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AGRARIAN SCIENCES

Diversity and phenology of epigeal Coleoptera assemblages in lettuce and tomato crops in Northern Buenos Aires province, Argentina

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Abstract: Epigeic coleopteran species are linked by complex trophic webs and implicated in several ecosystem services for agriculture. Although there are reports of ground-dwelling Coleopterans inhabiting main extensive agroecosystems, their assemblages in horticultural crops in Argentina have been little explored. We examined the community structure of epigeal Coleoptera assemblages of Curculionidae, Carabidae, Staphylinidae and Coccinellidae species, in lettuce and tomato crops located in Northern Buenos Aires province, over a 3-year sampling period (2010 to 2013) by using pit-fall traps. Crop species and cycles, and phytosanitary measures (conventional and organic farming), were main factors considered as influencing the insect species composition, abundance and seasonal occurrence in the assemblages. Seventy coleopteran species were identified. The curculionids *Ceutorhynchini* sp. and *Phyrdenus muriceus* (Germar), the carabid *Scarithes anthracinus* Dejean, the coccinelid *Eriopis connexa* (Germar) and the staphylinids *Aleochara* sp. and *Aleochara obscurus* Bernhauer are the most common species in lettuce and tomato crops in the region studied. Especially the carabids, staphylinids and *E. connexa* are known act as natural enemies of several pests in the agroecosystems studied. Coleopteran assemblages found in lettuce differed from those associated to tomato crops, being the cropping season the main factor that influenced the community structure.

Key words: community, diversity, functional group, guild, horticultural crop, coleopterans.

INTRODUCTION

Agricultural activities significantly alter soil properties, as well as its biota in terms of their abundance, biomass and diversity (Brown et al. 2001). Among soil macrofauna (organisms with a body size > 2 mm), beetles represent a numerous and diverse group of species. They are linked by complex trophic webs, and engaged either directly or indirectly in several ecosystem processes such as biological control of pests, as phytophagous, decomposition, nutrient cycling, erosion control, genetic resources and pollination. Furthermore, because of the niche breadth associated to their different developmental stages, beetles connect hypogean and epigean trophic webs, facilitating matter and energy transference (Coleman et al. 2017).

Species composition and relative abundance of Coleoptera may vary according to crop management systems. Monoculture, tillage, weeds and pest control produce a simplification of community structure, being generalist species less affected by this management practice. Conversely, those heterogeneous systems that provide both shelter and food to them and other invertebrates pose a greater diversity of coleopterans - both taxonomic and functional

– especially promoting biological control of pests (Fournier & Loreau 1999, Magura et al. 2001, Fernandes et al. 2018). Organic farming relies on cropping practices that keep agricultural systems operating as naturally as possible. Thus, by reducing or banning chemical inputs organic crops show increased levels of species richness and abundance, depending on the taxonomic group (Shah et al. 2003, Hole et al. 2005, Zalazar & Salvo 2007). For example, Puech et al. (2014) showed that abundances of ladybirds and carabid beetles were higher in organic fields.

Arthropods commonly show associations with plant species, and their populations are subject to variations as vegetation changes over time. Intensive agriculture in temperate regions is practiced in crop cycles, following the seasons. Typically, a short-term replacement of plant species occurs which leads to changes in the arthropod community structure throughout the growing period. Understanding seasonal patterns of biodiversity in agroecosystems may help to enhance management strategies based on ecological processes such as biological control, nutrient cycling, soil formation, etc., and ultimately to increase crop production (Altieri 1999).

In community ecology, identification of species is a key step to further analyzing patterns of their abundance, seasonal occurrence, feeding habits, etc. in a given place (Morin 1999, Gotelli 2004). In hyperdiverse faunistic groups, such as Coleoptera, this task may be limited by the lack of taxonomic specialists and/or taxonomic keys, as well as reference specimens in local collections. Therefore, there are restrictions at identifying all the species in a community, and, in general, the emphasis is placed on the most predominant groups.

Knowledge of ground-dwelling beetles inhabiting horticultural crops in Argentina is scarce. There are studies on extensive crops, especially for Carabidae and Curculionidae (Marasas et al. 1997, Lanteri et al. 2002, Marasas 2002, Novo et al. 2002, Cicchino et al. 2003, 2005, Paleologos 2012), and other important families have been less studied. Since soil Coleopterans are taxonomically and functionally diverse, knowledge of their assembling in agroecosystems could provide insights to detect micro-environmental heterogeneity and to design tools for preserving them (Agosti & Sciaky 1998, Niemelä et al. 1990, Paleologos et al. 2008).

In this work we examine the assemblage structure of epigeal Coleoptera that inhabits two main horticultural crops of Argentina, lettuce (*Lactuca sativa* L.) and tomato (*Solanum lycopersicon* Mill.), cultivated under conventional and organic management. The study was focused on determining the taxonomic composition, abundance, and dominance of the species belonging to the main four families present in these crops: Curculionidae, Carabidae, Staphylinidae and Coccinellidae. Our hypothesis is that given coleopterans are among the most ubiquitous insect groups and perform multiple ecological functions in agroecosystems, their communities will be well represented in horticultural crops and will show different structure according to the crop species, the cropping season and the cultural practices implemented by producers, from conventional to organic farming.

