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Species diversity of entomophilous plants and flower-visiting insects is sustained in the field margins of sunflower crops

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Field margins are key landscape features sustaining biodiversity in farmland mosaics and through that, ecosystem services. However, agricultural intensification has encouraged fencerow removal to enlarge cropping areas, reducing farmland biodiversity and its associated ecosystems services. In the present work, we assess the role of field margins in retaining farmland biodiversity across the sunflower cropping area of Argentina. Flower-visiting insects and entomophilous plants were intensively sampled along the margins of sunflower fields, in eight locations across eastern Argentina. We recorded 149 species of flowering plants and 247 species of flower-visitors. Plants and arthropods were mostly natives. Most of the floral visitors captured provide ecosystem services to agriculture. Our results show that many species of beneficial insects and native plants occur in semi-natural linear features in the intensively managed farmland of Argentina. Field margins may constitute the last refugia of native plant species and their associated fauna in farmland mosaics. Conservation of field margins in Argentine farmland may therefore be essential for preserving biodiversity and associated ecosystem services.

Keywords: agro-ecosystems; biodiversity; conservation; ecosystem services; floral visitors; semi-natural habitat; weeds

Introduction

Field margins are widely recognized as landscape features that sustain farmland biodiversity (Marshall and Moonen 2002; Marshall 2004). Species-rich vegetation along field margins may function as habitat or corridors for beneficial arthropods, such as pollinators of adjacent crops or predators and parasitoids that regulate pest populations (Marshall et al. 2002; Roy et al. 2003). However, agricultural intensification has promoted the removal of fencerows to enlarge fields, with the concomitant loss of semi-natural habitats that provide food and shelter for wildlife (Robinson and Sutherland 2002). Moreover, field margin vegetation is usually intensively managed to control potential weed invasion and agricultural pests.

The importance of field-margin vegetation for providing ecosystem services associated with arthropod biodiversity has been reported in many studies, mostly from Europe. These investigations have studied how the management of field margin vegetation affects numerous taxonomic and functional groups of arthropods, such as

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bumblebees (Kells et al. 2001), butterflies (Feber et al. 1996; Dover and Sparks 2000; Saarinen 2002), predatory beetles (Asteraki et al. 1995), spiders (Baines et al. 1998), hoverflies (Frank 1999), parasitoids (Tscharntke 2000), pollinators (Lagerlöf et al. 1992), and arthropod assemblages (Thomas and Marshall 1999; Meek et al. 2002). In contrast, in-depth research on this topic is practically absent for agro-ecosystems in Argentina.

Sunflower is an important oil crop that is grown in an extensive area of eastern Argentina, from the Chaco province, in the north of the country, to the southeast of the Buenos Aires province (Figure 1). Some commercial sunflower hybrids are

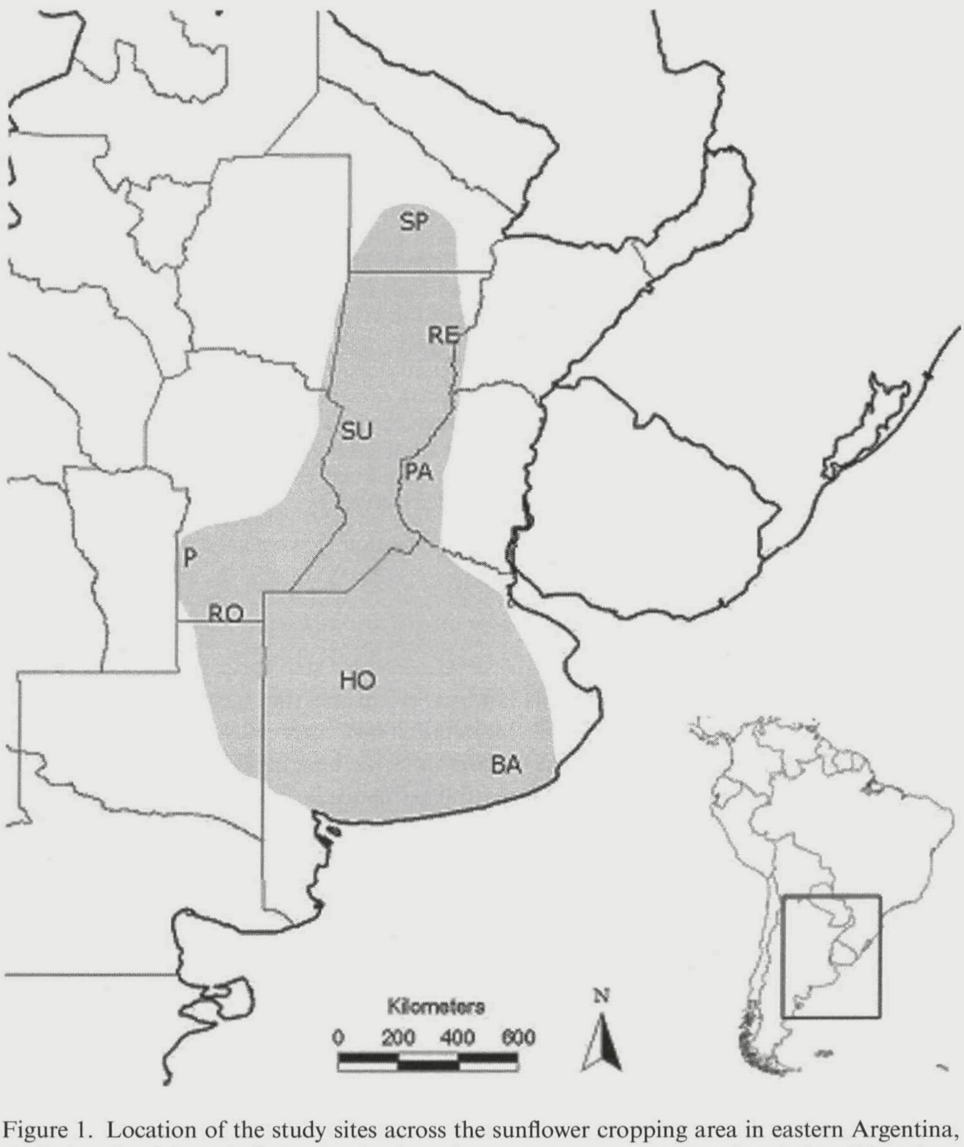

Figure 1. Location of the study sites across the sunflower cropping area in eastern Argentina, the limits of which are indicated by the shaded area. Acronyms correspond to the localities where fields were located (see Table 1 for details).

usually self-fertile, whereas others are self-sterile and require pollen from other plants. Self-pollination usually results in lower seed set, smaller seeds, lower oil content and lower germination rate (Delaplane and Mayer 2000). Therefore, sunflower is highly dependent on entomophilous pollination to ensure both seed yield and oil quality. In Argentina, although the domestic bee (*Apis mellifera*) is the most important pollinator of sunflower crops, many native species of bees (*Melissodes* spp., *Melissoptila tandilensis*, *Megachile* spp.) may also visit the flowering heads and could be considered potential sunflower pollinators (Torretta et al. 2010).

