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Spillover of tachinids and hoverflies from different field margins

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Abstract

The introduction and conservation of field margins have been proposed as an intervention to counteract the decline in farmland biodiversity. However, how these margins can affect the movement of species and individuals (i.e. spillover) of natural enemies between field margins and crop is still unclear. In this work, we investigated the spillover of two different groups of natural enemies: tachinids (Diptera: Tachinidae) and aphidophagous hoverflies (Diptera: Syrphidae). For comparison we also investigated the response of non-aphidophagous hoverflies. We examined the spillover from two types of field margin (grass margin vs. hedgerow + grass margin) to adjacent maize fields located in landscapes with different proportion of arable land. The spillover of natural enemies was affected by the field margins, but the response varied between insect groups. The spillover of tachinids was higher from the grass margin than from hedgerows, suggesting that the spillover of this group may be related to the low contrast between the vegetation structure of the margin and the crop. In contrast to tachinids, the abundance of aphidophagous hoverflies was higher toward the center of the crop field, independently of the type of field margin. The spillover of non-aphidophagous hoverflies was not affected by the type of field margin. These species were only affected by the landscape composition as their species richness and abundance were higher in landscapes with low amounts of arable land. Measures focusing on the creation and management of field margins need to consider the local contrast between field margins and crops in relation to the life-history traits of different taxa.

Zusammenfassung

Es wurde vorgeschlagen, dass Einrichtung und Schutz von Feldrändern dem Rückgang der Biodiversität in der Agrarlandschaft entgegenwirken sollten, aber wie diese Ränder die Bewegung von Arten und Individuen von natürlichen Feinden zwischen Feldrändern und Feldfläche (sog. "spillover") beeinflussen ist immer noch unklar. Wir untersuchten den spillover von

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zwei unterschiedlichen Gruppen von natürlichen Feinden: Raupenfliegen (Diptera: Tachinidae) und aphidivore Schwebfliegen (Diptera: Syrphidae). Zum Vergleich betrachteten wir auch die nicht-aphidivoren Schwebfliegen. Wir untersuchten den spillover zwischen zwei Arten von Feldrändern (Grasrand und Hecke mit Grasrand) und den angrenzenden Maisfeldern, die in Landschaften mit unterschiedlichen Anteilen von Ackerflächen lagen. Der spillover der natürlichen Feinde wurde vom Feldrandtyp beeinflusst, aber die beiden Gruppen reagierten unterschiedlich. Der spillover der Raupenfliegen war vom Grasrand größer als von der Hecke, was nahelegt, dass der spillover bei dieser Gruppe eher mit dem geringen Kontrast zwischen der Vegetationsstruktur von Rand und Feldfrucht zusammenhängt. Dagegen war die Abundanz der aphidivoren Schwebfliegen zur Feldmitte hin erhöht, unabhängig vom Typ des Feldrands. Der spillover der nicht-aphidivoren Schwebfliegen wurde nicht durch den Typ des Feldrandes beeinflusst. Wir fanden nur einen Einfluss der Landschaft, da ihr Artenreichtum und ihre Abundanz in Landschaften mit geringem Ackerflächenanteil höher waren. Maßnahmen zur Schaffung und Pflege von Feldrändern müssen den lokalen Unterschied zwischen Feldrändern und Feldfrüchten in Bezug auf die Biologie der verschiedenen Taxa berücksichtigen.

Keywords: Agricultural intensification; Agri-environment schemes; Hedgerows; Natural enemies; Parasitoids; Species movement

Introduction

The expansion of agriculture has led to a rapid increase of arable land with a consequent fragmentation of natural habitats (Tilman et al. 2001). Agricultural landscapes are often characterized by a mosaic of semi-natural habitats interspersed within a homogeneous matrix dominated by only a few crops. This simplification of agricultural landscapes is responsible for the severe reduction in the diversity of insect natural enemies, which in turn is possibly negatively affecting important ecosystem services such as pest biological control (Wilby & Thomas 2002; Bianchi, Booij, & Tscharntke 2006; Macfadyen et al. 2009; Geiger et al. 2010; Thies et al. 2011; Jonsson et al. 2012). In Europe, agri-environment schemes (AES) have been implemented to counteract this decline in farmland biodiversity. Within farms, the conservation and implementation of semi-natural elements such as hedgerows, field margins, and wildflower strips are among the most common interventions (Marshall & Moonen 2002; Haaland, Naisbit, & Bersier 2011). Although there is growing empirical evidence suggesting that the presence of these semi-natural elements can help to mitigate the negative effects of agricultural intensification on insect diversity (e.g., Merckx, Marini, Feber, & Macdonald 2012; Macfadyen & Muller 2013; Haenke et al. 2014; Dainese, Inclán, Sitzia, & Marini 2015), it is still unclear how these farmland interventions affect the movement of natural enemies.

The spillover of natural enemies represents the movement of species from one habitat to another in search of specific resources such as prey or hosts, nectar for adults or shelter. In agricultural landscapes, the spillover of natural enemies is known to be affected by the quality and the contrast of the different habitats (Polis, Anderson, & Holt 1997; Prevedello & Vieira, 2010; Eycott et al. 2012; Schellhorn, Bianchi, & Hsu 2014). Habitats with high degree of contrast are expected to be relatively impermeable to movement, while structurally similar habitats are likely to be more permeable (Stamps, Buechner, & Krishnan 1987). Furthermore, there is growing evidence suggesting that the spillover of natural enemies is further affected by landscape processes (e.g., the proportion of forests and mass-flowering crops in the landscape) as the movement of natural enemies can be affected by the availability and concentration of resources like flowers and hosts or preys (Meyer, Jauker, & Steffan-Dewenter 2009; Haenke et al. 2014; González, Salvo, & Valladares 2015; Inclán, Cerretti, & Marini 2015). Several authors have found spillover of species from natural habitats into adjacent agricultural fields (e.g., Geiger, Wäckers, & Bianchi 2009; Rusch, Valantin-Morison, Sarthou, & Roger-Estrade 2010; Blitzer et al. 2012; González, Salvo, & Valladares 2015; Macfadyen et al. 2015), but movements in the opposite direction have also been observed (e.g., Rand, Tylianakis, & Tscharntke 2006; Blitzer et al. 2012; Frost, Didham, Rand, Peralta, & Tylianakis 2015). Although there are several studies showing that the spillover of natural enemies can alter important ecosystem services such as pollination and natural pest suppression (e.g., Haenke et al. 2014; Frost, Didham, Rand, Peralta, & Tylianakis 2015; Macfadyen et al. 2015), most of these studies have focused on the spillover between natural habitats and agricultural fields, while less attention has been made on the spillover of natural enemies from managed field margins.

Studies on the spillover of natural enemies have often focused on a single taxon, ignoring that dispersal dynamics can vary substantially across different groups of natural enemies. While some groups of natural enemies are tightly associated to semi-natural habitats and are highly sensitive to habitat fragmentation, other taxa are well adapted to fragmented landscapes and are capable to use ephemeral and spatially scattered resources in the agricultural matrix (Tscharntke, Rand, & Bianchi 2005; Macfadyen et al. 2015). In this study, we examined the spillover of tachinids and aphidophagous hoverflies from two contrasting field margins (grass margin vs. hedgerow + grass margin) into adjacent maize fields located in landscapes with different proportion of arable land. For comparison we further evaluated the