite the importance of conserving plant-herbivore interactions and the associated ecological functions, most studies have focused on traditional population and community measures of plants and herbivores, such as abundance and species diversity (Wirth et al., 2008). However, these descriptors may ignore important modifications in species interactions and ecosystems functioning, as species interactions depend on species co-occurrence in space and time (Tylianakis et al., 2010, 2007).

To overcome these limitations, ecological networks, in which species are depicted as nodes and their interactions are depicted by links, have proven to be a powerful approach to understand how species interactions shape biological communities (reviewed by Bascompte and Jordano, 2013). Indeed, ecological networks have been successfully used to understand the underlying evolutionary and ecological mechanisms of species interactions (Fagundes et al., 2016; Guimarães et al., 2011; Nuismer et al., 2013). For instance, plant-herbivore networks are expected to have a modular structure characterized by groups (i.e. modules) of species, with increased numbers of interacts within modules than between them, as a result of ecological and evolutionary constraints in herbivore plant consumption (Cagnolo et al., 2011; Krause et al., 2003). In networks with such modular topology, the effects of species loss or disrupted interactions are expected to be greater within modules and have limited effects across modules, thus increasing network stability (Krause et al., 2003; Stouffer and Bascompte, 2011). In turn, opportunistic generalist species may disrupt such topology by fusing groups (Olesen et al., 2007) and thus increasing network connectivity between species and modules.

Additionally, ecological networks have been suggested as a valuable analytical tool to analyze the consequences of species changes promoted by human disturbances (Benítez-Malvido et al., 2016; Tylianakis et al., 2010). For instance, important changes in the structure of network interactions have been reported in response to secondary succession gradients (Villagalaviz et al., 2012), global warming (Bähner et al., 2017), species invasion (Falcão et al., 2017) and habitat modification (Tylianakis et al., 2007). In fact, some studies suggest that changes in the structure of network interactions after anthropogenic disturbance can occur even when species richness is unaffected (e.g. Tylianakis et al., 2007). Nevertheless, few studies have examined what changes in plant-herbivore interaction networks occur after anthropogenic disturbances (but see Bähner et al., 2017; Tylianakis et al., 2007; Valladares et al., 2012).

Habitat loss and fragmentation are some of the most pervasive forms of anthropogenic disturbance affecting species occurrence, distribution and interactions (Haddad et al., 2015). In tropical landscapes, forest fragmentation and its subsequent effects (e.g. edge effects; Murcia, 1995) have promoted shifts in the occurrence of several species, including changes in plant and herbivore taxa (Laurance et al., 2002). The negative effects of forest fragmentation are especially associated with the increase in the proportion of edge-affected habitats with altered microclimatic conditions (Laurance et al., 2002). Such altered conditions tend to favor a narrow and non-random subset of pioneer plants, thus impoverishing plant assemblages locally and regionally (Lobo et al., 2011; Santos et al., 2010, 2008). This plant functional group can generally tolerate herbivory given its high growth rates (Coley, 1988; Stowe et al., 2000), having typically broader adaptations and more diffuse associations with generalist herbivores (Becerra, 2007, 1997). Consequently, substantial changes take place in the herbivore communities in forest edges (Wirth et al., 2008). Indeed, several studies reported increased densities of generalist herbivores at forest edges in a number of different ecosystems (e.g. Barbosa et al., 2005; Harris and Burns, 2000; Major et al., 2003; Meyer et al., 2009; Wirth et al., 2007). As a consequence of the modifications in plant and herbivore occurrences, some studies have shown subsequent effects in plant-herbivore interactions (for a review, see Wirth et al., 2008), such as changes in the amount of plant tissue consumed (Rao et al., 2001; Urbas et al., 2007), in the use of plant resources in disturbed habitats (Falcão et al., 2011), as well as changes in herbivore foraging behavior (Silva et al., 2013).

However, notwithstanding the effectiveness of ecological network models to characterize the consequences of anthropogenic disturbances, little attention has been given to the consequences of forest fragmentation for plant-herbivore interaction topologies (but see Valladares et al., 2012). Here, we evaluate how edge proximity alters plant-insect herbivore networks by comparing forest edges with forest interior. Given the biological homogenization and dominance of pioneer plants and generalist herbivores in edge-affected habitats (see above), we tested the hypothesis that plant-herbivore interaction networks in forest edges have lower modularity and herbivore specialization. We present a novel approach to the study of anthropogenic-disturbed systems by analyzing a wide number of plant-herbivore interactions, instead of adopting a single-taxon approach (e.g. leaf-cutting ants, Falcão et al., 2011; leaf miner insects, Cagnolo et al., 2011).

2. Methods

2.1. Study site

This study was carried out at Usina Serra Grande, a large private sugar company which retains ca. 9000 ha of native forest cover assigned to a unique biogeographic region of the Brazilian Atlantic forest: the Pernambuco Center of Endemism (Santos et al., 2007), one of the most threatened region of the Brazilian Atlantic forest (Silva and Tabarelli, 2000). This landscape (Fig. 1) is located in the state of Alagoas and encompasses the largest and best conserved forest fragment in the northeast of the Brazilian Atlantic forest (Santos et al., 2008), locally called “Coimbra Forest”. Apart from Coimbra Forest, and as observed in the entire region (Ranta et al., 1998), the landscape is composed of small remnant forest patches embedded in a homogeneous and hostile matrix dominated by sugarcane monocultures and human settlements. Annual rainfall is 2000 mm, with a dry season (<60 mm/month) from November to January. Remnant vegetation is composed of lowland *terra firme* forest

Download English Version:

<https://daneshyari.com/en/article/5742353>

Download Persian Version:

<https://daneshyari.com/article/5742353>

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