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Biodiversity and distribution of beneficial arthropods within hedgerows of organic Citrus orchards in Valencia (Spain)

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Abstract: A study of natural enemies within hedgerows and on ground covers was carried out in two organic citrus orchards in two areas of Valencia (Spain) using two sampling methods, yellow sticky traps and a vacuum machine. Hedgerows had significantly higher levels of natural enemies, followed by citrus and ground covers. The species of natural enemies in hedgerows were similar to those found in citrus orchards, but different from those identified on ground cover. In hedgerows and citrus the predominant predators were Coniopterygidae (Neuroptera) and Cecidomyiidae (Diptera), and the most abundant parasitoids were Aphelinidae (Hymenoptera).

Key words: predators, parasitoids, hedgerows, citrus, biological control, population dynamics.

Introduction

The intensification of agricultural production systems has produced a rapid decline in biodiversity in agroecosystems (Barr et al., 1993; Chamberlain et al., 2000; Robinson and Sutherland, 2002; Benton et al., 2003), reductions in landscape heterogeneity (Weibull et al., 2000) and the loss of non-cropped habitats (Marshall and Moonen, 2002; Petit and Usher, 1998). Non-crop habitats such field margins, fallows (setaside land), hedgerows and wood lots are relatively undisturbed and temporally permanent areas that hold a substantial proportion of the biodiversity in agricultural landscapes (Bianchi et al., 2006). In recent years, the strategies of conservation biological control have had great importance, and though it is said the more diverse natural vegetation species are, the more diversity of natural enemies is found there, the role of certain hedgerow species and ground covers associated to citrus orchards has not been studied in depth (Boriani et al., 1998; Burgio et al., 2004; Franco et al., 2006; Maudsley, 2002; Pollard and Holland, 2006).

This study is the first step toward establishing the role of certain Mediterranean hedgerows and ground covers in the natural enemies populations associated to organic citrus orchards in Valencia (Spain). The main objectives of the present study are: (1) to determine natural enemies of several hedgerows, in order to catalogue predatory species and study their population dynamics; (2) to compare the diversity of predators in the three substrates, hedgerows, orchard and ground covers.

Material and methods

Samples were taken in citrus and hedgerows of two organic citrus orchards located in Alcudia and Alzira, in the region of Valencia (Spain). A total number of 23 field samplings were carried out in Alcudia from May 2006 to May 2007 and 12 in Alzira from October 2006 to May 2007. Samples were made fortnightly, except in winter when samples were collected monthly.

The hedgerows sampled included three monospecific species: *Cupressus sempervirens* L., *Ailanthus altissima* Mill. and *Punica granatum* L., and four mixed species typical on the Mediterranean forest: *Pistacia lentiscus* L., *Crataegus monogyna* Jacq., *Rhamnus alaternus* L. and *Pistacia terebinthus* L. Two kinds of ground covers were also sampled, a spontaneous one and another with sown alfalfa. Plant species found in the spontaneous cover varied depending on the time of the year. In winter, more than 60% were *Bromus* spp., *Echinocloa* spp. and *Hordeum murinum* L., and in summer, more than 70% was *Cynodon dactylon* (L.) Pers.

Arthropods were collected with two methods, a portable vacuum device and yellow sticky traps, with four repetitions per plant species sampled. Samples with the portable vacuum consisted of 2 minutes of suction per plant species. During all the sampling period, 949 suction samples and 973 sticky traps were collected.

Results and discussion

A total of 118,176 arthropods were collected, belonging to 13 different orders. The distribution and abundance of natural enemies differed depending on the plant strata: hedgerows, citrus or ground cover. There were significantly higher numbers of Diptera in the herbaceous strata compared with hedgerows and citrus orchards (Figure 1). Only two families were studied in this order: Cecidomyiidae and Syrphidae. The family Cecidomyiidae was the most abundant. Captures in the Syrphidae were very low, maybe due to the fact that the sampling methods used were not suitable for this family.

