

*Apidologie*

DOI: 10.1007/s13592-018-0600-4

**ELECTRONIC SUPPLEMENTARY MATERIAL**

**Complementarity and redundancy in the functional  
niche of cider-apple pollinators**

Marcos Miñarro<sup>1\*</sup>, Daniel García<sup>2</sup>

<sup>1</sup> *Servicio Regional de Investigación y Desarrollo Agroalimentario (SERIDA). Apdo. 13, E-33300 Villaviciosa, Asturias, Spain*

<sup>2</sup> *Departamento de Biología de Organismos y Sistemas, Universidad de Oviedo, y Unidad Mixta de Investigación en Biodiversidad (CSIC-Uo-PA). C/Catedrático Rodrigo Uría s/n, E-33006 Oviedo, Asturias, Spain*

Corresponding author:

Marcos Miñarro

(mminarro@serida.org)

**Table S1.** List of pollinator species in cider apple orchards, showing the number of sites in which each species was found and the year of occurrence.

Order	Family	Species	Group	#sites	Year 2015	Year 2016	
Hymenoptera	Apidae	<i>Apis mellifera</i>	Honey bee	26	X	X	
		<i>Eucera</i> sp.	Wild bee	1	X	X	
		<i>Nomada succinta</i>	Wild bee	1	X		
		<i>Bombus pascuorum</i>	Bumblebee	8	X	X	
		<i>Bombus pratorum</i>	Bumblebee	11	X	X	
		<i>Bombus terrestris</i>	Bumblebee	24	X	X	
	Andrenidae	<i>Andrena bicolor</i>	Wild bee	2	X		
		<i>Andrena cyanomicans</i>	Wild bee	2	X	X	
		<i>Andrena dorsata</i>	Wild bee	7	X	X	
		<i>Andrena flavipes</i>	Wild bee	8	X	X	
		<i>Andrena fulva</i>	Wild bee	2	X	X	
		<i>Andrena haemorrhhoa</i>	Wild bee	3	X		
		<i>Andrena humilis</i>	Wild bee	1	X		
		<i>Andrena lathyri</i>	Wild bee	2	X	X	
		<i>Andrena leptopyga</i>	Wild bee	1	X		
		<i>Andrena minutula</i>	Wild bee	7	X	X	
		<i>Andrena nigroaenea</i>	Wild bee	10	X	X	
		<i>Andrena nitida</i>	Wild bee	3	X	X	
		<i>Andrena pilipes</i>	Wild bee	6	X	X	
		<i>Andrena similis</i>	Wild bee	1	X		
		<i>Andrena thoracica</i>	Wild bee	1		X	
		<i>Andrena trimmerana</i>	Wild bee	1		X	
		Halictidae	Halictidae sp1.	Wild bee	1	X	
			<i>Halictus (Seladonia) sp.</i>	Wild bee	1	X	
			<i>Halictus crenicornis</i>	Wild bee	1	X	
	<i>Halictus scabiosae</i>		Wild bee	3	X	X	
	<i>Halictus tumulorum</i>		Wild bee	7	X	X	
	<i>Lasioglossum calceatum</i>		Wild bee	3	X	X	
	<i>Lasioglossum fulvicorne</i>		Wild bee	2	X		
	<i>Lasioglossum lativentre</i>		Wild bee	1		X	
	<i>Lasioglossum limbellum</i>		Wild bee	1		X	
	<i>Lasioglossum littorale</i>		Wild bee	3		X	
	<i>Lasioglossum lucidulum</i>		Wild bee	1		X	
	<i>Lasioglossum malachurum</i>		Wild bee	8		X	
	<i>Lasioglossum morio</i>		Wild bee	1	X		
	<i>Lasioglossum pallens</i>		Wild bee	1	X		
<i>Lasioglossum parvulum</i>	Wild bee		1		X		
<i>Lasioglossum pauperatum</i>	Wild bee		1		X		
<i>Lasioglossum pauxillum</i>	Wild bee		7	X	X		
<i>Lasioglossum punctatissimum</i>	Wild bee		2	X	X		
<i>Lasioglossum puncticolle</i>	Wild bee		1		X		
<i>Lasioglossum zonulum</i>	Wild bee	2	X	X			
Megachilidae	<i>Osmia bicornis</i>	Wild bee	1	X			
Tenthredinidae	<i>Tenthredo koehleri</i>	Other	1	X			

