ARTHROPOD FAUNA OF WINTER WHEAT OF SOUTHWEST BUENOS AIRES PROVINCE, ARGENTINA

Gabriel Pompozzi*, Nelson Ferretti, Sofía Copperi*, Miguel Simó*** and Adriana A. Ferrero***

* Laboratorio de Zoología de Invertebrados II, Departamento de Biología, Bioquímica y Farmacia, Universidad Nacional del Sur, San Juan 670 (8000), Bahía Blanca. Provincia de Buenos Aires, ARGENTINA.
** Centro de Estudios Parasitológicos y de Vectores CEPAVE (CCT-CONICET) (UNLP), Calle 2 N°584 (1900), La Plata. Provincia de Buenos Aires, ARGENTINA.
*** Sección Entomología, Facultad de Ciencias, Universidad de la República, Iguá 4225 (11400), Montevideo. URUGUAY. E-mail: gabrielpompozzi@conicet.gov.ar

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ABSTRACT: Agroecosystems are populated by a great diversity and number of invertebrates that are often disturbed by agricultural practices and grazing. The arthropods are good indicators of the heterogeneity of the habitat, the biodiversity of the ecosystem and the stress conditions of the environment, therefore its use for environmental management can reduce pest invasion. The goals of this study are to describe the composition of the arthropod fauna and to analyze how this fauna are distributed throughout the phenological development in a crop of winter wheat at southwestern Buenos Aires Province. Two sampling methods were conducted: at ground level by using pit-fall traps and herbaceous level using a garden-vacuum. A total of 29608 arthropods were collected belonging to 19 orders. The most abundant order was Diptera, followed by Hemiptera, Collembola, Hymenoptera, Acarii, Coleoptera and Araneae. The abundance of the arthropod community associated with the crop increased in the last phenological stages of it. This study comprises one of the first approaches involving the study of the arthropod fauna associated with a winter wheat crop at southwestern Buenos Aires Province, and also is one of the few contributions about this topic in Argentina.

KEY WORDS: composition, abundance, cereal crop, Argentina.

Agroecosystems are often disturbed by agricultural practices and grazing (Thorbek, 2003). These disturbed areas are populated by great diversity and number of invertebrates. The large-scale studies have provided overviews of the effects of crops on populations of invertebrates, resulting in a reduction both in abundance and species diversity increasing the cultivated fields (Kladviko, 2001; Aparicio et al., 2003; Postma-Blaauw et al., 2010). The level of internal regulation of the functions of the agro-environment is partly dependent on the diversity of plants and animals (Altieri, 1994). Biodiversity supports the production of certain ecological services including recycling of nutrients, regulation of local microclimate and hydrological processes, suppression of undesirable organisms and detoxification of harmful chemicals (Altieri, 1999). The indiscriminate use of agrochemicals to combat pests and weeds, one of the traditional farming practices, produce indirect effects, such as the reduction of natural enemies (Bell et al., 2002; Liljesthrom et al., 2002). Strategies for a conservational biological control promote the rational use of chemicals combined with increasing the habitat heterogeneity (Settle et al., 1996). The managing of the habitat (spatial and temporary arrangements of the vegetation) in the agroecosystems can reduce the invasion of pests by means of the top-down effects that operates with the increase of natural enemies (Altieri, 1994); or also the pests can be suppressed by the bottom-up effects that operates in the first trophic level (vegetation) for the diversity of habitat (Andow, 1991). The type and abundance of the wished biodiversity depends on the structure and managing of the agroecosystem of interest (Landis et al., 2000; Nicholls & Altieri, 2002). Due to their small size, diversity and high sensibility to the variations of the environment, arthropods could be good indicators of the heterogeneity of the habitat, the biodiversity of the ecosystem and the stress conditions of the environment (Weaber, 1995; Andersen & Majer, 2004). Herbivorous insects achieve higher levels of abundance and, on the other side, natural enemies achieve lower levels in agricultural systems than in a diversified habitat (Andow, 1991; Tohasca, 1993). The monoculture, by eliminating plant diversity, reduces the sources of food and shelters to herbivorous insects and also to their natural enemies, leading to an undesirable damage of insect pest (Altieri, 1999). Moreover, direct seeding, as a result of the absence of ground management and the presence of stubble on the surface, creates an environment that, unlike the conventional tillage, favors the development of populations living in the soil (Lietti et al., 2008). In this system, the fauna is more diverse and abundant and there is a tendency to the restoration of the native one (Neave & Fox, 1998). However, this trend varies with the season, the age of the system, the sequence of crop and the group of arthropod considered (Rodriguez et al., 2006). In addition, with direct sowing it is necessary the application of herbicides to avoid the development of weeds, which are harmful to the insects in general, including the beneficial ones (Benamú et al., 2010). Using the conventional tillage of the soil it is not necessary to apply pesticides, and with a good rotation of the cultivated soils it is possible to diminish the deterioration of the same ones. Nevertheless, this managing of the soil diminishes the number of generalist predators, which can migrate and shelter in the edges of the crops (Thorbek & Bilde, 2004). Therefore, a habitat of considerable importance in agroecosystems is the constituted for the spontaneous vegetation existing in the edges of the cultures, which are a reservoir for the arthropods and other general predators (Thorbek & Bilde, 2004). Additionally, they work as a place from where certain species can colonize the crops (Nyffeler et al., 1992). Annual crop fields are often surrounded by margin habitats with perennial or annual non-crop vegetation (Denys & Tscharntke, 2002). The wheat (*Triticum aestivum* L.) is an annual crop and is the most important winter cereal of the central-south of Buenos Aires province, Argentina (Carrasco & Baez, 2006). The knowledge of how entomofauna interacts with winter cereals in this country is scarce, with few studies above coleopteran, aphids and spiders (Marasas et al., 1997; Reviriego et al., 2006; Armendano & Gonzalez, 2011). The aims of this study are to make a description of the composition of the arthropod fauna present in a crop of winter wheat, to determine how arthropods are distributed throughout the phenological development of the crop and to analyze the gradient of abundance of arthropods from the center of the crop toward the edge (area of spontaneous vegetation).

