Agriculture, Ecosystems and Environment 230 (2016) 242–250

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Old fields increase habitat heterogeneity for arthropod natural enemies in an agricultural mosaic

R. Gaigher*, J.S. Pryke, M.J. Samways

Department Conservation Ecology and Entomology, Stellenbosch University, Private Bag X1, Matieland, 7602, South Africa

ARTICLE INFO

Article history:
Received 14 December 2015
Received in revised form 15 April 2016
Accepted 8 June 2016
Available online xxx

Keywords:
Agricultural matrix
Agroecosystem
Farmland
Insect conservation
Parasitoids
Predators

ABSTRACT

Spatially heterogeneous agricultural landscapes can support high levels of biodiversity. However, our understanding of the biodiversity value of most landscape elements and their role in the farmland mosaic is limited. We assessed the potential of old fields, a common small-scale feature of farmland in the Cape Floristic Region (CFR), for maintaining arthropod natural enemy (NE) diversity. We also assessed how habitable they are to NEs occurring in remnant fynbos vegetation, compared to the dominant surrounding vineyards. Furthermore, we compared habitat preferences of hymenopteran parasitoids, which are mostly habitat and trophic specialists, with those of generalist predatory arthropods. NE abundance and richness was as high in old fields as in natural vegetation, and was significantly higher than in vineyards. Old fields provided high plant diversity and prey abundance which were positively correlated with NE diversity. Ten out of eleven species of conservation significance assessed here occurred in old fields, including Western Cape and South African endemics, rare and uncommon species. Old field assemblages complemented fynbos and vineyard assemblages, and contained many unique species. They also shared many more species with natural assemblages than did vineyards, representing a more habitable transformed landscape element than cultivated areas for most species. Parasitoids showed greater habitat specificity than predators, and are likely to benefit more from the positive effect of increased habitat heterogeneity. Our results show that small-scale non-natural landscape features can provide additional resources, increase compositional heterogeneity and may help soften the overall agricultural mosaic for arthropod NEs in the CFR. Understanding the value of different landscape mosaic elements is an important step towards a broader landscape-scale approach to farmland biodiversity conservation.

1. Introduction

Intensification of agriculture has been associated with considerable loss of biodiversity (Attwood et al., 2008; Tilman et al., 2001). However, there is increasing evidence that the maintenance or re-establishment of habitat heterogeneity at various spatial and temporal scales can help prevent biodiversity declines in farmland (Benton et al., 2003; Bianchi et al., 2006; Tscharntke et al., 2005). Agricultural landscapes vary considerably in their degree of heterogeneity (Fahrig et al., 2011), and although certain regions have undergone severe farmland homogenization (Tilman et al., 2001), many agricultural landscapes still comprise a diverse mix of different land-uses and biotopes. This landscape-scale habitat heterogeneity can benefit biodiversity in various ways.

Different biotopes differ in the resources that they provide, thereby favouring different species (Benton et al., 2003; Bianchi et al., 2006). Where this leads to high species turnover among patches, it can enhance overall biodiversity across the landscape (Vrdoljak and Samways, 2013). Patch diversity can also benefit species that show complementary habitat use, as they move among mosaic elements and exploit resources provided by different patch types (Cunningham et al., 2013; Mandelik et al., 2012), a behaviour which is considered to be an important mechanism for persistence in these fragmented environments (Mandelik et al., 2012).

Structurally diverse mosaics may also help increase functional connectivity in agricultural landscapes (Driscoll et al., 2013; Fischer et al., 2006). The presence of various uncultivated elements in farmland, such as field margins and planted corridors, have been shown to increase dispersal through the landscape for a range of

* Corresponding author.
E-mail addresses: reneg@sun.ac.za (R. Gaigher), jpryke@sun.ac.za (J.S. Pryke), samways@sun.ac.za (M.J. Samways).

http://dx.doi.org/10.1016/j.agee.2016.06.014

arthropod taxa by providing more permeable movement conduits and increasing the quality of the cultivated matrix (Jauker et al., 2009; Nicholls et al., 2001; Steffan-Dewenter, 2003; Wratten, 1993). A heterogeneous mosaic may therefore help counteract some of the negative effects of fragmentation and isolation by increasing dispersal opportunities for a wider variety of species (Driscoll et al., 2013; Fischer et al., 2006).

The positive influence of landscape heterogeneity may be particularly important where natural vegetation remnants form part of the mosaic, as remnants are often important refuges for native species (Phalan et al., 2011). There is growing recognition that the conservation of patch-dependent farmland species relies on the quality of the surrounding agricultural matrix in addition to the preservation of large, high-quality natural patches (Donald and Evans, 2006).

It is important to understand how species utilize different mosaic elements in the landscape, as this will improve our understanding of species persistence in fragmented landscapes, as well as inform land-management practices for conserving farmland biodiversity (Donald and Evans, 2006; Driscoll et al., 2013). Although the role of certain biotopes such as natural remnants has received much attention (Bianchi et al., 2006), the biodiversity value of most farmland habitat types and their role within the mosaic is not well understood (Bianchi et al., 2006; Cosentino et al., 2011).

