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The importance of the qualitative composition of floral margins to the maintenance of rich communities of bees

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Abstract: The transformation of natural environments due to the intensification of agriculture has had negative effects on the communities of bees, with negative side-effects on pollination, in both farmed and natural systems. The addition of herbaceous plant edges to crop fields may improve the abundance and diversity of pollinators. The present study emphasises the importance of the right choice of plant species in floral margins to improve the abundance and diversity of bees.

Key words: pollinators, bees, biodiversity, field margins, edges, agriculture

Introduction

In recent decades, we have witnessed a progressive decline in the diversity and abundance of pollinators (Potts *et al*., 2010). The intensification of agriculture is one of the main factors responsible for this decline. Bees constitute one of the groups of pollinators that have suffered most from the intensification of agricultural practices, especially because of the destruction of nesting sites, the reduction of pollen and nectar resources and the negative effects of pesticides (Ortiz-Sánchez & Belda, 1994; Klein *et al*., 2007). This global biodiversity crisis underlines the need for sustainable agriculture and the adoption of appropriate landscape management practices, to restore or preserve biodiversity in agricultural areas. The addition of floral margins to crop fields has generally resulted in benefits to pollinators (Sanchez *et al*., 2014; Willmer, 2011). This work has the purpose to state the importance of the composition of floral margins to the maintenance of flourishing bee communities.

Material and methods

The present study was conducted in four localities characterized by intensive agriculture in the Region of Murcia (SE Spain). In each locality, a strip of approximately 100 m^2 in the margin of a vegetable crop was sown in autumn using nine plant species: *Borago officinalis*, *Brassica oleracea*, *Chrysanthemum coronarium*, *Coriandrum sativum*, *Diplotaxis catholica*, *Echium vulgare*, *Salvia verbenaca*, *Silene vulgaris* and *Vicia sativa*. Enough seeds were used to achieve densities of 5 or 10 plants per square meter for the species having medium-sized or small plants (Pérez-Marcos *et al*., 2017), respectively, considering the germination and

survival rates obtained in laboratory and field trials. Pollinator sampling was carried out fortnightly, from February to July 2014. The abundance of pollinators was estimated counting the number of specimens visiting each plant species within a 2 x 2 m square during 5 minutes. This procedure was performed, placing the square randomly within the floral strip, three times per locality and sampling. Bees were identified to the genus and the rest of the pollinators to the order level. Sampled specimens were collected to confirm the identity of the taxa in the laboratory.

Results and discussion

Bees were the most-abundant group of pollinators (*Apis mellifera*, 49.7%, and wild bees, 41.4%); the rest of the groups (Syrphidae, Diptera, other Hymenoptera, Coleoptera and Lepidoptera) represented 8.9% of the pollinators (Figure 1a).

A total of 21 bee genera were registered during the sampling period. *Apis* (50.27%) was the most-abundant genus, followed by *Andrena* (13.83%), *Eucera* (9.94%), *Lassioglossum* (6.35%) and *Hoplitis* (6.26%). The rest of the 16 genera represented less than 5% of the observations.

There was great variation in the number of bee genera among plant species (Figure 1b). *Echium vulgare* registered the highest number of genera (19), followed by *B. officinalis* (17), *C. sativum* (10), *Ch. coronarium* (9), *Diplotaxis* spp. (8, including *D. catholica* and *D. erucoides* that grew naturally), *B. oleracea* (7), *S. vulgaris* (7), *S. verbenaca* (4) and *V. sativa* (4). Besides, there were specific differences in the communities of bees visiting each plant species. *A. mellifera* represented more than half of the bees observed on *B. officinalis*, *C. sativum*, *Diplotaxis* spp. and *V. sativa*, whereas wild bees were dominant on the rest of the plant species. *Andrena* was the most-abundant bee on *B. oleracea, Eucera* on *Ch. coronarium*, *Lassioglossum* on *S. vulgaris* and *Hoplitis* on *E. vulgare*. The differences in the number of bee genera among plant species could be explained by bee preferences and the length of the blossoming period of the plants. For example, *E. vulgare* had a long blossoming period while *S. vulgaris* and *V. sativa* had short ones (Sanchez *et al*., 2014). Differences were also patent regarding the host-pollen specialisation of the bee genera. For instance, *Apis*, *Andrena, Lasioglossum* and *Eucera* were recorded on six or more plant species (polylectic species), while *Hoplitis* was observed on only three (oligolectic species). This specialisation could be due to the ability of bee species to exploit plant resources depending, for example, on bee morphology and floral structure. The plants with the highest bee richness had, in general, the greatest bee abundance.