MATERIAL AND METHODS

Study site

The study was conducted in a field located at Southwest of Buenos Aires province, Argentina (38° 20’ 09” S; 62° 42’ 44” W) (Fig. 1). In this area, a winter wheat field of approximately 54 ha. was located. In the cultivated field it has not been applied pesticides for the last 30 years. The crop was set in August 2010 (winter in southern hemisphere) and harvested in December 2010 (beginning of summer in southern hemisphere). The sowing method was conventional, with plowed before planted. The crop field was surrounded of spontaneous vegetation, where species of Poaceae and Brassicaceae are dominant, like *Nasella caudata* Trin., *Amelichloa ambigua* Speg. and *Diplotaxis tenuifolia* L. (DC.), between others. The study site was located in an area of temperate climate with an annual average temperature of 14° and an annual average rainfall of 670 mm.

Sample design and data analysis

Two sampling methods were used: one covering ground level and another one in the herbaceous level. Pit-fall traps were used for the ground level sampling. The traps consisted in plastic cups of 9 cm of diameter and 16 cm of high, filled with ethylene-glycol (20%), water and a few drops of detergent. Plastic roofs were placed on pit-fall traps to avoid inundations of traps. Traps were refilled every 15 days and 10 traps were used in a straight line from the center of the crop to the boundary and edge of crop (trap number 1 in the center of crop and trap number 10 in the edge). In total, eight dates of sampling were obtained. The herbaceous stratum was sampled with a modified garden-vacuum (G-Vac). Each sample units consisted in one minute duration of vacuum. One sample and two replicates were obtained for each collector on each sampling area. Three collectors sampled in four different areas: crop center, between center and boundary, boundary and in the edge of crop, resulting in a total of 36 samples of G-Vac per date. Three sampling dates were carried out corresponding with the last three months of the crop, where the aerial portion of the plant was conspicuous. Voucher specimens were deposited in Laboratorio de Zoología de Invertebrados II (Universidad Nacional del Sur, Bahía Blanca). Cluster analysis with Bray-Curtis similarity indices were used to compare the arthropod composition in the crop-edge gradient with the program PAST v 1.89 (Hammer et al., 2001).

