



Tree species composition rather than diversity triggers associational resistance to the pine processionary moth

Bastien Castagneyrol^{a,b,*}, Margot Régolini^{a,b,c}, Hervé Jactel^{a,b}

^aUniv. Bordeaux, UMR1202, BIOGECO, F-33400 Talence, France

^bINRA, UMR1202, BIOGECO, F-33610 Cestas, France

^cEuropean Forest Institute, EFI Atlantic, 33610 Cestas, France

Received 6 January 2014; accepted 21 June 2014
Available online 27 June 2014

Abstract

The reduction of insect herbivory is one of the services provided by tree diversity in forest ecosystems. While it is increasingly acknowledged that the compositional characteristics of tree species assemblages play a major role in triggering associational resistance to herbivores, underlying mechanisms are less well known. We addressed this question in the ORPHEE experiment by assessing pine processionary moth infestations (*Thaumetopoea pityocampa*) across a tree diversity gradient from pine monocultures to five species mixtures. We showed that tree species richness *per se* had no effect on the probability of attack by this pest. By contrast, the infestation rate was strongly dependent on plot composition. Mixtures of pines (*Pinus pinaster*) and birches (*Betula pendula*) were less prone to *T. pityocampa* infestations, whereas mixtures of pines and oaks (*Quercus* spp.) were more often attacked than pine monocultures. By taking into account the relative height of pines and associated broadleaved species, this effect could be explained by pine apparency. Pines were on average 343 ± 5 cm height. Birches, as fast growing trees, were slightly taller than pines (363 ± 6 cm), while oak trees were significantly smaller (74 ± 1 cm). Host trees of *T. pityocampa* were then partly hidden in mixtures of pines and birches but more apparent in mixtures with oaks. We suggest that reduced pine apparency disrupted visual cues used by female moths to select host trees prior to oviposition. This study highlights the need to take into account tree traits such as growth rate when selecting the tree species that have to be associated in order to improve forest resistance to pest insects.

Zusammenfassung

Die Reduktion von Pflanzenfraß durch Insekten ist eine der Leistungen, die von der Baumdiversität in Waldökosystemen erbracht wird. Während zunehmend anerkannt wird, dass die Zusammensetzung von Baumgemeinschaften eine wichtige Rolle beim Auslösen von gemeinschaftlicher Abwehr gegen Herbivore spielt, ist über die zugrunde liegenden Mechanismen wenig bekannt. Wir untersuchten diese Frage im ORPHEE-Experiment, indem wir den Befall durch den Pinienprozessionsspinner (*Thaumetopoea pityocampa*) über einen Gradienten von Monokultur bis zur Fünf-Arten-Mischung registrierten. Wir zeigten, dass der Baum-Artenreichtum *per se* keinen Einfluss auf die Befallswahrscheinlichkeit hatte. Dagegen hingen die Befallsraten

*Corresponding author at: UMR 1202 BIOGECO, 69 route d'Arcachon, F-33612 Cestas Cedex, France. Tel.: +33 05 57 12 27 30; fax: +33 05 57 12 28 81.
E-mail address: bastien.castagneyrol@pierroton.inra.fr (B. Castagneyrol).

stark von der Zusammensetzung der Bestände ab. Systeme von Pinie (*Pinus pinaster*) und Birke (*Betula pendula*) wurden weniger stark befallen, während Mischungen von Pinien und Eichen (*Quercus* spp) häufiger als Reinbestände von Pinien attackiert wurden. Wenn man die relative Höhe von Pinien und der vergesellschafteten Laubbaumarten in Betracht zieht, könnte dieser Effekt mit der Apparenz der Pinien erklärt werden. Die Pinien waren im Mittel 343 ± 5 cm hoch. Die Birken waren als schnellwachsende Bäume etwas höher (363 ± 6 cm) als die Pinien, während die Eichen bedeutend kleiner waren (74 ± 1 cm). Die Wirtsbäume von *T. pityocampa* waren damit in den Mischbeständen von Pinie und Birke teilweise verborgen, traten bei Vergesellschaftung mit Eichen aber deutlicher in Erscheinung. Wir meinen deshalb, dass die verminderte Apparenz der Pinien visuelle Signale stört, die von den Weibchen genutzt werden, um vor der Eiablage Wirtsbäume auszuwählen. Diese Untersuchung macht deutlich, dass es notwendig ist, Eigenschaften wie die Wachstumsgeschwindigkeit zu berücksichtigen, wenn die Baumarten für eine Mischkultur ausgewählt werden, um die Abwehr eines Forstbestandes gegen Schadinsekten zu verbessern.