MATERIALS AND METHODS

Study area and sampling

The study was carried out in commercial farms located surrounding La Plata city, Northern Buenos Aires province, Argentina. This area is known as 'La Plata Horticultural Belt', and comprises about 4,500 ha of cultivated land, being 70% dedicated to a variety of vegetables, strawberry and blueberry crops (including open and protected fields). Chemical control is the conventional phytosanitary measure to suppress pests and weeds, but organic farming that includes spraying with natural pesticides (purines) and conservation biological control through habitat manipulation is gaining importance (Salas Gervassio et al. 2016).

To evaluate species composition and community structure of epigeic Coleopteran assemblages in *L. sativa* and *S. lycopersicon*, open field crops under conventional (CM) or organic (OM) pest management were selected in the localities of Colonia Urquiza (34°56'36.76 "S, 58°05'20.24"W), Los Hornos (34°58'55.77"S, 57°59'02.01"W) and Lisandro Olmos (35°00'20.48"S, 58°01'59.89"W) (La Plata county, Buenos Aires Province, Argentina).

Insects were sampled by means of pitfall trapping, a technique that allows estimating relative abundance. This method has been widely used in other arthropod community studies (Boito et al. 2009, Cheli & Corley 2010). The trap consisted in a plastic cup (800 ml, 12 cm height, and 10 cm upper diameter), filled with 350 ml of a saturated $NaHCl_3$ water solution, and detergent as tensioactive. In each farm, an area of 150 m^2 of each crop was chosen, and 11 traps were installed at about 5-10m distance along cultivated rows (Jones & Eggleton 2000). The top of the container was covered with a lid.

Open-field lettuce is cultivated almost year-round, in two cycles: fall-winter (May to August) and spring-summer (September to January). Open-field stalked tomato is cultivated during the warmer months, i.e., spring-summer (October to March). Samplings were taken bi-weekly in lettuce crops and monthly in tomato crops, up to the end of the cropping cycle. Once the traps were emptied and the solution transferred into sealed plastic bags (Ziploc®), new clean solution was added accordingly. Bags were labeled and transported to the laboratory. Information regarding in-farm plant diversity, cultural methods practiced by producers, etc. was gathered.

Structure of assemblages

The material collected was rinsed with tap water and filtered using a 1-mm diameter metallic mesh to separate insects from debris. All specimens were assorted firstly according to supra-order taxonomic categories and preserved in 70% ethanol for further examination. Coleopteran species identifications were made at genus and/or species levels, whenever possible, by using taxonomic keys and diagnostic descriptions (Crowson 1981, Borror et al. 1989, Britton & Mackerras 1991, Artigas 1994, Lawrence & Britton 1994, White 1998, Arnett & Thomas 2001, Arnett et al. 2002), and compared with reference specimens deposited at División Entomología, Museo de La Plata. Consultations were also made to: CARABIDAE: Sergio Roig-Juñent; and CURCULIONIDAE: Analía Lanteri and Guadalupe Del Río (Museo de La Plata, La Plata, Argentina). STAPHYLINIDAE were identified by Mariana Chani Posse. Insects were assigned to six different assemblages: four for lettuce crops (two types of plant protection management) × (two cropping seasons), and two for tomato crops (two types of plant protection management). To analyse spatial (crops, plant protection management) and temporal (cropping seasons) patterns of the six epigeic Coleopteran assemblages, relative abundance per species or morphospecies was calculated as the number of individuals per species/total number of individuals collected, and then each value plotted sequentially taking into account dominance categories, from lowest to greater abundances. The categories were: 1) dominant (≥ 5 %); 2) codominant (4.9 - 2 %), and rare (de 0 - 1.9%) (Pedraza et al. 2010).

Niche partitioning of species in the six assemblages was explored by adjusting data of their abundances to the Log-normal and Logarithmic series, which show non-interacting, randomly distributed individuals in a community. These models have been reported as common to a large number of different communities (Magurran 1988, Morin 1999, Magurran & Henderson 2011). Species-abundance curves fitting was made by means of PAST software, v. 2.16 (Hammer et al. 2001), and significance of goodness of fitting was evaluated by chi-square tests (P > 0.05).

Finally, to compare the six assemblages with respect to their species overlap a multivariate analyses of hierarchy clustering was carried out (Gotelli 2004). The variables considered were: crop (lettuce or tomato), cropping season for lettuce (fall-winter or spring-summer), and plant protection practices (conventional or organic farming). The method consisted in testing three different dissimilarity (1 – similarity) or distance coefficients: qualitative Jaccard and Sørensen, and quantitative Sørensen. Qualitative data were referred as the presence or absence of a given species, and quantitative also included abundance of each species (Gotelli 2004). Clustering using the three coefficients was performed but the Sørensen quantitative coefficient was chosen since it described more realistically the structure of Coleopteran assemblages found. The matrix used had 70 species × 6 assemblages.

Sørensen similarity coefficient (C_S) (Magurran 1988) between pairs of assemblages was calculated as:

$$C_S = 2pN/aN + bN$$

where:

aN= total number of individuals of all species in assemblage A.

bN= total number of individuals of all species in assemblage B.

pN= sum of the lowest abundance of each shared species in A and B.