RESULTS AND DISCUSSION

Diversity and abundance of arthropods

A total of 29608 arthropods were collected belonging to 19 orders (Fig. 2). The most abundant was Diptera (7473, 25.2%), followed by Hemiptera (6771, 22.9%), Collembola (5119, 17.3%), Hymenoptera (2931, 9.9%), Acarii (2787, 9.4%), Coleoptera (2173, 7.3%) and Araneae (1343, 4.5%). These seven orders comprise the 96.6% of the total. The abundance of the arthropod community associated with the crop increased in the last phenological stages of it (Fig. 3). This increment is expected due to an increase in both temperature and crop leaf cover in the later stages of growth of the wheat. The orders Hemiptera, Diptera and Orthoptera showed a markedly increased in their abundance in the last two phenological stages of the wheat (spike and grain maturity), while other abundant arthropods orders, like Hymenoptera, Collembola and Acarii maintained constant values of abundance during all the stages of the crop. The sharp increment of the order Orthoptera could be explained by an increased in food availability, as this order is herbivore (Thomas & Marshall, 1999). Moreover, orders like Collembola and Acarii are associated with soil, and possibly for this reason its abundance does not vary significantly with increasing field herbaceous cover (Lindberg & Bengtsson, 2005).

Arthropods at herbaceous level

In herbaceous level 10871 specimens were collected distributed in 14 orders. A high abundance of herbivorous insect was observed within the crop, diminishing it as reaching the boundary and being less abundant in the edge. At this stratum, the order Hemiptera was the most abundant comprising 51.5% of specimens collected at herbaceous level, followed by Diptera (15.7%), Hymenoptera (11.8%), Coleoptera (8.7%) and Araneae (7.2%). These orders completed the 95% of total captured with G-Vac. The order Hemiptera was highly abundant within the crop, both in center (2315 specimens) and in the area placed between the center and the boundary of the crop (2057), diminishing their abundance in the boundary (833) and in the edge (392). The Hemiptera, are benefited by monoculture (Ruiz et al., 2003). Moreover, the spiders, being the most abundant within the generalist predators, maintained a constant number in all sampled areas of the crop, even out of crop. Spiders increase their abundance and diversity in a heterogeneous environment (Settle et al., 1996). Armendano & González (2011) found that the field margins constitute the most rich and dense habitats for spiders in a winter wheat field at northeastern of Buenos Aires Province. However, in this study spiders conserve similar abundances within and out of crop. The Cluster analysis obtained with the Bray-Curtis similarity index showed more similarity between the two areas within the crop, and the area outside the crop was excluded by the analysis, showing the lowest similarity with the remained areas (Fig. 4).

Arthropods at ground level

At this stratum, 18737 arthropods were collected belonging to 17 orders. The most abundant orders collected with pit-fall traps were Diptera (30.7%) and Collembola (27%). At the ground level, like in herbaceous level, an increase of the abundance of the orders Hemiptera and Orthoptera were observed in the last phenological stages of the wheat crop. The Collembola (springtails) are sensitive to soil management systems (Lindberg & Bengtsson, 2005) and in this study, they were the second most abundant order at ground stratum. The conventional tillage possible may not produce drastic effects on the soil microfauna due to the great abundance of springtails. Nonetheless, more exhaustive studies are needed for discuss the effects of conventional tillage over the entomofauna. No variation in the abundance of arthropods along the crop-edge gradient was observed. Cluster analysis grouped the traps within the crop and excluded the trap number 10 located at further edge, with the exception of the trap number 3, which showed the most differences (Fig. 5). Trap number 3 may have differed by a high abundance of Diptera compared with the remaining traps. The trap number 10 is out of wheat crop, and this area has vegetation with high floral and structural diversity that generally tends to present high invertebrate diversity (Thomas & Marshall, 1999). However, in this study, a higher diversity in the edge of crop was not observed, but more extended studies are needed to understand about how arthropods interact with the agroecosystems at Buenos Aires Province.

CONCLUSIONS

This study comprises one of the first works on the arthropod fauna associated with a winter wheat crops at Southwestern Buenos Aires Province, and also is one of the few contributions on this topic in Argentina. While these results should be improved with future studies, for example, in more than one season, the results presented here indicate high values of abundance of arthropods in wheat. The absence of pesticides in this area could be reflected by the abundance of certain groups considered as pests, however, a highly abundance of generalist predators can be found. Therefore, it is of considerable interest to start thinking more at level of biological control and integrated pest management before proceeding with an indiscriminate use of agrochemicals.