Neuroptera were quite common in all sampled trees, been slightly more abundant in *Citrus* sp. and being absent on weeds (Figure 1). Previous studies had already emphasized the importance of this predators on citrus orchards (García-Marí et al., 1991; Llorens 1990; Llorens and Garrido, 1992; Ripollés et al., 1995), but it was not known that they were very abundant in Mediterranean hedgerows.

Very low numbers of Coccinellidae were found in ground covers in comparison with hedgerows and citrus orchards. The species of coccinellids identified were similar to those reported in the studies carried out in citrus orchards by Alvis Dávila (2003) and Bru (2006), although their relative importance varied.

The highest number of families was found in the order Heteroptera. They appeared more frequently in ground covers than in hedgerows, whereas in citrus orchards their presence was very low (Figure 1). Four predatory families were identified: Anthocoridae, Miridae, Reduviidae and Nabidae. Mirids were the most common family in all strata. Nabidae tended to inhabit in great numbers in ground covers, whereas Reduviidae were rare in all plant species. Our results differ from those obtained by Ribes et al. (2004) in organic citrus orchards in Tarragona (Spain). In their study, the proportion of anthocorids in citrus plants was higher than other predatory heteropterans. In our study, the most abundant family was the Miridae, confirming previous studies carried out in woody strata (Pollard and Holland, 2006; Fauvel, 1999).

This study also compared natural enemies found on different hedgerows species and citrus orchard. We found that there were significant differences between plant species and between groups of predators, indicating that plant species influence the diversity and abundance of natural enemies (Figure 2). Neuroptera were common in all plant species, but significantly more abundant in *Rhamnus alaternus*. Heteroptera were more frequent in *R. alaternus*. Coccinellidae were more frequent in *Citrus* sp., Diptera Cecidomyiidae in *Crataegus monogyna* and Formicidae and Araneae in *Cupressus sempervirens*. Aphelinidae

were the most abundant parasitoids, being less common in *C. sempervirens* and more predominant in *Citrus* (data not shown).

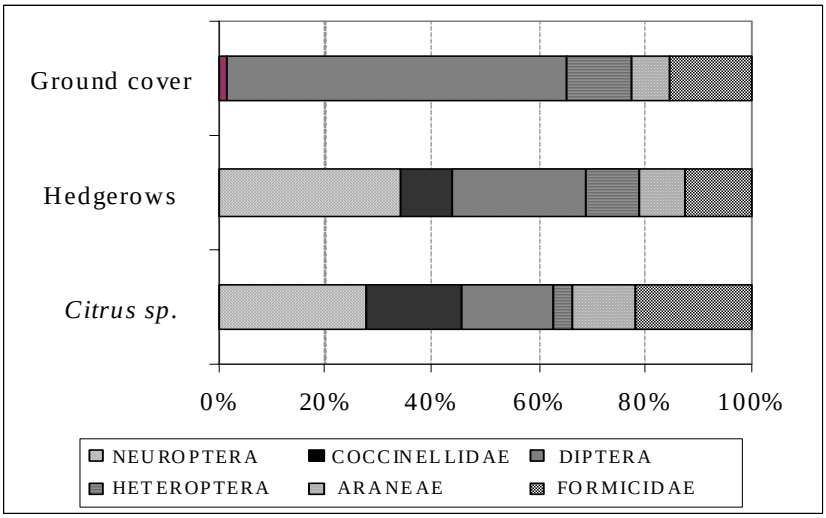

Figure 1. Abundance and diversity of predatory insects and Aranaea captured in two organic citrus orchards located in Valencia (Spain) from May 2006 to May 2007.

The population dynamics throughout the year indicated that certain natural enemies, like the coccinellid *Stethorus punctillum*, are distributed during the year among all plant species studied. Other natural enemies were more frequent at a particular time of the year in one plant species, and later on they moved on to another plant species. This is the case of *Conwentzia psociformis*, which inhabited *R. alaternus* in winter but was found in other plant species, like *Citrus* sp. and *P. terebinthus*, during the summer months (Figure 3).