© 2014 Gesellschaft für Ökologie. Published by Elsevier GmbH. All rights reserved.

Keywords: Associational resistance; Biodiversity; Forest; Herbivory; ORPHEE; *Thaumetopoea pityocampa*; Tree apparenz; Tree height

Introduction

Tree diversity supports ecosystem functioning and provides numerous ecosystem services in forests, such as wood production or carbon sequestration (Gamfeldt et al. 2013; Vilà et al. 2013). Tree diversity also contributes to reduce damage caused by insect herbivores, a phenomenon known as associational resistance (Castagneyrol, Jactel, Vacher, Brockerhoff, & Koricheva 2014; Jactel & Brockerhoff 2007; Vehviläinen, Koricheva, & Ruohomäki 2007). However, recent biodiversity experiments questioned the generality of associational resistance in forest (Koricheva et al. 2006), showing no effect of tree diversity on herbivory (Plath, Mody, Potvin, & Dorn 2011) or even higher damage in mixed forests than in monocultures (i.e. associational susceptibility Plath, Dorn, Riedel, Barrios, & Mody 2011; Schuldt et al. 2010).

Reduced insect ability to locate and reach host trees inter-mixed with non-host plants has been proposed as one of the main reasons why mixed forests should be more resistant to herbivores than pure stands. The host concentration hypothesis (Root 1973) states that specialist herbivores are more likely to immigrate to and less likely to emigrate from patches in which their resource is concentrated (e.g. Hambäck, Ågren, & Ericson 2000). Because in forests tree diversity often comes with a decrease in the density of each species, the host concentration hypothesis may contribute to explain associational resistance (Castagneyrol, Jactel, Charbonnier, Barbaro, & Dulaurent-Mercadal 2014; Giffard, Jactel, Corcket, & Barbaro 2012).

Beside this simple numerical effect of reduced host availability, mixtures of host and non-host trees may also reduce tree apparenz by disrupting the cues that herbivores use to locate their hosts. For instance, it has been shown that associational resistance may occur in trees that are physically hidden by taller non-host neighbours (Castagneyrol, Giffard, Péré, & Jactel 2013; Dulaurent et al. 2012; Floater & Zalucki 2000). Alternatively, non-host trees may reduce the ‘chemical apparenz’ of hosts by the emission of non host volatiles,

perceived as repellents or diluting host attractants (Bruce, Wadhams, & Woodcock 2005; Jactel, Birgersson, Andersson, & Schlyter 2011; Zhang & Schlyter 2004). Host concentration and disruption of host cues are not independent processes as patches where a given host species is more concentrated also display a larger amount of cues, and are then more likely to be found by herbivores from the distance (Andersson, Löfstedt, & Hambäck 2013).

The presence of broadleaved species has proven to provide associational resistance to the pine processionary moth *Thaumetopoea pityocampa* (hereafter referred to as PPM), which is one of the main defoliators of pines in Europe and North Africa (Dulaurent et al. 2012; Jactel et al. 2011). Damage is done in autumn and winter by larvae feeding on needles. Caterpillars remain congregated in permanent silky nests, easy to locate in the tree crowns. Caterpillars go down the trees in procession to pupate in the soil of forest tracks or open habitats in late winter. Adult moths emerge in summer and mate almost immediately in the understorey. Then, females search for an appropriate host prior to oviposition. They use visual cues to locate the host tree, flying towards dark tree silhouettes against a clear background (Démolin 1969). This behavior has been proposed to explain why isolated pine trees or pine stand edges are significantly more infested by the PPM than stand interiors (Dulaurent et al. 2012). Because caterpillars do not relocate after eggs have hatched, the location of caterpillars and associated defoliations results from the female’s choice of oviposition site. Dulaurent et al. (2012) showed that broadleaved hedgerows bordering pine stands reduced pine infestation by disrupting the visual cues that gravid PPM females use to locate their hosts; host trees were hidden by broadleaved trees and the taller the hedgerow, the stronger was the protection effect. Jactel et al. (2011) also demonstrated that birch trees (*Betula pendula*) could provide neighbouring pine trees with associational resistance via the release of non-host volatiles disrupting both the mating behavior and the host location process in the PPM.

However there has been no experimental tests of the effects of tree diversity *per se* on the resistance of mixed pine forests

Download English Version:

<https://daneshyari.com/en/article/4384087>

Download Persian Version:

<https://daneshyari.com/article/4384087>

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