Besides pollination, insects visiting sunflower crops may perform other ecological functions, such as predation and parasitism of pests, and may find habitat in the adjoining field margins. Hence, the aim of our study was to assess the value of field margins to sustain the biodiversity of both flowering plants and flower-visiting insects. To achieve this objective, we intensively sampled flower-visiting insects and the entomophilous flowering plants occurring along the margins of sunflower fields distributed across the sunflower-growing area of Argentina (Figure 1). We emphasize that this study has been carried out to highlight the contribution of field margins to retain farmland biodiversity, whatever the contrast between sites in climate, soil and land use (Table 1). Indeed, our aim was not to disentangle how field margin biodiversity is differentially affected by contrasting environmental conditions, but to show that a functionally diverse biota is being sustained along the margins of sunflower crops irrespective of the conditions prevailing at each site. Additionally, we analysed the ecological functions performed by flower-visiting insects, including not only pollination of sunflower crops but also other ecosystem services, such as agricultural pest regulation through the activity of predators and parasitoids.

Material and methods

Study sites

Entomophilous flowering plants and the flower-visiting insects occurring along the margins of sunflower fields were studied in eight locations representative of the growing area of Argentina (26°51′ to 37°47′ S, Figure 1). Locations are situated along a latitudinal gradient (Table 1, Figure 1), which extends across three phytogeograpic regions (Cabrera 1971; Soriano 1991). Weather data has been provided by the National Meteorological Service of Argentina. When climatic data for a particular location were unavailable, we used the information from the nearest weather station (Table 1).

Field margins are defined here as the narrow strips of semi-natural habitats along the field boundary that create an interface with the adjacent field (Marshall and Moonen 2002). Fields in the study area are delimited by wire-fencerows, which usually have herbaceous vegetation. At each location, a commercial field was selected according to the following criteria: (1) most of the sunflower plants were in full blossom (R-5 stage, Schneiter and Miller 1981); (2) the presence of continuous fencerows along the four sides of the fields; (3) fields were representative of the prevalent land use in each location and region (CNA 2002). We assume that the fields were sown with different hybrids according to their flowering response to day length and temperature (Marc and Palmer 1981), which varies between the sampled sites (Table 1). Moreover, agricultural management may also differ across sites due to local factors, even though most crop protection practices are generally standardized and no-tillage is widespread across the study area.

Table 1. Description of the study sites.

Sites (acronyms)	Sáenz Peña (SP)	Reconquista (RE)	Sunchales (SU)	Paraná (PA)	Paunero (P)	Roca (RO)	Hortensia (HO)	Balcarce (BA)
Geographic coordinates	26° 51′ 125″ S 60° 24′ 449″ W	29° 12′ 21.1″ S 59° 39′ 36.4″ W	30° 55′ 04.7″ S 61° 34′ 57.5″ W	31° 49′ 31.2″ S 60° 26′ 22.1″ W	33° 53′ 28.0″ S 65° 00′ 05.5″ W	34° 59′ 51.3″ S 64° 18′ 06.7″ W	35° 56′ 44.9″ S 61° 11′ 43.7″ W	37° 46′ 54.8″ S 58° 18′ 44.6″ W
Phytogeographic provinces	Chaco	Chaco	Espinal	Espinal	Inland Pampa	Inland Pampa	Inland Pampa	Southern Pampa
Altitude (m above sea level)	86	50	97	84	376	173	76	109
Annual mean T min (°C)	16.3	15	13.4[a]	13.1	11.2[b]	9.9[c]	10.0[d]	8.2[e]
Annual mean T max (°C)	278	25.6	25.6[a]	23.8	22.9[b]	22.9[c]	21.9[d]	20.0[e]
Annual mean precipitation (mm)	1254	1380	942[a]	1126	847[b]	934[c]	1015[d]	889[e]
Sampling dates	9–13 Nov 2004	15–19 Nov 2004	14–21 Dec 2005	18–22 Dec 2004	4–9 Jan 2006	18–22 Dec 2006	4–10 Jan 2007	21–27 Jan 2005
Sampling effort (hours)	22	27	26	19	26	24	20	12
Field area (ha)	46	20	37	25	50	48	50	25
Field perimeter (m)	2750	1800	2460	2000	3000	2880	2950	1970
Neighbouring crops	sunflower pasture	sunflower pasture	sunflower Pasture foxtail millet	sunflower pasture maize	sunflower pasture	sunflower alfalfa maize	sunflower wheat maize	sunflower soybean

Weather data from: [a]Ceres, [b]Río Cuarto, [c]Gral Pico, [d]Pehuajó, [e]Tandil.

Sampling procedure

Sampling comprised the survey of entomophilous plants occurring along field margins, which were flowering simultaneously with sunflower crops, and the collection of insects visiting their flowers. Sampling was therefore carried out during full blossoming of the neighbouring sunflower crop (November–January 2004/05, and December–January 2005/06, and 2006/07). Some locations had to be surveyed in different years because of both the sampling time devoted to each site and the wide latitudinal range explored, so the complete sampling was carried out in three consecutive years (Table 1). Fields were sampled by walking along the entire field perimeter, which ranges between 1800 and 3000 m (Table 1). Plant survey and insect captures at each site were performed simultaneously by a minimum of two and a maximum of three people. Sampling time for each field was assessed by the total number of hours spent performing insect captures on flowering plants (Table 1).

Sampling of entomophilous flowering plants

All plant species having entomophilous flowers were recorded in the margin of each field. We only listed those plant species that were flowering simultaneously with the neighbouring crops. Plant species were classified according to their origin (natives and exotics), and life history (forbs and woody species: trees, shrubs, vines). Botanical nomenclature, authorities and species status were revised following Zuloaga and Morrone (1999) (Appendix 1).

Sampling of flower-visiting insects

Only diurnal insects visiting flowers were captured in sunflower field margins. Sunflower crops are mostly pollinated by diurnal insects, even though many nocturnal insects, mostly lepidopterans from Noctuidae, may visit sunflower. Moreover, it has been determined that nocturnal flower visitors would not directly contribute to sunflower pollination (Torretta et al. 2009). In this research, it was observed that sunflower stigmas are highly receptive during the day, especially around midday. The authors concluded that it is highly improbable that moths do effectively pollinate sunflowers, because these flower visitors potentially transfer pollen during the night when sunflower stigmas are least receptive (Torretta et al. 2009). For this reason, only diurnal, flower-visiting insects were considered in this study.

Insect captures were carried out between 8.30 a.m. and 6 p.m. Observations were made when weather conditions allowed from moderate to high insect activity (temperature above 15°C, null or moderate wind, sunny days). Insects were captured when foraging on flowers using entomological nets, killed *in situ* and preserved to be identified later. The plant species on which each flower-visiting insect had been captured were also registered. Taxonomic determination was carried out at the lowest possible taxonomic level (i.e. species, genus, tribe or family). Individuals that could not be identified at the species level were assigned to morph-species groups. The complete list of floral visitors captured in field margins was compared with that of diurnal insects visiting sunflower crops (Torretta et al. 2010). The authors captured 76 species (or morpho-species) of flower-visiting insects, which belonged to eight taxonomic orders. A total of 32 taxa of bees (Apoidea) were identified: Apidae and Megachilidae being the most numerous families. Flies (Syrphidae, Tachinidae, Sarcophagidae), beetles (Coccinelidae, Chrysomelidae, Scarabaeidae, Melyridae), and butterflies (Hesperidae, Pyralidae), among other insect groups, were also captured when visiting sunflower heads (Torretta et al. 2010). All captured specimens are preserved in the Entomological Collection of the Agricultural Botany Unit (FAUBA), at the School of Agronomy, University of Buenos Aires.

