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Edges within farmland: Management implications of taxon specific species richness correlates

Martin Šálek[a,*], Tomáš Kučera[b], Kamil Zimmermann[c], Iveta Bartůšková[d], Michal Plátek[c,d], Stanislav Grill[b], Martin Konvička[c,d]

[a]*Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Květná 8, 603 65 Brno, Czech Republic*
[b]*Department of Ecosystem Biology, Faculty of Science, University of South Bohemia, Branišovská 31, 370 05 České Budějovice, Czech Republic*
[c]*Institute of Entomology, Czech Academy of Sciences, Branišovská 31, 370 05 České Budějovice, Czech Republic*
[d]*Department of Zoology, Faculty of Science, University of South Bohemia, Branišovská 31, 370 05 České Budějovice, Czech Republic*

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Abstract

In intensively farmed landscapes worldwide, edges separating fields from managed forests represent potential biodiversity reservoirs. We examine variables strongly associated with species richness of several taxa representing diverse ecological guilds – vascular plants, carabids, butterflies, birds and small mammals – inhabiting farmland-forest edges in South Bohemia, Czech Republic. Our main objective was to assess the edge characteristics that could be managed for enhancing species richness of the studied taxa. We found only weak between-taxon correlations and hence often taxon-specific responses to geography, vegetation, adjoining site management, and surrounding habitat diversity and edge density. Therefore, the environmental variables associated with species richness in one taxon are not influential in other taxa. Still, edge width, diversified management of adjoining farmland or forest patches, and surrounding landscape heterogeneity in taxon-specific distances contributed to the species richness of all studied groups, suggesting that these parameters should be targeted by managers in order to enhance farmland biodiversity.

Zusammenfassung

In intensiv bewirtschafteten Landschaften stellen die Randflächen, die Ackerflächen von Forsten trennen, potentielle Biodiversitätsreservoire dar. Wir untersuchten Variablen, die deutlich mit dem Artenreichtum von verschiedenen Taxa (Gefäßpflanzen, Laufkäfer, Schmetterlinge, Vögel und Kleinsäuger) assoziiert waren. Bei unseren Untersuchungen in Süd-Böhmen (Tschechische Republik) beabsichtigten wir, die Eigenschaften von Randflächen auszuwerten, bei denen durch Managementmaßnahmen ein höherer Artenreichtum der untersuchten Taxa erreicht werden könnte. Wir fanden nur schwache Korrelationen zwischen den Taxa und daher häufig taxonspezifische Reaktionen auf Geographie, Vegetation, Management der angrenzenden Flächen, Dichte von Randstrukturen sowie die Diversität der umgebenden Habitate. Die Umweltvariablen, die mit dem Artenreichtum

*Corresponding author. Tel.: +420 387775621.
E-mail address: martin.sali@post.cz (M. Šálek).

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eines Taxons assoziiert sind, haben deshalb keine große Bedeutung für andere Taxa. Dennoch trugen die Randflächenbreite, diversifiziertes Management der angrenzenden Feldflächen und Forsten sowie die Heterogenität der umgebenden Landschaft in taxonspezifischen Radien zum Artenreichtum aller untersuchten Taxa bei, was nahelegt, dass diese Parameter durch das Management ins Auge gefasst werden sollten, um die Biodiversität in der Agrarlandschaft zu erhöhen.

Keywords: Forest-farmland edges; Biodiversity conservation; Carabids; Butterflies; Birds; Small mammals; Floristic composition; Agricultural landscape