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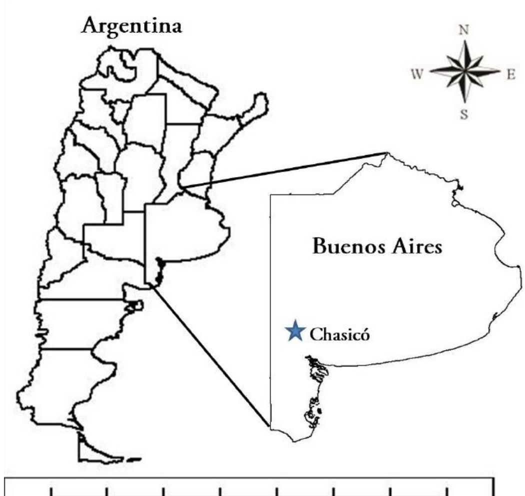

Figure 1. Geographic location of the study area (Chasicó, Buenos Aires province, Argentina).

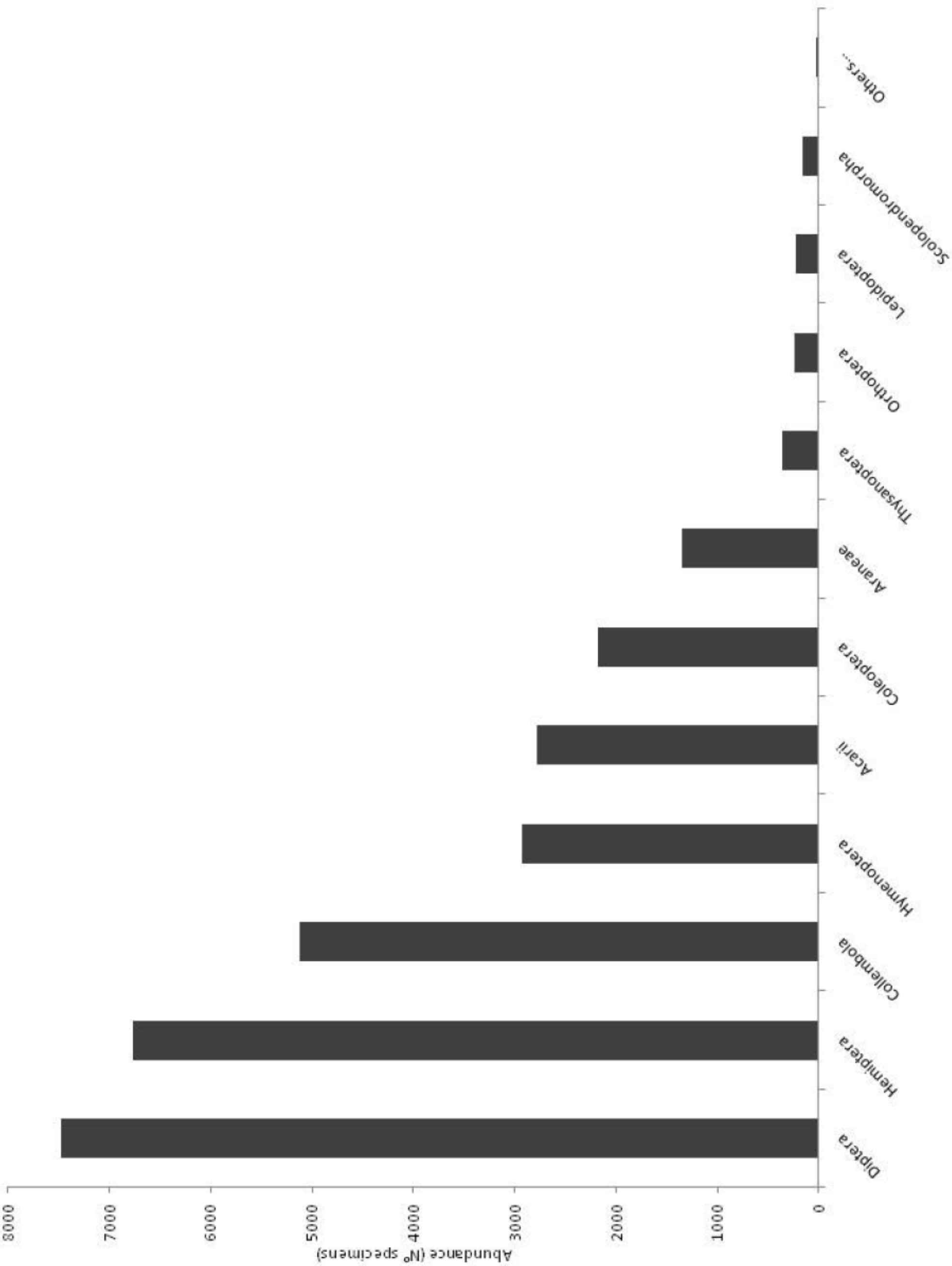

Figure 2. Abundance of arthropod orders collected from wheat crop.