Functional classification of flower-visiting insects

Flower-visiting insects were arranged into six functional groups, according to the ecological function they perform: (1) pollinators (species visiting flowers to collect pollen to feed their larvae); (2) cleptoparasites (species ovipositing on nests/prey of other species); (3) predators (species capturing other flower visitors to feed their larvae); (4) parasitoids (species having a larval cycle developed on living insects and killing their host), which also includes hyper-parasitoids (species that are parasites on another parasitic species); (5) herbivores (species that feed on living plant tissues); and (6) decomposers (species whose larval cycle is developed on animal or vegetal dead matter in decomposition). For this purpose, we have reviewed the literature about biology and natural history of the captured species (Hull 1973; Rubio Espina 1976; McAlpine et al. 1981; Willink 1998; Willink and Roig Alsina 1998; O´Neill 2001; Cordo et al. 2004; Pastrana 2004; Moré et al. 2005; Fernández and Sharkey 2006; Mulieri et al. 2006; Stireman et al. 2006; Bell et al. 2007, Mariluis et al. 2007; Michener 2007, Colomo de Correa and Roig Alsina 2008), paying particular attention to both larval and adult stages, because adult and immature stages of many insect species differ in their feeding and habitat requirements (Appendix 2). Species or morpho-species with unavailable information about their life histories were grouped according to the higher taxonomic level at which information was available. All groups we have defined here may present some functional overlapping. Cleptoparasite bees, for instance, in addition to parasitizing nests of pollinator bees, may also pollinate the flowers they visit, though this secondary function should be considered as accidental. Criteria for assigning a prevalent ecological role to particular insects were based on the information available in the literature.

Results

Entomophilous plant species

A total of 149 plant species were listed on the margins of the eight surveyed sunflower fields (Appendix 1). Most plant species were native (106) to the study area and the number of species per field varied across locations (Table 2). Plant species belonged to 37 botanical families. On average, flower-visiting insects were captured on 41% (range 35–68%) of all entomophilous plants that were flowering simultaneously with sunflower crops (Table 2, Appendix 1).

Flower-visiting insects

Across all sites, 247 insect species were captured when visiting flowers of entomophilous plants occurring along field margins (Table 2). Flower visitors

Table 2. Number of species of entomophilous plants and floral visitors sampled in sunflower field margins.

	Sites (acronyms)								
	Sáenz Peña (SP)	Reconquista (RE)	Sunchales (SU)	Paraná (PA)	Paunero (P)	Roca (RO)	Hortensia (HO)	Balcarce (BA)	Total
Entomophilous plants									
Number of weed species	37	26	31	17	13	36	35	18	149
Number of weed species with floral visitors (% of total)	13 (35)	12 (46)	21 (68)	11 (65)	9 (69)	22 (65)	19 (54)	9 (50)	43 (41)
Status									
Natives	35	23	20	14	9	18	16	3	106
Exotics	2	3	11	3	4	18	19	15	43
Life form									
Forbs	22	21	11	7	9	33	33	18	127
No forbs	15	5	20	10	4	3	2	0	22
Floral visitors									
Total species (families)	25 (4)	69 (22)	44 (15)	49 (15)	30 (16)	50 (19)	58 (20)	13 (9)	247 (36)
Hymenoptera	24 (3)	33 (7)	20 (5)	24 (5)	19 (8)	33 (8)	40 (9)	3 (2)	151 (10)
Diptera	1 (1)	29 (9)	18 (7)	16 (5)	7 (4)	10 (4)	10 (5)	5 (3)	61 (13)
Lepidoptera		7 (6)	6 (3)	7 (3)	2 (2)	3 (3)	4 (2)	4 (3)	26 (7)
Coleoptera				1 (1)	2 (2)	4 (4)	4 (3)	1 (1)	8 (5)
Blattaria				1 (1)			1 (1)		1 (1)

Plants are grouped according to their status (natives and exotics) and life forms (forbs and no-forbs). Floral visitors were arranged according the five represented taxonomical orders.

belonged to 36 families in five orders (Table 2, Appendix 2). The number of flower-visiting insect species captured at each site ranged from 13 to 69 (Table 2). Hymenoptera and Diptera were the most abundant orders, whose species interacted with many plant species. Butterflies were represented by few species (Table 2, Appendix 2), even though many individuals were captured.

The most important bee species visiting sunflower crops in Argentina were also captured when visiting flowers in field margins (*Apis mellifera*, *Melissodes tintinnans*, *Melissodes rufithorax*, *Melissoptila tandilensis*, *Megachile* spp.; Torretta et al. 2010), as well as numerous fly species also visiting sunflower (e.g. *Palpada* spp., Torretta et al. 2010). The domestic bee (*Apis mellifera*) was the only exotic pollinator from Hymenoptera. Many diurnal, flower visitors of sunflower were also captured in flowering plants along field margins (Table 3). Only five species of flower visitors were exotics. Besides the domestic bee, three muscoid species (*Chrysomya albiceps*, *Chrysomya megacephala*, *Musca domestica*) and one syrphid (*Eristalis tenax*) were exotics to the study area (Appendix 2).

Ecological functions performed by flower visitors

Pollinators were the most abundant group of flower visitors collected along field margins of sunflower crops, and nearly all of them were bees (101 species). Moreover, individuals of *Trimeria rachiphora*, a species of masarine wasp, were also captured (Table 3). Masarine wasps have a particular feeding behaviour that notably differs from that of most wasps. Wasps belonging to this group collect pollen for feeding larvae rather than feeding them on insect prey as is usual for most wasp species.

Cleptoparasites comprised 15 species from Hymenoptera; most of them were bees from different genera from Megachilidae and Apidae. In addition, one cleptoparasitic wasp species from Pompilidae was captured (Table 3).

Predators were mainly wasp species (Table 3) belonging to numerous genera from different families (Table 3, Appendix 2). These wasp species predate a wide range of insects, such as mole crickets, grasshoppers, bees, spiders, coleopterans and dipterans. This group also includes species that are predators during their larval stage, such as species from the genera *Toxomerus* and *Allograpta* (Syrphidae), which are widely recognized as aphidophagous.

Parasitoids included 29 species of floral visitor (Table 3). Most parasitoids and hyperparasiotids were dipterans belonging to Tachinidae, Bombyliidae and Conopidae families. Four species from Tiphiidae were also captured, a family of solitary wasps whose larvae parasitize species of Scarabaeidae at larval stage.

Herbivorous insects were mainly lepidopterans (26 species, Table 3), which consume plant tissues during the pre-imaginal stage. Most captured species have diurnal activity. Moreover, individuals from three other diurnal lepidopteran species belong to the Arctiidae and Sphingidae, families that mostly comprised species with nocturnal habits. Only two species from Hesperiidae captured in the field margins were also observed as visitors of sunflower heads (Table 3). None of the lepidopterous species captured in field margins have also been reported as night flower visitors of sunflower in Argentina (Torretta et al. 2009). The herbivorous group also contained some species of Coleoptera from the Chrysomelidae and Elateridae (Table 3). For instance, *Diabrotica speciosa* is a polyphytophagous species that feeds on many plant species and usually oviposits on sunflower plants (Cabrera Walsh 2003).

Table 3. Number of species of floral visitors captured in field margin plants and sunflowers.