Introduction

Agricultural intensification has led to a rapid decline of farmland biodiversity during the last century (Donald, Green, & Heath, 2001; Benton, Vickery, & Wilson, 2003). Farmlands underwent a substantial simplification in terms of structure, habitat diversity and management practices; small-grained mosaics and highly heterogeneous land uses were converted to uniform intensively farmed units (Firbank, Petit, Smart, Blain, & Fuller, 2008). Additionally, reduction of the number and size of unploughed semi-natural vegetation patches, which are reservoirs for farmland biodiversity, increased their mutual isolation, causing a gradual loss of associated species and populations (Benton et al. 2003), although strong differences among regions exist (Tryjanowski et al., 2011). Effects of all these processes are particularly severe in the productive landscapes of Western and Central Europe (Tscharntke, Klein, Kruess, Steffan-Dewenter, & Thies, 2005; Firbank et al., 2008). There is increasing demand for more detailed information on the relationship between habitat structure and biodiversity, and for better understanding of the factors affecting species richness of individual taxa in intensive farmlands (e.g. Wuczyński, Dajdok, Wierzcholska, & Kujawa, 2014).

Many studies exploring the effects of human activity on farmland biodiversity have focused on a single taxonomic group, typically a group that is easily detectable and hence potentially useful as indicator (Biaggini et al., 2007; Eglington, Noble, & Fuller, 2012). Resulting inferences, however, may be biased by taxon-specific patterns in such aspects as average home range, temporal population dynamics, dispersal ability, or scale-dependent perception of habitat suitability (Billeter et al., 2008; Gabriel et al., 2010). Although several studies have found positive species richness correlations among indicator taxa (e.g., Pearson & Carroll, 1998; Kati et al., 2004), others failed to reveal strong relationships (Vessby, Söderström, Glimskär, & Svensson, 2002; Dauber et al., 2003; Billeter et al., 2008). The available across-taxon comparisons are largely limited to taxa of a similar body size, tractable by similar sampling methods, and sharing similar positions in trophic pyramids, such as various arthropod orders tracking the effects of farmland structures on taxa from different trophic levels, from primary producers through arthropod and vertebrate herbivores to arthropod and vertebrate predators, remain rare (but see Vessby et al., 2002; Ekroos et al., 2013).

Within intensively farmed landscapes, linear edges separating fields from remnant forest fragments represent crucial biodiversity reservoirs (McCollin, 1998; Červinka, Šálek, Pavluvčík, & Kreisinger, 2011). Edges (or ecotones: cf. Murcia, 1995) typically host species from both adjoining habitats, plus edge specialists profiting from edge-specific light, microclimate and hydrology conditions. Higher floristic richness and microhabitat heterogeneity of linear edges enhance the relative amount of food resources, compared to both forest fragments and fields ("edge effect"; Murcia, 1995). Edge biota is further affected by adjoining farmland management, as well as by the management, if any, of the edge itself (Smith et al., 2008). At the same time, the heterogeneity of the surrounding landscape influences the colonization-extinction dynamics of the edge habitat on taxon-specific spatial scales (Benton et al., 2003; Fuentes-Montemayor, Goulson, & Park, 2011; Merckx, Marini, Feber, & Macdonald, 2012). Landscape heterogeneity can be expressed as landscape composition, i.e. the relative representation of the habitat types present, and edge density, i.e., the geometry and spatial position of land cover patches (Flick, Feagan, & Fahrig, 2012). The species richness of a particular edge site is thus determined by site-specific characteristics, site management, and wider landscape composition and configuration (Holland, Bert, & Fahring, 2004).

The main objective of this study is to assess the associations between species richness of several taxa, representing several ecological guilds, inhabiting linear forest-farmland edges within an intensively farmed landscape. To do this, we selected vegetation as primary producers, butterflies representing herbivore insects, ground beetles representing small-bodied arthropod carnivores, and birds and small mammals representing large-bodied arthropod and/or seed predators. We asked (1) to what extent is the variation in species richness in one taxon reflected in other taxa (i.e., between-taxon correlations); (2) which environmental characteristics of the farmland edge habitat predict species richness of individual groups; (3) how is the species richness of individual taxa affected by landscape predictors at different spatial scales; and (4) to what extent can the factors predicting the species richness of individual taxa predict the species richness of other taxa? In more general terms, we ask if the factors determining the suitability of an edge as a biodiversity reservoir apply across the diverse taxa