Results were graphically expressed with a dendrogram plotted using Euclidean distances (Peña 2002). Cluster analyses were performed using the *Cluster* procedure (SAS v. 9.1), and then, a dendrogram was plotted by means of Semi-Partial R Square (SPRQ) that measures the loss of homogeneity when two groups join a new one. A lower SPRQ value shows that two homogeneic groups join a new one meanwhile higher values suggest that two heterogeneous groups were joint.

RESULTS

Species inventory

During the study period, a total of 1,510 adult coleopterans of the main four families were captured. From those, 708 were found in lettuce crops and 802 in tomato crops. Twenty-five taxa (species/morphospecies) were identified as Curculionidae, belonging to five subfamilies. Over 60% of specimens were identified as *Phyrdenus muriceus* (Germar, 1824) (Table SI - Supplementary Material).

Regarding the Carabidae, 17 taxa from three subfamilies and seven tribes were registered. More than a half of individuals belonged to *Pachymorphus striatulus* (Fabricius, 1792). A new species, *Rhytidognathus platensis* Roig-Juñent & Rouaux 2012, was described (Roig-Juñent & Rouaux 2012) (Table SII)

A total of 27 taxa were identified as Staphylinidae, representing five subfamilies and eight tribes (Table SIII). *Apocellus obscurus* Bernhauer, 1908 (32%), *Aleochara* sp2 (19%) and *Aleochara* sp7 (10%) were the most abundant species.

The family Coccinellidae was represented by only one species, *Eriopis connexa* Germar 1924 which reached 17% of the total of individuals trapped.

Structure of assemblages

For the four epigean Coleoptera assemblages in lettuce crops, five to eight species were dominant, four to eight co-dominant, and a variable number of species were rare (Fig. 1a, b, c and d). The species *P. striatulus, P. cordicollis* and *E. connexa* were found in general as dominant or co-dominant species, although the latter was not registered in late crops sprayed with insecticides. *Scarites anthracinus* Dejean and *P. muriceus* were dominant in early crops, independently whether they were managed conventionally or organically. Besides, some species, as *P. cordicollis*, were dominant in warmer months (spring-summer). Interestingly, rare species in organic sites doubled those found in conventionally managed farms.

In tomato crops, six species were found dominant, meanwhile other three species were co-dominant in organic farms and seven in conventionally managed crops (Fig. 2a, b). Dominant species were *P. muriceus,* Baridinae sp6*, E. connexa, A. obscurus, Aleochara* sp7 and *S. anthracinus*. As in lettuce crops, a greater number of rare species were found in organic sites.

Relative abundances of the 70 species of epigeic Coleoptera conforming the six assemblages fit to logarithmic (fall-winter CM lettuce crop) and log-normal (two OM lettuce crops and two tomato crops, CM and OM) distributions, with the exception of the spring-summer CM lettuce crop that fitted to both distributions (Table IV and Fig. 3a, b, c, c`, d, e, f).

Similarity analysis showed that lettuce crops resembled more in composition and abundance of epigeic Curculionidae, Carabidae, Staphylinidae and Coccinellidae than in tomato crops (Table V).

Furthermore, coleopteran assemblages slightly showed greater distance between lettuce and tomato crops. Species in lettuce crops were split based in the cropping season (lowest SPRQ values for late crops, both plant protection management practices), being early crops segregated in a second group. Crop management in lettuce had less impact on epigeic coleopteran structure than seasonality (Fig. 4).

DISCUSSION

We report novel information on the coleopteran assemblages that inhabit soils of *L. sativa* and *S. lycopersicon* crops in northern Buenos Aires province, Argentina. They were composed of 70 species or morphospecies of Curculionidae (26), Carabidae (16), Staphylinidae (27) and Coccinellidae (1). The curculionids Ceutorhynchini sp. and *P. muriceus*, the carabid *S. anthracinus*, the coccinelid *E. connexa* and the staphylinids *Aleochara* sp. 2, and *A. obscurus* were the most common species recorded in lettuce and tomato crops in the region studied. Besides, a great number of new Coleopteran species are expected to be described, as it was the case of the carabid weevil *R. platensis* (Roig-Juñent & Rouaux 2012). Changes in assemblage structure in relation to the crop species, cultural practices and seasonality were observed. In general, organic crops showed greater species richness of epigeic coleopterans, with few dominant and co-dominant species and plenty of rare species. The cropping season affected the presence and abundance of coleopterans, probably because of their life histories and life cycles, being aestival species predominant. Overall, the four families have members that belong to different