Family	Floral visitors			Functional groups					
	No. of species or morphospecies in:			Pollinators	Cleptoparasites	Predators	Parasitoids	Herbivores	Decomposers
	weeds	sunflowers*	shared						
Hymenoptera									
Apoidea									
Andrenidae	22	1	1	22					
Apidae	43	13	9	36	7				
Colletidae	6			6					
Halictidae	26	7	4	26					
Megachilidae	18	11	7	11	7				
Crabronidae	15	2	2			15			
Sphecidae	4					4			
Vespoidea									
Pompilidae	4				1	3			
Tiphiidae	4	1	1				4		
Vespidae	9			1		8			
Diptera									
Anthomyiidae	1	1	1						1?
Bibionidae	1								1?
Bombyliidae	4						4		
Calliphoridae	3								3
Conopidae	1						1		
Culicidae	1					1			
Muscidae	4								4?
Sarcophagidae	10	1	1						10
Stratiomyiidae	3								3?

(Continued)

Table 3. (Continued).

Family	Floral visitors: No. of species or morphospecies in: weeds	sunflowers*	shared	Functional groups: Pollinators	Cleptoparasites	Predators	Parasitoids	Herbivores	Decomposers
Syrphidae	12	7	4			4			8
Tabanidae	1								1?
Tachinidae	20	3	3				20		
Coleoptera									
Cantharidae	1	2	1			1?			
Chrysomelidae	2	2	2					2	
Elateridae	1							1	
Lampyridae	2								2?
Melyridae	2	3	2					2?	
Lepidoptera									
Arctiidae	2							2	
Hesperiidae	4	2	1					4	
Lycaenidae	2							2	
Nymphalidae	7							7	
Pieridae	5							5	
Riodinidae	5							5	
Sphingidae	1							1	
Blattaria									
Blatellidae	1	1	1						1?
Total species	247	57	40	102	15	36	29	31	34
(%)				41.3	6.1	14.5	11.7	12.5	13.9

Floral visitors are arranged according to their taxonomy (order and family) and functional groups.
*Data from Torretta et al. 2010.
? Species or morpho-species with unknown life cycles.

Finally, we found 26 species of flower visitors that usually behave as decomposers, which mainly comprised dipterous species from several families (Sarcophagidae, Calliphoridae and Syrphidae). Some syrphid species, during their aquatic pre-imaginal stage, feed on decaying organic matter in stagnant water, while others were saprophagous (Table 3).

Discussion

Our research is the first report for cropping systems in Argentina that highlights the importance of field margins to sustain flower-visiting insects and associated plants and hence farmland biodiversity (Table 2). Results were consistent across sampling sites, albeit they differed greatly in climate, soils and land use (Table 1). Locations were distributed across three biogeographic regions, the farthest sites being more than 1200 km apart (Figure 1). Although we recognize that the sampling procedure had some limitations, we also stress that our research was not focused on performing either an in-depth regional inventory or a comparison across sites of both weeds and flower visitors associated with field margins delimiting sunflower crops. Indeed, our findings highlight that field margins are key habitats for populations of beneficial insects and native plants, because these landscape features provide food (nectar and/or pollen), shelter and nesting, whatever the differences among sites in either their prevalent environmental conditions or land uses.

Field margins sustain flower visitors that provide ecosystem services

Most flower-visiting insects captured along the field margins surrounding sunflower crops may provide ecosystem services to agriculture. Sunflower pollinators also interacted with numerous flowering plants occurring in the adjacent field margins (Table 3; Torretta et al. 2010). In addition, many beneficial flower visitors apparently move between sunflower crops and the semi-natural vegetation strips in the adjacent margins, as suggested by the overlapping composition of insects listed on both habitats (Table 3). This finding leads us to assume the occurrence of spill-over effects between field margins and crop edges (Rand et al. 2006). Interactions between flower visitors and entomophilous flowering plants along field margins, and therefore the ecosystem services provided by them, would be more numerous than those reported here because samplings were carried out only during sunflower flowering (see Sampling limitations). Moreover, many species from other groups are involved in regulating the population size of pest insects, such as predators and parasitoids (Table 3). Our results are therefore in agreement with previous research that has been recently reviewed in-depth (Kremen and Chaplin-Kramer 2007; Tscharntke et al. 2007).

Field margins offer refugia for native plant species

Field margin flora was composed of many native species belonging to the original vegetation of each sampling site (Cabrera 1967, 1971; Burkart 1969). Our findings suggest that field margins provide refugia for native plant species. Most of them present low regional occurrence (i.e. rare species), which is in agreement with recent findings in the Rolling Pampa (Poggio et al. 2010). Interestingly, native and exotic plants were indistinctly visited by insects (mostly native) (Appendix 2). Exotic plant species were also numerous along field margins (Table 2), particularly in those sites that had experienced greater agricultural intensification (Viglizzo et al. 2011). In the Southern Pampa, for instance, where the sampling location near Balcarce was situated, agriculture has experienced a continuous intensification since the early 1990s. Between the late 1980s and the first half of the 2000s, the period in which most changes associated with agricultural intensification occurred, the area of this region that is devoted to growing annual crops has increased on average from 39.2% to 52.6%, whereas grassland area decreased from 60.8% to 47.4% (Viglizzo et al. 2011).

Sampling limitations

Sampling protocol applied here was effective to show that field margins sustain functionally diverse flower-visiting insects and provide refugia for native plant species. Sampling was intensive enough to assess the local species richness at each site (alpha diversity). However, the sampling procedure we applied had several limitations suggesting that the diversity of both taxonomic groups was underestimated. As only one field was sampled at each site, sampling did not account for the spatial variability in the species composition across fields at each location (beta diversity). In addition, one sampled field per location was insufficient to assess the total species richness at regional scale (gamma diversity), particularly because many rare species were not captured.

Simultaneous sampling of insects visiting flowers in both the field margin vegetation and the neighbouring blossoming sunflower crops helped to provide some clues about the movement of flower visitors between both adjacent habitats. Nonetheless, sampling only during sunflower flowering did not allow us to elucidate whether field margin vegetation provides enough flower resources for pollinators when sunflower crops are not in blossom. As sunflower flowering is concentrated over a short period, which may last 20–25 days at field scale and 10–15 days for an individual head (Torretta et al. 2009), most flower-visiting insects captured would necessarily rely on plants occurring in field margins to find food and complete their life cycle. Moreover, many other flower visitors could not be able to feed on sunflower and they would necessarily rely on flowering plants occurring along field margins. Sampling should therefore have been started before the start of sunflower blossoming and finished afterwards. This extended sampling may help to reveal how many species of the flower-visiting insects, occurring within fields during sunflower blossom, may also occur in the vegetation along field margins when sunflower crops have no flowers (i.e. during both the vegetative and the seed-filling periods).

Sampling would have been biased towards an over-representation of pollinators, because of the decision to only capturing flower-visiting insects with diurnal habits. Nocturnal flower visitors may perform many ecological functions in agro-ecosystems. For instance, species of nocturnal moths are herbivores during the larval stage (e.g. Noctuidae).