**Table S1.** (Continue)

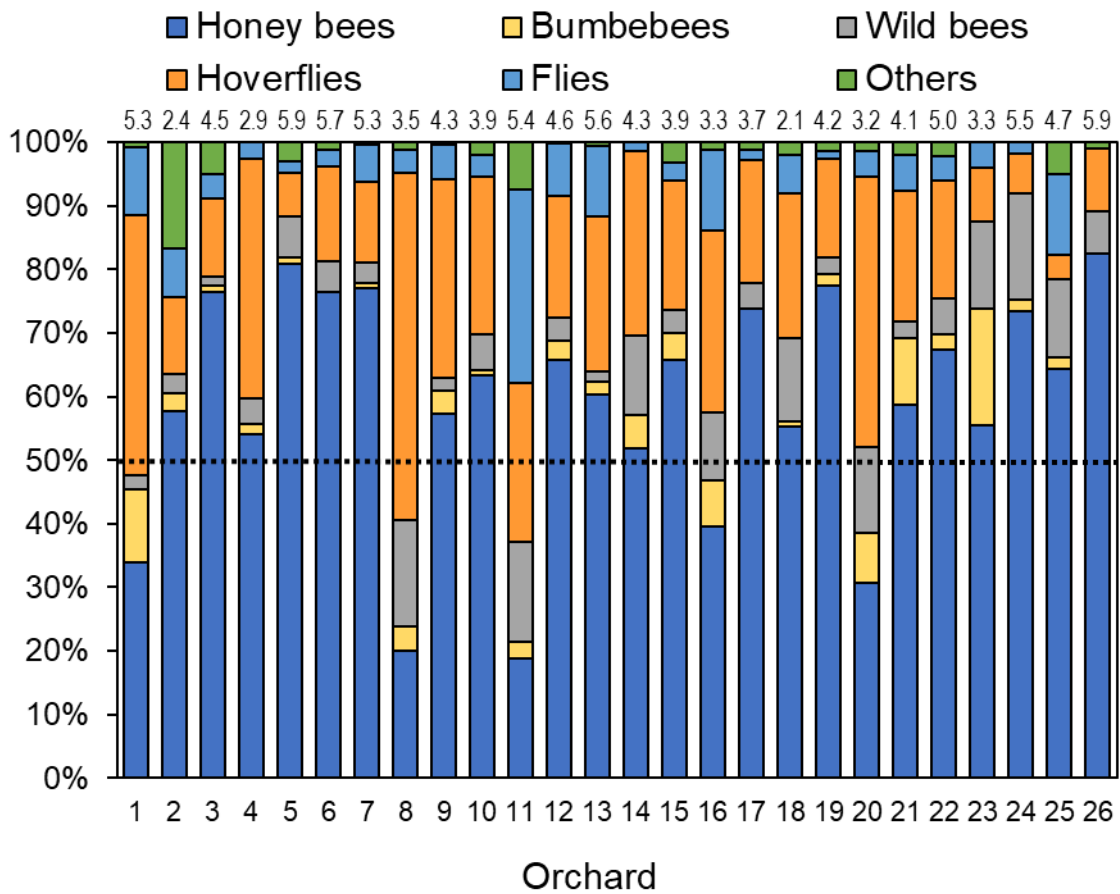
Order	Family	Species	Group	#sites	Year 2015	Year 2016
Diptera	Syrphidae	<i>Cheilosia pagana</i>	Hoverfly	1	X	
		<i>Chrysotoxum festivum</i>	Hoverfly	1		X
		<i>Helophilus pendulus</i>	Hoverfly	1	X	
		<i>Episyrphus balteatus</i>	Hoverfly	22	X	X
		<i>Eristalis arbustorum</i>	Hoverfly	5	X	X
		<i>Eristalis interrupta</i>	Hoverfly	1	X	
		<i>Eristalis pertinax</i>	Hoverfly	2		X
		<i>Eristalis similis</i>	Hoverfly	13	X	X
		<i>Eristalis tenax</i>	Hoverfly	23	X	X
		<i>Eupeodes corollae</i>	Hoverfly	9	X	X
		<i>Melanostoma mellinum</i>	Hoverfly	2	X	
		<i>Melanostoma scalare</i>	Hoverfly	1		X
		<i>Meliscaeva auricollis</i>	Hoverfly	3	X	X
		<i>Neoscia podagrica</i>	Hoverfly	1	X	
		<i>Parhelophilus</i> sp.	Hoverfly	1	X	
		<i>Platycheirus albimanus</i>	Hoverfly	4	X	X
		<i>Sphaerophoria scripta</i>	Hoverfly	13	X	X
		<i>Syrphus ribesii</i>	Hoverfly	1	X	
		<i>Syrphus vitripennis</i>	Hoverfly	1	X	
		<i>Volucella bombylans</i>	Hoverfly	1		X
	<i>Xanthandrus comtus</i>	Hoverfly	1	X		
	Asilidae	<i>Molobratia teutonus</i>	Fly	1		X
	Bombyliidae	<i>Bombylius major</i>	Fly	1	X	
	Empididae	<i>Empis</i> sp.	Fly	1	X	
	Muscidae	<i>Neomyia cornicina</i>	Fly	1		X
	Rhinophoridae	<i>Stevenia deceptor</i>	Fly	1		X
		<i>Tricogena rubricosa</i>	Fly	1		X
	Sarcophagidae	<i>Sarcophaga</i> sp.	Fly	1	X	
	Tachinidae	<i>Zophomyia temula</i>	Fly	1		X
	Coleoptera	Cantharidae	<i>Rhagonycha fulva</i>	Beetle	4	X
Cetoniidae		<i>Oxythyrea funesta</i>	Beetle	5	X	X
		<i>Trichius zonatus</i>	Beetle	1		X
		<i>Tropinota squalida</i>	Beetle	1		X
		<i>Valgus hemipterus</i>	Beetle	1		X
Elateridae		<i>Agrypnus murinus</i>	Beetle	1	X	
Melolonthidae		<i>Hoplia hungarica</i>	Beetle	1		X
Oedemeridae		<i>Oedemera nobilis</i>	Beetle	3	X	X
Mecoptera	Panorpidae	<i>Panorpa</i> sp.	Other	1	X	