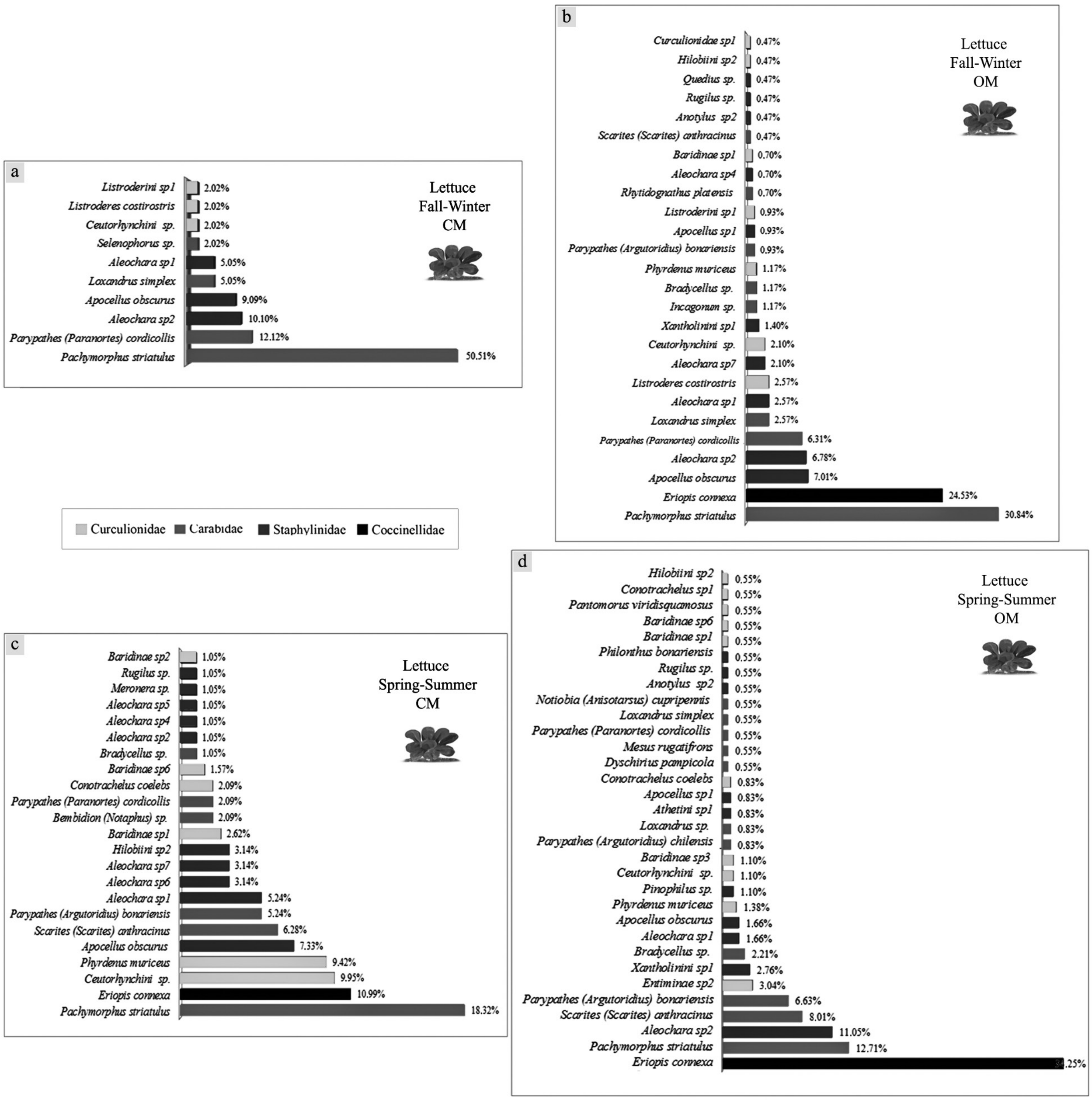

Figure 1. Relative abundance and dominance structure of Curculionidae, Carabidae, Staphylinidae and Coccinellidae species, collected in conventionally (CM) and organic (OM) managed lettuce crops, during different cropping seasons: (a) Fall-winter, CM; (b) Fall-winter, OM; (c) Spring-summer, CM, and (d) Spring-summer, OM. Dominance categories (from Pedraza et al. 2010): highly dominant: > 5%, co-dominant: 4.9 - 2%, and rare: 0 - 1.9%.

functional groups (phytophages, predators, parasitoids and saprophages), i.e., exploiting diverse vegetation conditions (monoculture or diversified orchards) and cultural practices (fertilizing, pest control).

The family Curculionidae - with ≈ 964 species described for Argentina (Morrone & Posadas 1998) - was well represented in both crops, although it was more abundant in tomato. They are all polyphagous phytophagous species