Conclusions

Our results emphasize the urgent need to preserve field margin habitats to support populations of beneficial insects and native plants in the highly intensively farmed croplands of Argentina. These linear semi-natural features may constitute the last patches providing refugia to native plant species and their associated fauna in intensively disturbed farmland mosaics. The necessity to conserve, even restore, field margin habitats in the farmland mosaics of Argentina is particularly important, because knowledge is lacking on the taxonomy and the natural history of many arthropod species. Conversely, the Argentine flora is almost completely known (Zuloaga and Morrone 1999). Although Argentina has signed up to the Convention on Biological Diversity, initiatives for biodiversity conservation in agro-ecosystems have not yet been applied. Within this scenario, we propose that research should consider the multiple aspects entangled at different scales. Research frameworks aimed at biodiversity conservation in agro-ecosystems of Argentina should therefore be interdisciplinary. Such approaches should not only be considered to better understand the biology and natural history of particular taxa (e.g. native pollinator bees, parasitoids), but also ought to merge perspectives from agronomy, community and landscape ecology, which may help to tackle the problems associated with designing and evaluating the initiatives to restore and manage non-cropped habitats. Ongoing research in the Pampas has been conceived, and is being carried out, bearing this perspective in mind.

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Appendix 1. List of entomophilous plant species collected in the field margins when co-flowering with sunflower

Data correspond to the sunflower fields sampled across eight sites (see Table 1). Status: n = native; e = exotic; Life forms: f = forbs; nf = no forbs. Acronyms: SP = Sáenz Peña, RE = Reconquista, SU = Sunchales, PA = Paraná, P = Paunero, RO = Roca, HO = Hortensia, BA = Balcarce.

Weeds Family Species	Status	Life form	Sites
Amaranthaceae			
Alternanthera philoxeroides (Mart.) Griseb	n	f	HO
Gomphrena celosioides Mart.	n	f	RE
Gomphrena martiana Gillies ex Moq.	n	f	P
Iresine diffusa Humb. & Bonpl. ex Will.	n	f	PA
Pfaffia tuberosa (Spreng.) Hicken	n	f	SP
Apiaceae			
Ammi majus L.	e	f	SU, P, RO, HO, BA
Conium maculatum L.	e	f	HO
Eryngium coronatum Hook. & Arn.	n	f	SU
Eryngium horridum Malme	n	f	SP, RE, PA
Eryngium sp.	n	f	RO
Foeniculum vulgare Mill.	e	f	HO
Hydrocotyle sp.	n	f	BA
Asclepiadaceae			
Araujia angustifolia (Hook. & Arn.) Decne.	n	nf	PA
Araujia hortorum E. Fourn.	n	nf	HO
Morrenia brachystephana Griseb.	n	nf	SU, PA, P, RO
Morrenia odorata (Hook. & Arn.) Lindl.	n	nf	SP
Oxypetalum solanoides Hook. & Arn.	n	f	RO
Asteraceae			
Anthemis cotula L.	e	f	SU, HO
Arctium minus (Hill) Bernh.	e	f	BA
Aspilia pascalioides Griseb.	n	f	RE
Baccharis pingraea DC.	n	f	SU, HO
Baccharis ulicina Hook. & Arn.	n	f	P
Bidens pilosa L.	n	f	RE
Carduus acanthoides L.	e	f	SU, PA, RO, HO, BA
Carduus thoermeri Weinm.	e	f	SU, PA, P, RO
Centaurea calcitrapa L.	e	f	BA
Centaurea solstitialis L.	e	f	RO
Cichorium intybus L.	e	f	SU, RO, BA
Cirsium vulgare (Savi) Ten.	e	f	SU, HO
Crepis setosa Haller f.	e	f	HO
Eclipta postrata (L.) L.	n	f	HO
Eupatorium macrocephalum Less.	n	f	SP

(*Continued*)

Appendix 1. (Continued).

Weeds	Status	Life form	Sites
Gaillardia megapotamica (Spreng.) Baker	n	f	P, RO
Galinsoga parviflora Cav.	n	f	HO
Holocheilus hieracioides (D. Don) Cabrera	n	f	SU
Hymenoxys tweediei Hook. & Arn.	n	f	RE
Hypochaeris microcephala var. *albiflora* (Kuntze) Cabrera	n	f	SP, RE, SU
Hypochaeris radicata L.	e	f	BA
Lactuca serriola L.	e	f	HO
Onopordum acanthium L.	e	f	BA
Picrosia longifolia D. Don	n	f	SU
Porophyllum obscurum (Spreng.) DC.	n	f	RE
Schkuhria pinnata (Lam.) Kuntze ex Thell	n	f	RO
Senecio grisebachii Baker	n	f	SU
Sonchus oleraceus L.	e	f	HO
Tagetes minuta L.	n	f	RE
Taraxacum officinale Weber ex F.H. Wigg.	e	f	RO, HO
Verbesina encelioides (Cav.) Benth. & Hook.	n	f	RO
Vernonia cognata Less.	n	f	SP
Vernonia incana Less.	n	f	SP,SU
Viguiera anchusaefolia (DC.) Baker	n	f	PA
Wedelia glauca (Ortega) O. Hoffm. ex Hicken	n	f	SP
Bignoniaceae			
Pithecocthenium cynanchoides DC.	n	nf	SP, PA
Boraginaceae			
Heliotropium amplexicaule Vahl	n	f	RE
Brassicaceae			
Brassica rapa L.	e	f	RE, BA
Diplotaxis tenuifolia (L.) DC	e	f	RO
Hirschfeldia incana (L.) Lagr.-Fossat	e	f	RO, HO
Raphanus sativus L.	e	f	RO, BA
Rapistrum rugosum (L.) All.	e	f	SU, PA, RO
Sisymbrium irio L.	e	f	RO
Sisymbrium officinale (L.) Scop.	e	f	P, HO
Buddlejaceae			
Buddleja tubiflora Benth.	n	nf	SP
Calyceraceae			
Acicarpha tribuloides Juss.	n	f	RE
Campanulaceae			
Wahlenbergia linarioides (Lam.) A. DC.	n	f	SU
Capparaceae			
Capparis tweediana Eichler	n	nf	SP
Caricaceae			
Carica quercifolia (A. St.-Hil.) Hieron.	n	nf	SP
Commelinaceae			
Commelina diffusa Burm. f.	n	f	SP, PA
Commelina erecta L.	n	f	SU, HO
Tripogandra sp.	n	f	RE

(*Continued*)

Appendix 1. (Continued).

Weeds	Status	Life form	Sites
Convolvulaceae			
Convolvulus arvensis L.	e	f	SP
Convolvulus bonariensis Cav.	n	f	RO
Cucurbitaceae			
Citrullus lanatus (Thunb.) Matsum. & Nakai	e	f	P
Cucurbita maxima Duchesne *andreana* (Naudin) Filov	n	f	HO
Fabaceae			
Acacia bonariensis Gillies ex Hook. & Arn.	n	nf	PA
Acacia caven (Molina) Molina	n	nf	RE
Desmanthus virgatus (L.) Willd.	n	f	SP
Desmodium cuneatum Hook. & Arn.	n	f	SP
Desmodium incanum DC.	n	f	RE
Indigofera asperifolia Bong. ex Benth.	n	f	SP
Indigofera suffruticosa Mill.	n	nf	RE
Lotus glaber Mill.	e	f	BA
Medicago sativa L.	e	f	RO, BA
Melilotus albus Desr.	e	f	RE, SU, RO, BA
Melilotus officinalis (L.) Lam.	e	f	RO
Rhynchosia edulis Griseb.	n	f	SP
Trifolium pratense L.	e	f	BA
Trifolium repens L.	e	f	SU, HO, BA
Gentianaceae			
Centaurium pulchellum (Sw.) Druce	e	f	SU, HO
Lamiaceae			
Hyptis lappacea Benth.	n	f	SP
Lamium amplexicaule L.	e	f	HO
Leonurus japonicus Houtt.	e	f	SP, RE
Marrubium vulgare L.	e	f	RO
Mentha pulegium L.	e	f	BA
Lythraceae			
Heimia salicifolia (Kunth) Link.	n	nf	SP, RE
Lythrum hyssopifolia L.	n	f	HO
Malpighiaceae			
Mascagnia brevifolia Griseb.	n	nf	SP
Malvaceae			
Abutilon sp.	n	nf	SP
Malva nicaeensis All.	e	f	HO
Modiolastrum gilliesi (Steud.) Krapov.	n	f	SU
Sphaeralcea bonariensis (Cav.) Griseb.	n	nf	SP, RE, SU, PA
Martyniaceae			
Ibicella lutea (Lind.) Van Eselt.	n	f	SU
Onagraceae			
Ludwigia grandiflora (Michx.) Greuter & Burdet	n	f	BA
Ludwigia peploides (Kunth) P. H. Raven	n	f	HO
Ludwigia sp.	n	f	RE

(*Continued*)

Appendix 1. (Continued).