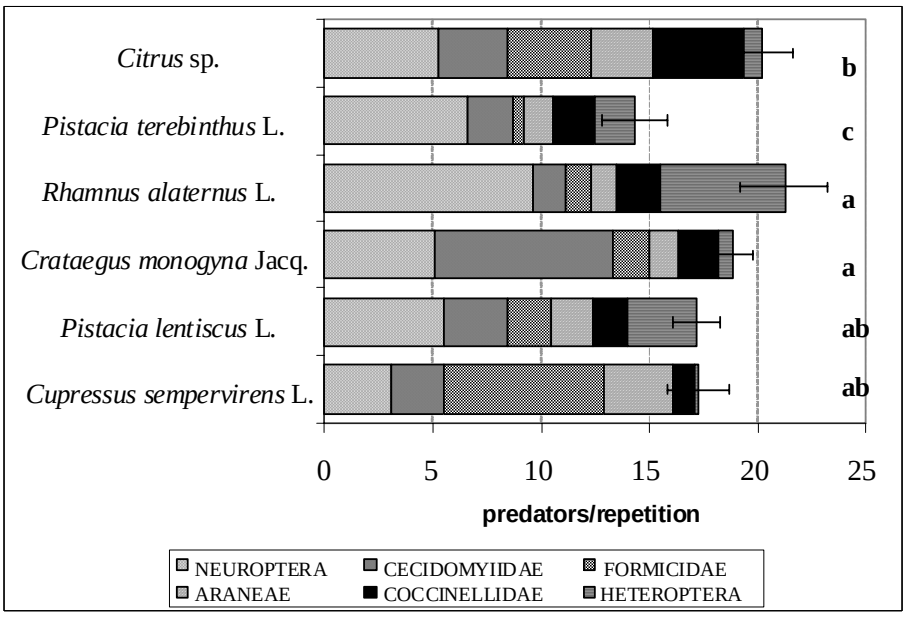

Figure 2. Relative abundance of groups of predators on hedgerows and citrus.

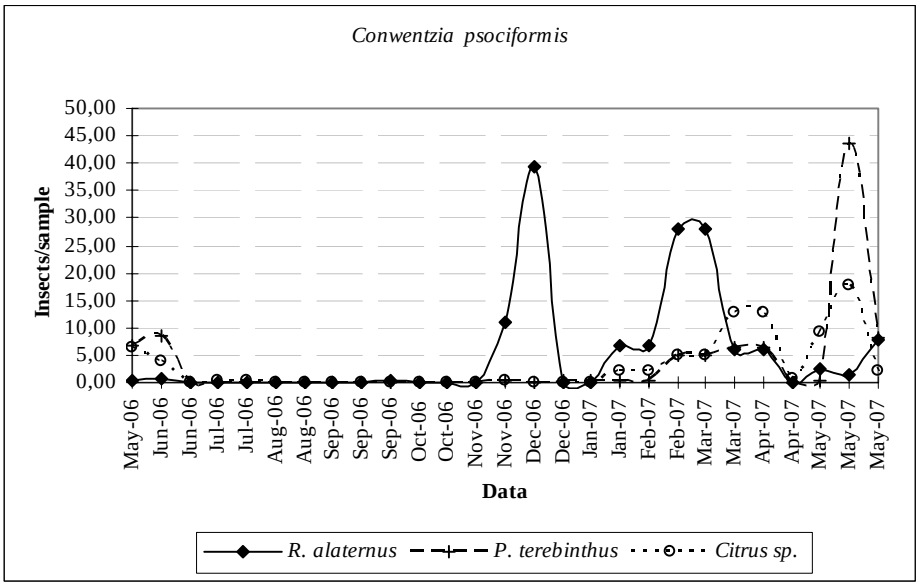

Figure 3. Population dynamics of the neuropteran predator Conwentzia psociformis.

Conclusions

The present study revealed a very high diversity and abundance of natural enemies within hedgerows. It also showed that citrus and hedgerows had similar species of predators, but differ to those species found on ground covers. In hedgerows the abundance of predators changed with the plant species considered. In conclusion, hedgerows present a wide variety of natural enemies that could help to control pests in citrus orchards. This could be linked to an increase in the diversity of vegetation.

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