**Table S2.** Frequency of movements between trees and between tree rows of the different pollinators. There were no statistical differences between pollinator groups.

Pollinator	Inter-tree movements		Inter-row movements	
	N	Mean $\pm$ SE	N	Mean $\pm$ SE
Honeybees	45	0.89 $\pm$ 0.23 a	45	0.37 $\pm$ 0.11
Bumblebees	74	0.76 $\pm$ 0.14 ab	74	0.23 $\pm$ 0.08
Wild bees	75	0.32 $\pm$ 0.07 b	75	0.14 $\pm$ 0.06
Hoverflies	44	0.65 $\pm$ 0.29 ab	44	0.32 $\pm$ 0.13

**Table S3.** Results of the Kolmogorv-Smirnov tests to compare the frequency distributions of pollinators throughout the 10 hours of sampling. Z-values for pair-to-pair comparisons are shown (\*\*\*:  $P \leq 0.001$ , \*\*:  $P \leq 0.01$ , \*:  $P \leq 0.05$ , n.s.:  $P > 0.05$ ).

	Honeybees	Bumblebees	Wild bees	Hoverflies	Flies	Beetles
Honeybees	-	3.164 ***	1.740 **	2.453 ***	0.814 n.s.	1.606 *
Bumblebees	-	-	3.110 ***	3.409 ***	1.141 n.s.	1.863 **
Wild bees	-	-	-	1.604 *	0.804 n.s.	1.607 *
Hoverflies	-	-	-	-	0.458 n.s.	2.536 ***
Flies	-	-	-	-	-	1.350 n.s.
Beetles	-	-	-	-	-	-



**Figure S1.** Community of insects visiting apple flowers in each of the 26 cider orchards studied in Asturias (NW Spain), pooling data from 2015 and 2016. Honeybees comprised over 50% of total abundance in 21 of the 26 orchards. Numbers at the top of the columns are visitation rates (number of insect visits/100 flowers/5 min). Orchards 19 and 24 had honeybee colonies and orchard 23, commercial colonies of *Bombus terrestris*.