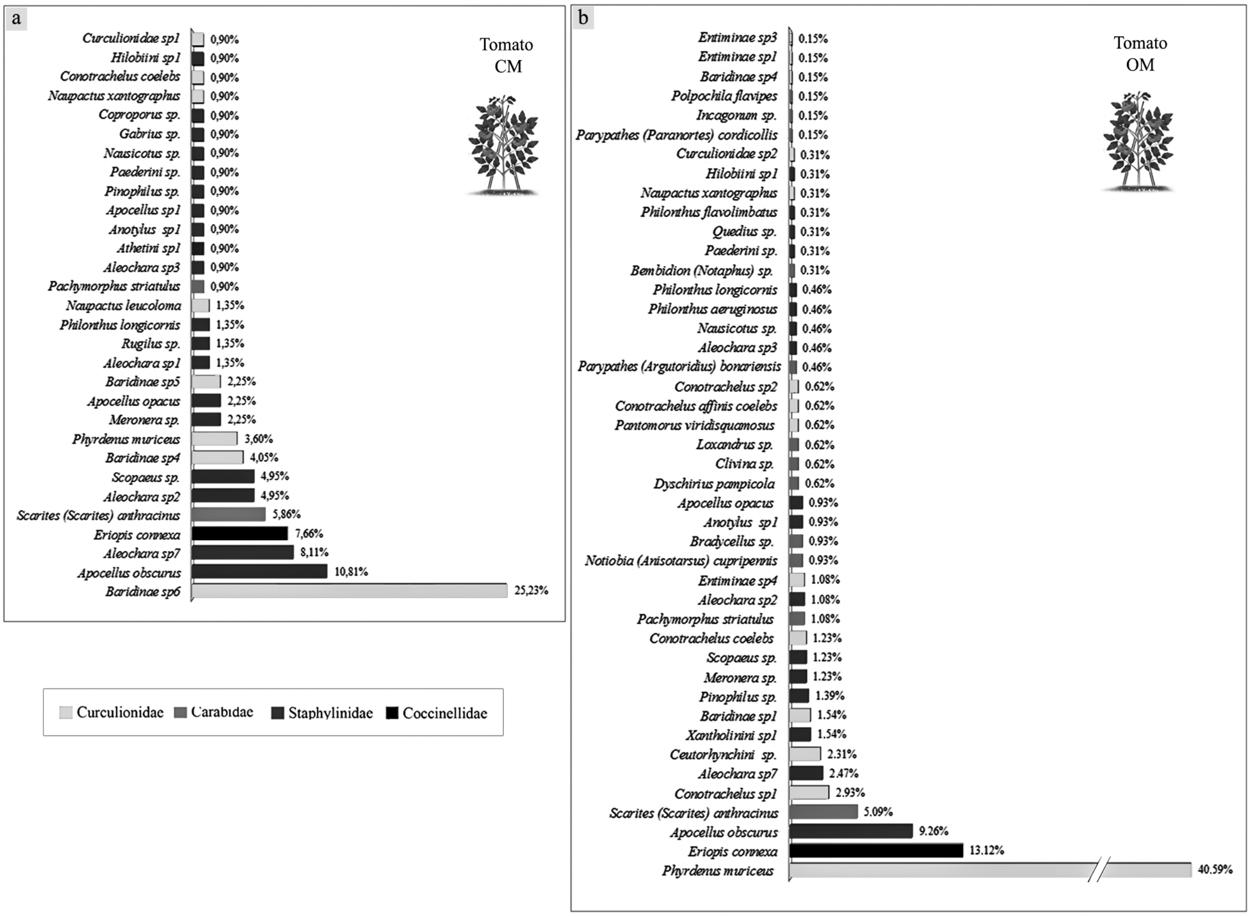

Figure 2. Relative abundance and dominance structure of Curculionidae, Carabidae, Staphylinidae and Coccinellidae species, collected in conventionally (CM), and organic (OM) managed tomato crops, during different cropping seasons: (a) Fall-winter, CM; (b) Fall-winter, OM; (c) Spring-summer, CM, and (d) Spring-summer, OM. Dominance categories (from Pedraza et al. 2010): highly dominant: > 5%, co-dominant: 4.9 - 2%, and rare: 0 - 1.9%.

that feed upon almost all plant tissues and organs. *Phyrdenus muriceus* was a dominant species in OM and co-dominant in CM tomato crops, respectively, and interestingly it was also found as dominant and codominant in soils of lettuce crops year-round. This weevil is considered of economic importance as a pest of tomato and eggplant, affecting the seedlings, roots, leaves and flowers (Cordo et al. 2004), and can cause up to 80% of crop losses few days after transplanting (Novo et al. 2002). It probably uses crops and non-cultivated solanaceous plants as shelter or for living, and switches to tomato crops from there (Artigas 1994, Lanteri et al. 2002, Novo et al. 2002). Curculionids are in general active in warmer months -when open-field tomato cropping is typical in the region- and populations peak at the end of crop´s cycle, making their control difficult (Lanteri 1994). Regarding the diverse family of Carabidae, with ≈ 679 species reported for Argentina (Roig-Juñent 1998), most of the species found in this study were predators, a common feeding habit of this group. However, few herbivorous were detected. The dominant carnivorous *P. striatulus, P. cordicollis, P. bonariensis and S. anthracinus* ground beetles have been reported as abundant in other agroecosystems in Argentina (Marasas

Table IV. **Values of probability and goodness of fit tests to distribution models of abundance logarithmic and log-normal for the species of Curculionidae, Carabidae, Staphylinidae and Coccinellidae conforming epigeic coleopteran assemblages in lettuce and tomato crops, in Northern Buenos Aires province, Argentina. Years: 2010-2013.**

		x^2	P
Lettuce FW CM	Logarithmic	8.854	0.115
Lettuce FW OM	Log-normal	3.939	0.268
Lettuce SS CM	Logarithmic	0.928	0.999
	Log-normal	0.321	0.851
Lettuce SS OM	Log-normal	1.719	0.423
Tomato SS CM	Log-normal	1.04	0.594
Tomato SS OM	Log-normal	1.036	0.792

Crop cycles: FW, fall-winter; SS, spring-summer; Plant protection measures: CM, conventional management of pests, use of agrochemicals; OM, organic farming.