Weeds	Status	Life form	Sites
Oxalidaceae			
Oxalis conorrhiza Jacq.	n	f	RO
Papaveraceae			
Argemone burkartii Sorarú	n	f	P
Passifloraceae			
Passiflora chrysophylla Chodat	n	nf	SP
Passiflora mooreana Hook. f.	n	nf	SP
Phytolacaceae			
Rivina humilis L.	n	f	PA
Polygonaceae			
Muehlenbeckia sagittifolia (Ortega) Meisn.	n	f	PA
Polygonum aviculare L.	e	f	RO, HO
Polygonum convolvulus L.	e	f	RO
Polygonum persicaria L.	e	f	
Portulacaceae			
Portulaca grandiflora Hook.	n	f	P, RO
Portulaca oleracea L.	e	f	RO, HO
Primulaceae			
Anagallis arvensis L.	e	f	SU
Ranunculaceae			
Clematis montevidensis Spreng.	n	nf	SP, PA, P, RO
Rubiaceae			
Borreria verticillata (L.) G. Mey.	n	f	SU
Spermacoceodes glabrum (Michx.) Kuntze	n	f	SP
Scrophulariaceae			
Angelonia integerrima Spreng.	n	f	SP
Mecardonia tenella (Cham. & Schtdl.) Pennel	n	f	SU
Scoparia montevidensis (Spreng.) R. E. Fr.	n	f	RE
Stemodia lanceolata Benth.	n	f	SP
Solanaceae			
Cestrum parqui L'Hér	n	nf	SP, PA
Cestrum strigillatum Ruiz & Pav.	n	nf	RE
Jaborosa bergii Hieron.	n	f	P
Nicotiana longiflora Cav.	n	f	SU, HO
Nierembergia aristata D. Don	n	f	SU
Physalis mendocina Phil.	n	f	RO
Physalis viscosa L.	n	f	RE, SU, HO
Solanum claviceps Griseb.	n	f	SP
Solanum elaeagnifolium Cav.	n	f	RO
Solanum glaucophyllum Desf.	n	f	HO
Solanum sisymbrifolium Lam.	n	f	SP, SU, PA, HO
Solanum sp.	n	f	SP
Solanum sublobatum Willd.	n	f	HO
Turneraceae			
Turnera grandiflora (Urb.) Arbo	n	f	SP, RE
Turnera sidoides L. subsp. *pinnatifida* (Juss. ex Poir.) Arbo	n	f	RO

(*Continued*)

Appendix 1. (Continued).

Weeds	Status	Life form	Sites
Verbenaceae			
Glandularia incisa (Hook.) Tronc.	n	f	RE, SU
Glandularia peruviana (L.) Small.	n	f	SP
Glandularia pulchella (Sweet.) Tronc.	n	f	RE
Glandularia sp.	n	f	RO
Lantana montevidensis (Spreng.) Briq.	n	nf	SP
Lippia asperrima (Cham.)	n	nf	SP
Phyla canescens (Kunth) Greene	n	f	SU, RO, HO, BA
Verbena gracilescens (Cham.) Herter	n	f	SU, RO, HO
Verbena intermedia Gillies & Hook.	n	f	P, HO
Verbena litoralis Kunth	n	f	SU, RO
Zygophyllaceae			
Kallstroemia tucumanensis Descole, O'Donell & Lourteig	n	f	SP

Appendix 2. List of species of floral visitors collected in the field margins when visiting entomophilous plants that co-flowered with sunflower

Data correspond to the sunflower fields sampled across eight sites (see Table 1). Functional groups: pol = pollinators; cle = cleptoparasites; pre = predators; par = parasitoids; her = herbivores; and dec = decomposers. Status: n = native; e = exotic. ? Species or morpho-species with unknown life cycles. Acronyms: SP = Sáenz Peña, RE = Reconquista, SU = Sunchales, PA = Paraná, P = Paunero, RO = Roca, HO = Hortensia, BA = Balcarce.

Floral Visitor	Status	Functional group	Sites
Orders Family Species or morphospecies			
Hymenoptera			
Apoidea			
Andrenidae (22)			
*Anthrenoides*sp. 3	n	pol	RE
*Anthrenoides*sp. 4	n	pol	SU
Callonychium mandibulare (Friese)	n	pol	P
Callonychium sp. 7	n	pol	P
Panurgillus sp. 1	n	pol	P
Parapsaenythia puncticutis (Vachal)	n	pol	SU
Parapsaenythia serripes (Ducke)	n	pol	HO
Protandrena sp. 3	n	pol	RE, PA
Protandrena sp. 4	n	pol	RO

(*Continued*)

Appendix 2. (Continued).

Floral Visitor	Status	Functional group	Sites
Psaenythia sp. 2	n	pol	SU
Psaenythia sp. 4	n	pol	RE
Psaenythia sp. 5	n	pol	RE
Psaenythia sp. 6	n	pol	RO
Psaenythia sp. 7	n	pol	RO
Psaenythia sp. 8	n	pol	RO
Psaenythia sp. 9	n	pol	RO
Psaenythia sp. 10	n	pol	RO
Psaenythia sp. 11	n	pol	HO
Psaenythia sp. 12	n	pol	HO
Psaenythia sp. 13	n	pol	HO
Psaenythia sp. 14	n	pol	HO
Rhophitulus (*Cephalurgus*) sp. 1	n	pol	SU
Apidae (43)			
Alepidosceles filitarsis (Vachal)	n	pol	P
Alloscirtetica vara (Brèthes)	n	pol	RO
Apis mellifera L.	e	pol	SP, RE, SU, PA, P, RO, HO, BA
Bombus bellicosus Smith	n	pol	HO
Bombus morio (Swederus)	n	pol	RE
Bombus pauloensis Friese	n	pol	PA
Brachynomada sp. 1	n	cle	HO
Caenonomada bruneri Ashmead	n	pol	SP, RE, SU
Centris catsal Roig Alsina	n	pol	SP
Centris mourei Roig Alsina	n	pol	SP
Centris tarsata Smith	n	pol	SP
Ceratina morrensis Strand	n	pol	RE
Ceratina rupestris Holmberg	n	pol	PA
Chalepogenus parvus Roig Alsina	n	pol	SU
Chalepogenus unicolor Roig Alsina	n	pol	SP
Diadasia patagonica (Brèthes)	n	pol	SU
Diadasia sp. 1	n	pol	SP
Diadasina distincta (Holmberg)	n	pol	RE
Doeringiella holmbergi (Schrottky)	n	cle	RE, RO
Doeringiella nobilis (Friese)	n	cle	PA, P, RO
Eucerini sp. 1	n	pol	SU
Exomalopsis jenseni Friese	n	pol	SP
Exomalopsis sp. 3	n	pol	SU
Exomalopsis trifasciata Brèthes	n	pol	RO
Leptometriella separata (Holmberg)	n	pol	PA
Melissodes rufithorax Brèthes	n	pol	SP, RE, PA, P, RO, HO
Melissodes tintinnans (Holmberg)	n	pol	RE, SU, PA, RO, HO
Melissoptila bonariensis Holmberg	n	pol	RE, PA

(*Continued*)

Appendix 2. (Continued).