In this work, we show how the richness and abundance of bees varied according to the plant species. *E. vulgare*, *B. officinalis* and *C. sativum* were the plants with the highest richness and abundance scores. The floral margins were also highly used by *Apis mellifera*; thus, the revegetation of edges in crop fields may be beneficial also to apiculture.

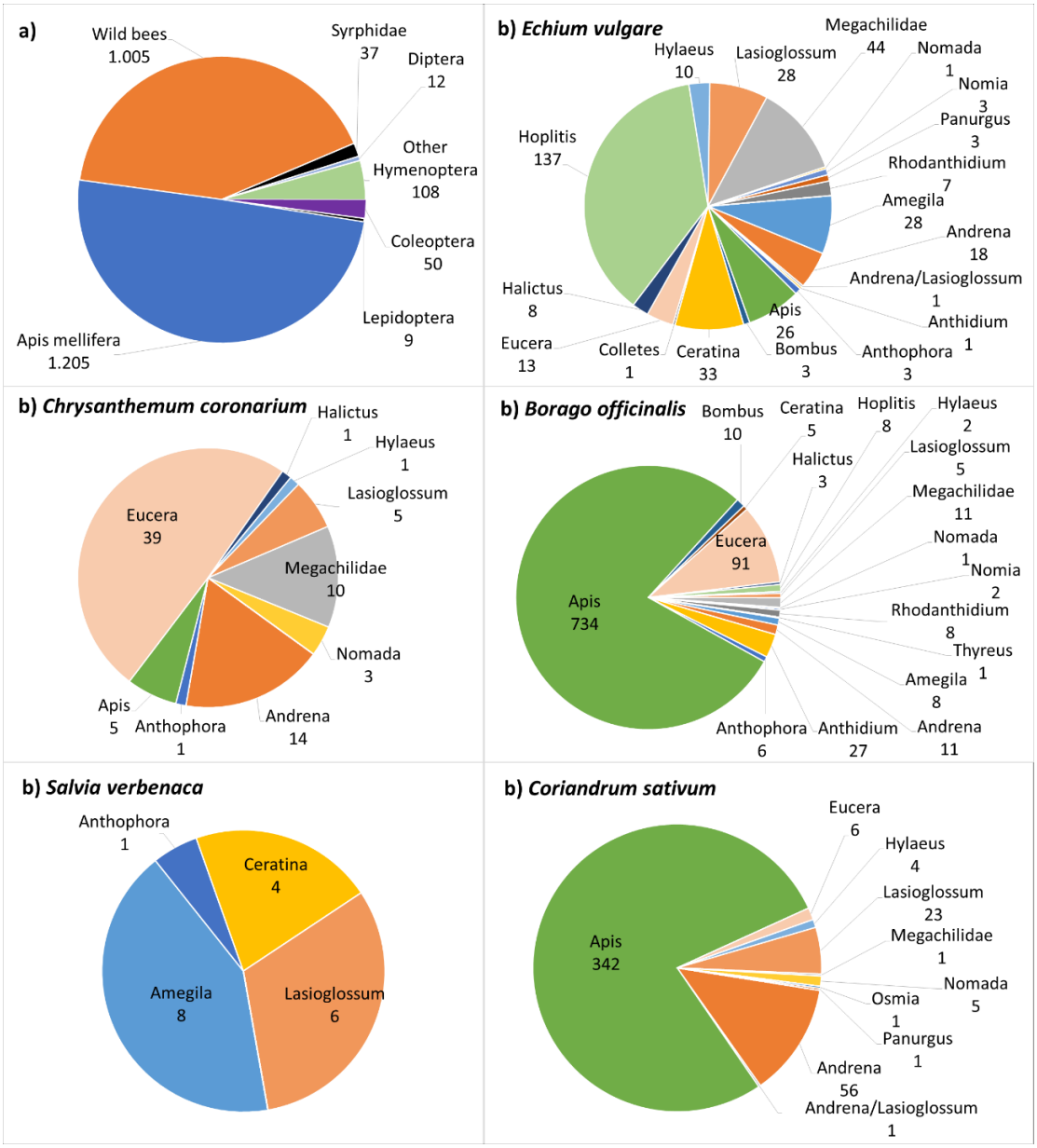

Figure 1. a) Abundance of the different groups of pollinators in the floral margins. b) Abundance of the bee genera registered on different plant species in the floral margins. The numbers indicate the total number of observations for each taxon.