Table V. **Similarity Sørensen quantitative indexes, calculated using specific composition and abundance of epigeic coleopteran species belonging to Carabidae, Curculionidae, Staphylinidae and Coccinellidae families (see also Fig. 4). Years: 2010-2013. LT: lettuce; TOM: tomato; FW: fall-winter; SS: spring-summer; CM: conventional use of pesticides; OM: organic farming.**

	LT FW CM	LT FW OM	LT SS CM	LT SS OM	TOM SS CM	TOM SS OM
LT FW CM	1.0000					
LT FW OM	0.6106	1.0000				
LT SS CM	0.4444	0.4013	1.0000			
LT SS OM	0.3018	0.5862	0.4240	1.0000		
TOM SS CM	0.1538	0.2112	0.3333	0.2172	1.0000	
TOM SS OM	0.1071	0.3282	0.3473	0.3468	0.3208	1.0000

2002, Paleologos 2012). Vegetation structure is a main factor affecting the distribution of Carabidae (Andow 1991, Carmona & Landis 1999) since it modifies microhabitats and alters insect displacement and prey searching. Thus, in *L. sativa* crops, where soils are bare of non-crop vegetation, cursorial forms were dominant, as *P. striatulus* and *P. cordicollis*. In general, carabids are active species during spring-summer months, and reduce their activity or enter in diapause in winter as larvae or pupae (Cepeda-Pizarro 1989, Grez et al. 2003). Exceptions in this study were the presence of the species *P. cordicollis* and *L. simplex*, both abundant and active in fall-winter lettuce assemblages during colder months (June - July). Similar findings were reported by Cicchino et al. (2005) and Castro et al. (2012, 2017) in other agroecosystems. The fossorial species *S. anthracinus* was dominant in tomato crops, majorly active from August to May. The Staphylinidae is a highly diverse family, with more than 1,017 species reported from Argentina (Chani Posse & Thayer 2008). They show varied feeding habits, such as predators, parasitoids, saprophagous, etc. In this study, parasitoids belonging to Aleocharinae (for example *Aleochara* spp.) and saprophagous to Oxytelinae (*A. obscurus* and *A. opacus*) were

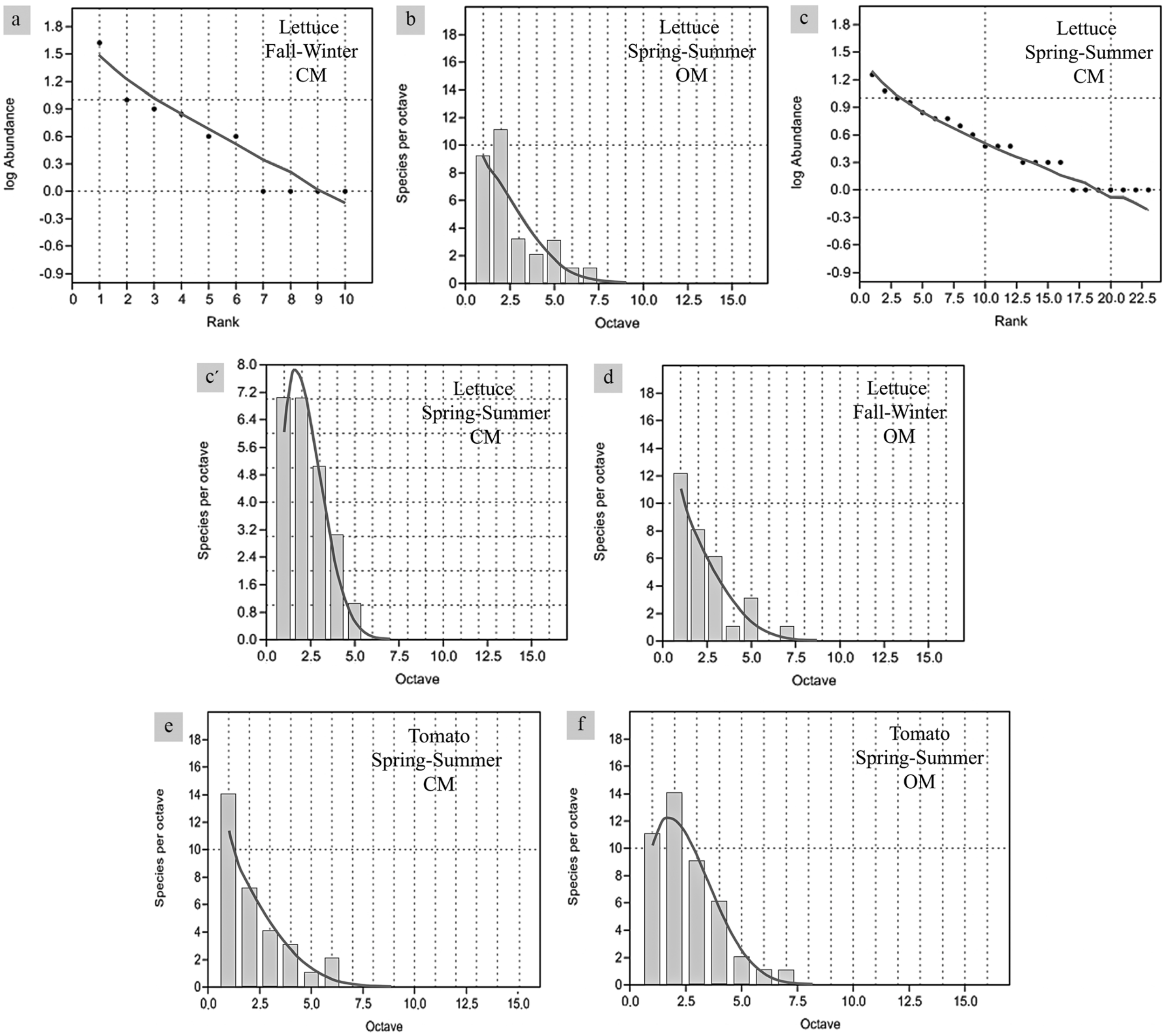

Figure 3. Rank-abundance curves plotted for logarithmic and log-normal series: (a) Lettuce, fall-winter, conventional management (CM); (b) Lettuce, fall-winter, organic management (OM); (c and c') Lettuce, spring-summer, conventional management (CM); (d) Lettuce, spring-summer, organic management (OM); (e) Tomato, conventional management (CM), and (f) Tomato, organic management (OM).