Floral Visitor	Status	Functional group	Sites
Melissoptila desiderata (Holmberg)	n	pol	SP, SU, PA, RO
Melissoptila tandilensis Holmberg	n	pol	RO, HO, BA
Melitoma segmentaria (Fabricius)	n	pol	SP
Nomada bonaerensis Holmberg	n	cle	RO
Parepeolus aterrimus (Friese)	n	cle	RE
Peponapis fervens (Smith)	n	pol	SP, HO
Ptilothrix tricolor (Friese)	n	pol	RO
Tapinotaspis chalybea (Friese)	n	pol	SU
Tetragonisca angustula (Latreille)	n	pol	SP
Thygater analis (Lepeletier)	n	pol	SP, PA
Trichonomada cf. *roigella* Michener	n	cle	HO
Trophocleptria sp. 1	n	cle	RE
Xylocopa ciliata Burmeister	n	pol	RO
*Xylocopa nigrocincta*Smith	n	pol	RE
Xylocopa splendidula Lepeletier	n	pol	SU, RO
Colletidae (6)			
Colletes argentinus (Friese)	n	pol	PA, HO
Colletes sp. 10	n	pol	HO
Colletes sp. 11	n	pol	RO
Leioproctus (*Tetraglossula*) sp. 1	n	pol	HO
Leioproctus (*Nomiocolletes*) sp. 9	n	pol	RE
Leioproctus (*Protodiscelis*) sp. 1	n	pol	RE
Halictidae (26)			
Augochlora (*Augochlora*) *amphitrite* (Schrottky)	n	pol	SP, RE, HO
Augochlora (*Augochlora*) *phoemonoe* (Schrottky)	n	pol	HO
Augochlora (*Oxystoglossella*) *iphigenia* Holmberg	n	pol	PA
Augochlorella sp. 2	n	pol	SP
Augochloropsis cf. *euterpe* Holmberg	n	pol	SU
Augochloropsis tupacamaru (Holmberg)	n	pol	HO
Augochloropsis sp. 3	n	pol	PA
Augochloropsis sp. 8	n	pol	RE
Augochloropsis sp. 9	n	pol	SP
Augochloropsis sp. 10	n	pol	SP, PA
Augochloropsis sp. 11	n	pol	SP
Augochloropsis sp. 12	n	pol	RE
Lasioglossum (*Dialictus*) sp. 4	n	pol	SP
Lasioglossum (*Dialictus*) sp. 15	n	pol	SU, RO
Lasioglossum (*Dialictus*) sp. 16	n	pol	P
Lasioglossum (*Dialictus*) sp. 19	n	pol	HO
Lasioglossum (*Dialictus*) sp. 20	n	pol	HO
Lasioglossum (*Dialictus*) sp. 21	n	pol	HO
Lasioglossum (*Dialictus*) sp. 22	n	pol	HO
Pseudagapostemon (*Neagapostemon*) *puelchanus* (Holmberg)	n	pol	HO

(*Continued*)

Appendix 2. (Continued).

Floral Visitor	Status	Functional group	Sites
Pseudagapostemon (*Neagapostemon*) sp. 1	n	pol	SU, P
Pseudagapostemon (*Pseudagapostemon*) cf. *hurdi* Cure	n	pol	HO
Pseudagapostemon (*Pseudagapostemon*) sp. 2	n	pol	RE
Pseudagapostemon (*Pseudagapostemon*) sp. 4	n	pol	RE
Pseudaugochlora graminea (Fabricius)	n	pol	SP
Ruizantheda divaricata (Vachal)	n	pol	HO
Megachilidae (18)			
Coelioxys (*Acrocoelioxys*) *tolteca* Cresson	n	cle	RE
Coelioxys (*Acrocoelioxys*) sp. 2	n	cle	SP, RE
Coelioxys (*Acrocoelioxys*) sp. 8	n	cle	RO
Coelioxys (*Acrocoelioxys*) sp. 9	n	cle	RO
Coelioxys (*Haplocoelioxys*) sp. 6	n	cle	P
Coelioxys (*Haplocoelioxys*) sp. 7	n	cle	P
Coelioxys (*Platycoelioxys*) sp. 3	n	cle	RE
Epanthidium bicoloratum (Smith)	n	pol	HO
Megachile (*Dactylomegachile*) *ctenophora* Holmberg	n	pol	SP, PA
Megachile (*Leptorachis*) *aetheria* Mitchell	n	pol	RE
Megachile (*Leptorachis*) *pallefacta* Vachal	n	pol	PA
Megachile (*Pseudocentron*) *botucatuna* Schrottky	n	pol	PA
Megachile (*Pseudocentron*) *cordialis* Mitchell	n	pol	PA
Megachile (*Pseudocentron*) *gomphrenae* Holmberg	n	pol	SP, PA, RO, HO, BA
Megachile (*Pseudocentron*) *gomphrenoides* Vachal	n	pol	HO
Megachile (*Pseudocentron*) *hoffmannseggiae* Jörgensen	n	pol	RE
Megachile (*Pseudocentron*) *neutra* Vachal	n	pol	RO, HO
Megachile sp. 35	n	pol	P
Crabronidae (15)			
Bembyx cf. *citripes* Taschenberg	n	pre	P
Cerceris sp. 3	n	pre	P
Cerceris sp. 4	n	pre	P
Cerceris sp. 5	n	pre	HO
Ectemnius sp. 1	n	pre	PA
Ectemnius sp. 3	n	pre	HO
Ectemnius sp. 4	n	pre	HO
Larra bicolor Fabricius/*L. praedatrix* (Strang)	n	pre	RO
Larra burmeisterii (Homberg)	n	pre	SU
Larra sp. 2	n	pre	RO

(*Continued*)

Appendix 2. (Continued).