Here, we assess the biodiversity value of old fields as a component of agricultural landscape mosaics in the Cape Floristic Region (CFR) of South Africa. About a quarter of the CFR has been transformed for agriculture (Fairbanks et al., 2004; Rouget et al., 2003), yet its farmland is diverse in habitat composition and is estimated to have high conservation potential (Cox and Underwood, 2011). These landscapes still have relatively large amounts of native vegetation, which has been shown to support high plant and arthropod diversity (Gaigher and Samways, 2010; Gaigher et al., 2015; Kehinde and Samways, 2012, 2014). Vineyards are the major cultivation land-use, but there are also various small-scale biotopes such as old fields, as well as riparian, alien tree-invaded and built-up areas.

Old fields, which are defined here as vineyards that had been abandoned for economic reasons, are of particular interest because studies in other regions have shown that uncultivated, non-natural elements such as uncropped grassy field margins (Vickery et al., 2009) and hedgerows (Maudsley, 2000) can greatly enhance farmland biodiversity. There is also evidence that disturbed, semi-transformed biotopes in CFR farmland mosaics can make a considerable contribution to the maintenance of certain native taxa such as insect pollinators and flowering plants (Vrdoljak and Samways, 2013). As old fields in this region generally have high herbaceous plant diversity and are relatively undisturbed, they have potential as additional or complementary biotopes for farmland species to utilize. In our study area, old fields occur as scattered patches throughout the landscape (on average representing about 15% of the total landscape), mostly embedded among active vineyard blocks. Although vineyards in this region can support certain taxa, such as bees and monkey beetles (Kehinde and Samways, 2014, 2012), they seem to be unfavourable to certain higher trophic level taxa such as parasitoid wasps, possibly reducing functional connectivity for populations that still occur in natural remnants (Gaigher et al., 2015). We were therefore also interested in assessing whether old fields provide a more habitable landscape feature than the dominant surrounding vineyards. This information would give an indication of their ability to soften the overall matrix.

To explore these questions, we compared the abundance, richness and assemblage structure of arthropod natural enemies (NEs) in natural vegetation, vineyards and old fields within CFR vineyard landscapes. We focused on NEs because higher trophic level species are more affected by habitat fragmentation (Steffan-Dewenter, 2003) and should therefore be responsive to the different land-uses. NEs also play an important role in regulating the population levels of other organisms (Shaw, 2006; Welch et al., 2012). Conservation of their diversity in the landscape is therefore important for maintaining agroecosystem function and may support agricultural production in the long term by providing greater pest-resilience under changing conditions (Tscharntke et al., 2005). The diversity patterns of parasitoids, that are typically more specialized (Shaw, 2006), and predators, that are mostly trophic and habitat generalists (Welch et al., 2012), were assessed separately as we expected different responses of these two groups due to differences in their life history traits and habitat requirements. With the information on their habitat occupancy we aimed to (1) assess the ability of old fields to maintain high NE diversity, (2) assess if NEs that occur in remnant natural vegetation can also utilize old fields, and (3) determine if habitat preferences in these landscapes differ between parasitoids and predatory arthropods.

2. Methods

2.1. Study design and data collection

Surveys were undertaken on six wine farms around Stellenbosch (33.920°S 18.860°E), Paarl (33.724°S 18.955°E) and Wellington (33.582°S 18.857°E) in January 2014 (Fig. 1). Each farm had remnant fynbos or Renosterveld vegetation, old fields and vineyards. The biotopes differed in plant species richness and structural complexity (natural > old fields > vineyards), plant composition (high indigenous tree, shrub and restio cover in natural sites; high herbaceous plant and grass cover in old fields; low non-crop plant cover in vineyards) and herbivore abundance (old fields > natural sites > vineyards) (Table 1). Old fields were of intermediate disturbance compared to natural and vineyard sites as they were not annually disturbed, but had been previously cultivated. In total, ten sites were selected in natural vegetation, nine in old fields and ten in vineyards. Where more than one vineyard or old field was selected on a single farm, spatially separated blocks were used (>500 m apart). As remnant vegetation often only occurred as single large fragments on farms, two natural sites were selected in single fragments at three of the farms, but they were all separated by >300 m. To sample both the edge and interior of each biotope, sampling was done at locations 10 m and 50 m from the biotope edge, adding up to 58 sampling locations in total.

Parasitoids and predatory arthropods were sampled using a fuel powered leaf blower (SH 86, Stihl, Cape Town, South Africa), set to vacuum mode with a fine mesh bag attached to the 10 cm diameter nozzle. At each sampling location, the vacuum nozzle was inserted into the vegetation 50 times while the sampler walked within a 10 m × 10 m area, avoiding vacuuming the same area more than once. Vines and cover crops were sampled in vineyards. Samples were transferred to plastic storage bags and kept at −15 °C before laboratory processing. As many arthropod groups of this region are taxonomically poorly known, all specimens were sorted to morphospecies (from here on referred to as species) to enable species-level analyses. To obtain broad taxonomic information, all specimens were identified to family level. Parasitoids were identified to family level using the keys in Goulet and Huber (1993), Prinsloo and Eardley (2012) and Prinsloo (1980), and mantids, lacewings and predatory beetles were assigned to family based on family descriptions in Picker et al. (2002) and Scholtz and Holm (1985). As taxonomic expertise was available for spiders, they were identified to species level where possible, and immatures were identified to genus or family level. Data were