dominant. Species of *Aleochara* are known as parasites of dipteran eggs and larvae (Chani Posse 2002), which probably develop in manure-fertilized soils, a common and cheap organic amendment used by farmers in the region studied. Adults prey upon eggs, larvae and pupae of Diptera (Cyclorrapha). Species can be either quite polyphagous or strict specialists. In North America, *Aleochara bilineata* Gyllenhal has been employed to control the cabbage root fly *Delia radicum* L. and the onion maggot *D. antiqua* Meigen (Diptera: Anthomyiidae) (Maus 1998, Chani Posse & Thayer 2008, Van Driesche et al. 2008). Generalist predators among paederines and staphylinines (for example: *Pinophilus* sp. and *Philonthus longicornis*) prey upon a variety of edaphic arthropods (acari, collembolan, larvae of dipterans, coleopterans

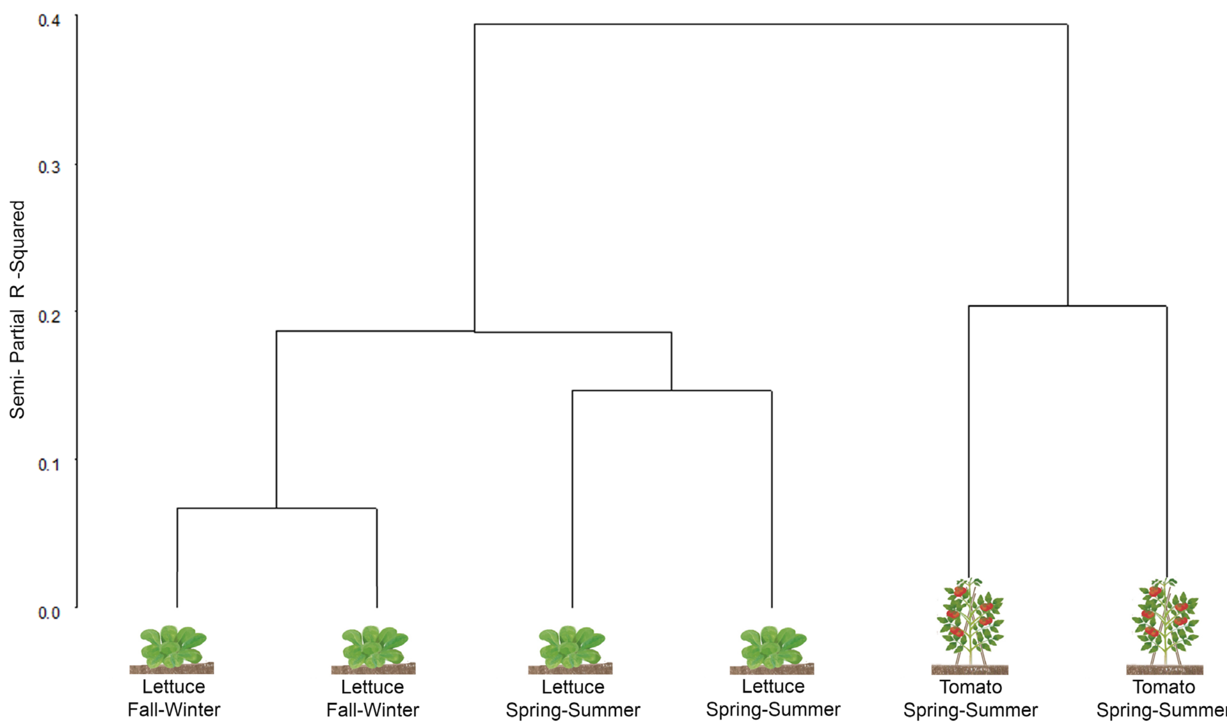

Figure 4. Cluster analysis for epigeic coleopteran assemblages conformed by the species of the dominant families Curculionidae, Carabidae Staphylinidae and Coccinellidae, inhabiting lettuce and tomato crops under different pest protection management (conventional use of insecticides –CM- and organic –OM- practices) in Northern Buenos Aires province, Argentina. Cropping seasons for lettuce: fall-winter and spring-summer. Years 2010-2013. Similarity index: Sørensen quantitative (CS) (Magurran 1988).

and lepidopterans), and other invertebrates (oligochaete and nematode worms) (Marchiori & Linhares 1999, Monzó et al. 2005). They were codominant or rare species, presumably due to competitive interactions with Carabidae (Hole et al. 2005). The family Coccinelidae is represented by ca. 150 species in Argentina (González 2014). In this study only *E. connexa* was caught in soils of lettuce and tomato crops and it behaved as a dominant species in five out of six assemblages. This is a common ladybird in many other horticultural crops in the region (Fogel et al. 2016). Its abundance is associated to aphids -its main prey- but also to sheltering and alternative food offered by other resources, such as non-crop plants (Bentancourt & Scatoni 2001, Dode & Romero Sueldo 2013). *Eriopis connexa* was collected year-round, with the exception of fall-winter lettuce crops, a result that could be explained by the characteristic overwintering aggregation habits of coccinelids (Koch 2003, Saini 2004). Among preys reported, *Aphis gossypii*, *Hyperomyzus lactucae, Macrosiphum euphorbiae* and *Myzus persicae* are common pests of horticultural crops (Molinari 2005, Fogel et al. 2016).