Floral Visitor	Status	Functional group	Sites
Oxybelus sp. 3	n	pre	P
Tachytes sp. 1	n	pre	P
Tachytes sp. 3	n	pre	RO
Trachypus flavidus (Taschenberg)	n	pre	HO
Trachypus petiolatus (Spinola)	n	pre	RO
Sphecidae (4)			
Isodontia visseri Willink	n	pre	HO
Prionyx sp. 3	n	pre	RE
Sphex argentinus Tsachenberg	n	pre	P
Stangeella cyaniventris (Guerin)	n	pre	P
Vespoidea			
Pompilidae (4)			
Anoplius sp. 1	n	pre	RO, HO
Ceropales brethesi Banks	n	cle	P
Dicranoplius satanus (Holmberg)	n	pre	HO
Pepsis sp. 3	n	pre	P
Tiphiidae (4)			
Eucyrthothynnus cf. *ichneumoneus* (Klug)	n	par	HO
Myzinum sp. 5	n	par	RO
Myzinum sp. 6	n	par	RO, HO
Tiphia andina Brèthes	n	par	HO
Vespidae (9)			
Brachygastra lecheguana (Latrielle)	n	pre	PA
Brachygastra sp. 2	n	pre	RE
Pachocynerus cf. *guadulpensis* (Saussure)	n	pre	RE
Pachodynerus argentinus Saussure	n	pre	P
Polistes cinerascens Saussure	n	pre	SU
Polybia occidentalis (Olivier)	n	pre	PA
Polybia scutellaris (White)	n	pre	HO
Polybia sericea (Olivier)	n	pre	RE, SU, PA
Trimeria rachiphorus (Schletterer)	n	pol	RO
Diptera			
Anthomyiidae (1)			
Anthomyiidae sp. 1	n	dec?	BA
Bibionidae (1)			
Bibionidae sp. 1	n	dec?	RE
Bombyliidae (4)			
Exoprosopa sp. 1	n	par	SU
Hemipenthes sp. 1	n	par	HO
Parasystoechus sp. 1	n	par	RO, HO
Parasystoechus sp. 2	n	par	RE, RO
Calliphoridae (3)			
Chrysomya albiceps (Wiedemann)	e	dec	RE, SU
Chrysomya megacephala (Fabricius)	e	dec	PA
Cochliomyia macellaria (Fabricius)	n	dec	RE, HO

(*Continued*)

Appendix 2. (Continued).

Floral Visitor	Status	Functional group	Sites
Conopidae (1)			
Conopidae sp. 1	n	par	RE
Culicidae (1)			
Culicidae sp. 1	n	pre	SU
Muscidae (4)			
Musca domestica L.	e	dec	PA
Muscina stabulans (Fallén)	n	dec	PA
Muscidae sp. 30	n	dec	PA
Muscidae sp. 31	n	dec	RE
Sarcophagidae (10)			
Helicobia sp. 1	n	dec	RE
Helicobia sp. 2	n	dec	PA
Oxysarcodexia paulistanensis (Mattos)	n	dec	SU, P
Oxysarcodexia terminalis (Wiedemann)	n	dec	PA
Oxysarcodexia varia (Walker)	n	dec	RE, SU, PA, RO
Ravinia aureopyga Hall	n	dec	RE, P
Sarcophagidae sp. 33	n	dec	RE
Sarcophagidae sp. 36	n	dec	RE
Sarcophagidae sp. 40	n	dec	RO
Sarcophagidae sp. 41	n	dec	RO
Stratiomyiidae (3)			
Stratiomyidae sp. 4	n	dec?	RE, P
Stratiomyidae sp. 7	n	dec?	RE
Stratiomyidae sp. 8	n	dec?	P
Syrphidae (12)			
Allograpta exotica Wiedemann	n	pre	RE, SU, RO, HO, BA
Copestylum compactum Curran	n	dec	RE
Copestylum sexmaculatum Palisot de Beauvois	n	dec	RE
Copestylum spinigerum Wiedemann	n	dec	SU
Eristalis tenax L.	e	dec	SU, PA
Palpada distinguenda Wiedemann	n	dec	SU, P, HO
Palpada elegans Blanchard	n	dec	SU, BA
Palpada furcata Wiedemann	n	dec	RE, PA
Palpada rufiventris (Macquart)	n	dec	SP, RE, HO
Psuedodoros clavatus Fabricius	n	pre	RE, SU
Salpingogaster halcyon Hull	n	pre	RE
Toxomerus sp. 1	n	pre	SU, RO, HO
Tabanidae (1)			
Tabanidae sp. 1	n	dec?	SU
Tachinidae (20)			
Archytas incertus (Macquart)	n	par	RE, PA
*Archytas*sp. 2	n	par	PA
*Archytas*sp. 3	n	par	SU

(*Continued*)

Appendix 2. (Continued).

Floral Visitor	Status	Functional group	Sites
Belvosia rufifrons Blanchard	n	par	RE
Gonia pallens Wiedemann	n	par	P, RO
Trichopoda sp. 1	n	par	RE, PA, P, RO
Tachinidae sp. 1	n	par	SU, PA, BA
Tachinidae sp. 52	n	par	RE, PA
Tachinidae sp. 53	n	par	RE
Tachinidae sp. 54	n	par	RE
Tachinidae sp. 55	n	par	RE, PA
Tachinidae sp. 56	n	par	RE
Tachinidae sp. 57	n	par	PA
Tachinidae sp. 58	n	par	RE
Tachinidae sp. 59	n	par	BA
Tachinidae sp. 62	n	par	SU
Tachinidae sp. 63	n	par	P, RO
Tachinidae sp. 70	n	par	HO
Tachinidae sp. 71	n	par	HO
Tachinidae sp. 72	n	par	HO
Coleoptera			
Cantharidae (1)			
Chauliognathus scriptus (Germ.)	n	pre?	P, RO, HO, BA
Chrysomelidae (2)			
Diabrotica speciosa (Germ.)	n	her	HO
Spintherophyta sp.	n	her	RO
Elateridae (1)			
Conoderus sp. 1	n	her	RO
Lampyridae (2)			
Lampyridae sp. 1	n	dec?	HO
Lampyridae sp. 2	n	dec?	HO
Melyridae (2)			
Astylus atromaculatus Blanchard	n	her?	P
Astylus quadrilineatus (Germ.)	n	her?	PA, RO
Lepidoptera			
Arctiidae (2)			
Eurata baeri Rothschild	n	her	RE
Philoros opaca Boisduval	n	her	RE
Hesperiidae (4)			
Epargyreus tmolis (Burmeister)	n	her	HO
Erynnis funeralis (Scudder et Burgess)	n	her	HO
Pyrgus sp.	n	her	RE
Vinius pulcherrimus Hayward	n	her	HO
Lycaenidae (2)			
Strymon bazochii (Godart)	n	her	SU
Strymon eurytulus (Hübner)	n	her	RE, SU, RO, HO, BA
Nymphalidae (7)			
Agraulis vanillae Stichel	n	her	SU, PA

(*Continued*)

Appendix 2. (Continued).

Floral Visitor	Status	Functional group	Sites
Euptoieta claudia (Blanchard)	n	her	SU
Junonia genoveva C. & R. Felder.	n	her	PA
Ortilia ithra (Kirby)	n	her	PA
Tegosa claudina (Eschscholtz)	n	her	PA
Tegosa frisia (Hewitson)	n	her	RE
Vanessa sp.	n	her	PA
Pieridae (5)			
Pyrisitia nise (Boisduval)	n	her	RE
Glutophrissa drusilla (Cramer)	n	her	PA
Tatochila vanvolxemii (Capronnier)	n	her	P, RO
Colias lesbias (Hübner)	n	her	BA
Tatochila autodice (Hübner)	n	her	BA
Riodinidae (5)			
Audre cf. *notialis* (Stichel)	n	her	RE
Audre epulus (Stichel)	n	her	RO
Audre erycina (Schweizer et Kay)	n	her	SU
Ematurgina bifasciata (Mengel)	n	her	P
Riodina lysippoides Berg	n	her	SU, PA
Sphingidae (1)			
Aellops tantalus (L.)	n	her	BA
Blattaria			
Blatellidae (1)			
Pseudomops neglecta Shelford	n	dec?	PA, HO