



# The influence of landscape context and farming practices on parasitism of cereal aphids

Indra Roschewitz\*, Melanie Hücker, Teja Tschardt, Carsten Thies

*Department of Agroecology, Georg-August University Göttingen, Waldweg 26, 37073 Göttingen, Germany*

## Abstract

Agri-environmental schemes in Europe aim to support biodiversity and ecological functions in agroecosystems, which are related to both farming practices and landscape context. Here, we analysed the relative importance of farming practices and landscape context on an important ecosystem service, the naturally occurring biological pest control. In a 3-years study, we investigated cereal aphids and their mortality due to parasitism in 24 paired winter wheat fields (i.e., one organic and one conventional field close to each other). The field pairs were located in 12 landscapes differing in landscape complexity, simple landscapes with high percentage of arable land (~80%), and complex landscapes with lower percentage of arable land (~50%) and high proportions of semi-natural habitats. Arable land (%) was used as simple predictor of landscape complexity, as it was closely related with other landscape metrics like habitat-type diversity. Aphid population densities varied considerably between the 3 years and the 12 different landscapes. Organic farming was related to lower abundance of cereal aphids at the time of wheat flowering, but not to higher parasitism. At wheat ripening, complex landscapes were related to higher parasitism than simple landscapes, presumably due to more overwintering sites, alternative hosts and nectar sources for parasitoids. However, aphid population densities were also higher in complex landscapes, presumably due to the high availability of winter hosts for these host-alternating species. In a geographical scale analysis, we tested the relative importance of landscape complexity at 5 spatial scales (1–3 km radius around the study sites). Parasitoids responded to landscape complexity at spatial scales of 1–2 km, whereas aphid densities responded to landscape complexity at all spatial scales, indicating a trophic level-specific perception of the surrounding landscape. We conclude that complex landscapes with low percentage of arable land appeared to enhance parasitism, but also the host-alternating aphids, so overall effects of landscape complexity on cereal aphid control appear to be ambivalent.

© 2005 Elsevier B.V. All rights reserved.

**Keywords:** Farming practices; Conventional farming; Organic farming; Landscape complexity; Cereal aphids; Aphid parasitoids; Biological control; Spatial scale

## 1. Introduction

Agriculture is multifunctional, it provides food, water and other biological goods, and influences the environment, biological diversity, recreation value,

\* Corresponding author. Tel.: +49 551 393734;  
fax: +49 551 398806.

*E-mail address:* [i.roschewitz@uaoe.gwdg.de](mailto:i.roschewitz@uaoe.gwdg.de) (I. Roschewitz).

and landscape aesthetics (Gurr et al., 2003). Increasing intensity of agricultural practices in the last decades caused environmental problems such as water contamination, soil degradation, and biodiversity losses (Matson et al., 1997; Krebs et al., 1999; Tilman et al., 2002). Organic and low-intensity farming systems are reported to produce food in a more sustainable way than conventional farming (Reganold et al., 2001), are financially supported by the EU via agri-environmental schemes (Council Regulation, 1992, 1999), and may contribute to the conservation of biodiversity (Dritschilo and Erwin, 1982; Kromp, 1989; Moreby et al., 1994; Paoletti, 1995; The Soil Association, 2000; Hyvönen et al., 2003). In contrast, other recent studies found similar or even higher numbers of species in conventional than in organic and low-intensity farming systems, respectively (Weibull et al., 2000, 2003; Kleijn et al., 2001; Melnychuk et al., 2003).

Intensive agriculture does not only lead to ecological problems on the local field scale, but also on the landscape level. Former heterogeneous, complex landscapes with well-balanced proportions of arable land, grassland, forests, fallows, hedgerows and other semi-natural habitats are often transformed to homogeneous, simple landscapes with high proportions of arable land. These large-scale changes of landscape context are related to the local loss of diversity and ecological functioning (Kareiva, 1990; Turner and Gardner, 1991; Pickett and Cadenasso, 1995; Polis et al., 1997; Roland and Taylor, 1997; Menalled et al., 1999; Thies and Tschardtke, 1999; Tischendorf and Fahrig, 2000; Thies et al., 2003). For example, parasitism of the rape pollen beetle (*Meligethes aeneus* F.), an important pest of oilseed rape (*Brassica napus* L.), decreases in simple landscapes, causing higher crop damage in simple than complex landscapes (Thies and Tschardtke, 1999).

Relatively little is known on the contribution of organic farming to the functioning of ecosystem services such as biological control of plant pests. Letourneau and Goldstein (2001) found higher natural enemy abundance in organic than in conventional tomato (*Lycopersicon esculentum* Mill.) fields in California, whereas herbivore abundance did not differ between the farming systems. Studies investigating the relative importance of (local) effects of farming practices and (regional) effects of landscape

context are rare. Weibull et al. (2003) and Weibull and Östman (2003) analysed these effects on species richness and species composition, and Östman et al. (2001a) on the condition of polyphagous carabid beetles (Coleoptera, Carabidae). Östman et al. (2001b) found that carabid beetles had a greater negative impact on cereal aphid (Homoptera, Aphidiidae) establishment in organic than in conventional farms, and in complex than in simple landscapes. After aphid establishment, population growth did not differ between the farming systems, but was greater in simple landscapes.

In this study, we simultaneously analysed the effects of farming practices (organically vs. conventionally managed) and landscape complexity (complex versus simple) on the abundance and parasitism of cereal aphids, which are economically important pests on wheat (*Triticum aestivum* L.). In a 3-year study, we analysed 72 wheat fields (24 per year), which were located in 12 agricultural landscapes of southern Lower Saxony (Germany) differing in landscape complexity. By comparing farms with similar landscape features but different farming systems, we were able to quantify the relative importance of local and landscape effects. We hypothesised that aphid abundance should be lower (1) in organic than in conventional fields, and (2) in complex than in simple landscapes, due to a better functioning of biological pest control.

## 2. Methods

### 2.1. Study area

The study was conducted in the years 2001–2003 in 12 agricultural landscapes around the city of Göttingen (North Germany). This area covers approximately 1350 km<sup>2</sup> and is dominated by agricultural land use, i.e., arable land-grassland mosaics covering about 75% of the region, while the remaining area is characterised by patchily distributed fragments of natural and semi-natural habitats such as grasslands, forests, fallows, and hedgerows. We selected 12 circular landscape sectors with a radius of 3 km in either simple landscapes with high percentage of annual crop fields (~80%) or complex landscapes with a low percentage of arable land (~50%) and with larger areas of non-crop habitats.

Download English Version:

<https://daneshyari.com/en/article/8970844>

Download Persian Version:

<https://daneshyari.com/article/8970844>

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