The Coleopteran assemblages displayed a lognormal distribution (Morin 1999) in conventional and organic tomato, and mostly in organic lettuce and conventional spring-summer lettuce crops, commonly found in rich communities (23 to 44 species). These communities are typically influenced by independent environmental factors, such as spatial and temporal patterns of plant and insect species, as in horticultural crops (Magurran 1988). Assemblages found in conventional lettuce crops adjusted to a log-series distribution. They were composed by 10 to 23 species, with common species having intermediate values of abundances. This species distribution model is common for small, stressed or pioneer communities (Morin 1999, Magurran 1988). The lettuce is cultivated throughout the year in the region. It has a productive cycle of approximately four months, after which it is removed, and the soil is carved again to start a new sowing period. This tillage activity certainly affects the edaphic fauna, promoting constant processes of colonization and replacement of species. In relation to similarity analyses, this study evidenced that epigeic coleopteran assemblages associated to *L. sativa* were clustered and differed from those registered in *S. lycopersicon*. Organic tomato crops were by far more diverse. In lettuce crops, species were markedly grouped according to cropping seasons (fall-winter and spring-summer), and cultural practices had less influence on the community structure. This result is coincident with Pedraza et al. (2010), who pointed out that seasonal patterns in life cycles can help reducing competence for food resources. In warmer months, assemblages were in general richer (37 vs. 23 species, Tables 1 to 3). Carabids were less abundant meanwhile curculionids were common in spring-summer months. Notably, *E. conexa*, which is dominant in most of assemblages, was absent in fall-winter conventional lettuce crops. This coccinelid can show resistance to widely used insecticides (Ferreira et al. 2013, Fogel et al. 2016, Santos et al. 2016, Spíndola et al. 2013). However, even when it has a polyphagous feeding habit, a decline in food availability in colder months can lead to overwintering behavior.

Generalist predators were dominant in all assemblages studied, and they may be playing an important role in reducing pest populations (Ghoneim 2014). Conservation and augmentative biological control programs based on the use of *E. connexa* are currently under study (Rocca et al. 2017, Silva et al. 2013). The Carabidae *P. striatulus, S. anthracinus, P. cordicollis,* and *P. bonariensis*, that preferably prey on lepidopteran and curculionid larvae (Bentancourt & Scatoni 2001, Cicchino & Farina 2007, Paleologos 2012) could also have potential as biocontrol agents. Several carabid species are commercially used, such as *Calosoma sycophanta* (L.) in North America to control the gypsy moth *Lymantria dispar* (L.). In Argentina, Tulli et al. (2009) found that *S. anthracinus* is a potential natural enemy against the gray field slug *Deroceras reticulatum*, a pest of lettuce crops, preying on eggs and juveniles. *Selenophorus* sp. is reported as a predator of *Tuta absoluta* (Meyrick) larvae, a key pest of tomato crops worldwide (Desneux et al. 2011, Ghoneim 2014).

General knowledge of soil fauna inhabiting horticultural crops, such as the coleopteran assemblages described in this paper, can help understanding the complex interactions they share, the processes in which they are involved, and ultimately be useful to design pest management strategies. Many of the epigeic coleopteran species are able to move vertically, connecting soil and canopy arthropod trophic webs. The potential of cultural practices that conserve soil generalist and oligophagous carabids, staphylinids and coccinelids has yet to be fully explored for pest control in these crops.

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SUPPLEMENTARY MATERIAL

Table SI. Species of Curculionidae collected by pit-fall trapping in lettuce and tomato crops, conventionally (CM) or organically (OM) managed, in spring-summer (SS) or fall-winter (FW) cycles, in Northern Buenos Aires province. Years: 2010-2013.
Table SII. Species of Carabidae collected by pit-fall trapping in lettuce and tomato crops, conventionally (CM) or organically (MO) managed, in spring-summer (SS) or fall-winter (FW) cycles, in Northern Buenos Aires province. Years: 2010-2013.
Table SIII. Species of Staphylinidae collected by pit-fall trapping in lettuce and tomato crops, conventionally (MC) or organically (MO) managed, in spring-summer (SS) or fall-winter (FW) cycles, in Northern Buenos Aires province. Years: 2010-2013.

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Authors contributions

JR carried out the field work. JR, NC, ASM and MCP made the taxonomic identifications of coleopterans. JR and MGL performed the data analyses and the interpretation of results. MGL wrote the manuscript with support from JR, NC, AS and MCP. MGL and NC supervised the project. All the authors have read the final manuscript and approved the submission.