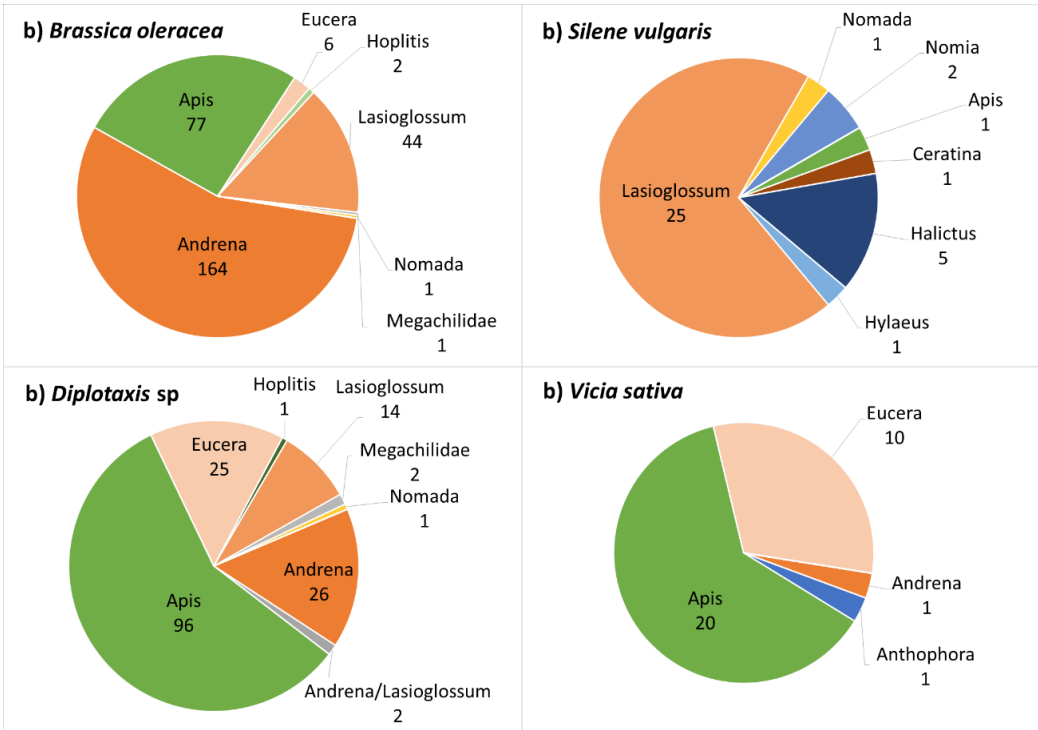

Figure 1. b) Continued from previous page. Abundance of the bee genera registered on different plant species in the floral margins. The numbers indicate the total number of observations for each taxon.

This work outlines the importance of the composition of the floral margin to the maintenance of diverse and flourishing communities of bees. It has also to be taken into account that the use of different plant species with different blossoming periods increases the availability of pollen and nectar through extended periods and, thus, could cover the needs of bees to a greater extent.

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