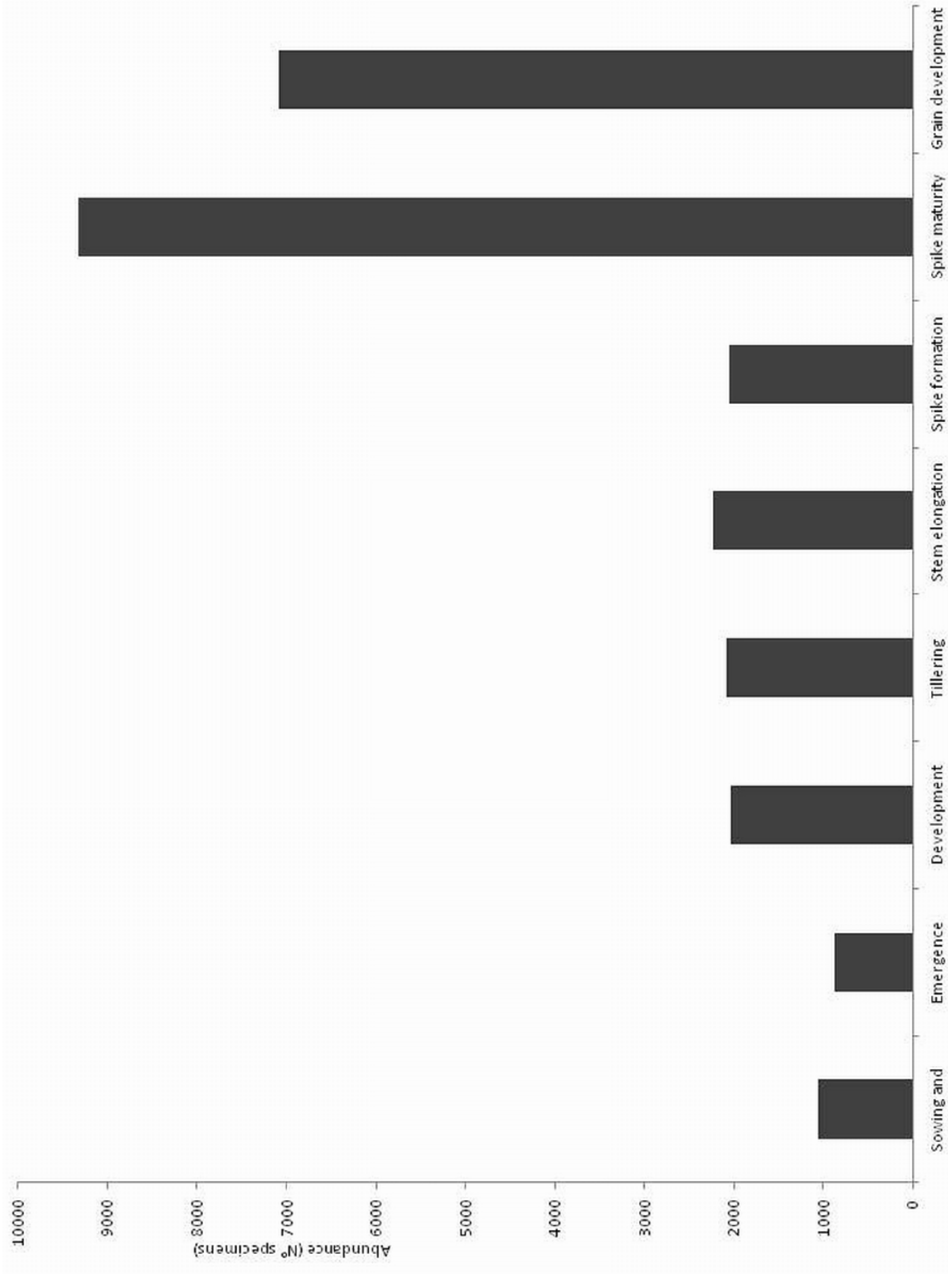

Figure 3. Abundance of arthropods associated with different phenological stages of wheat crop.

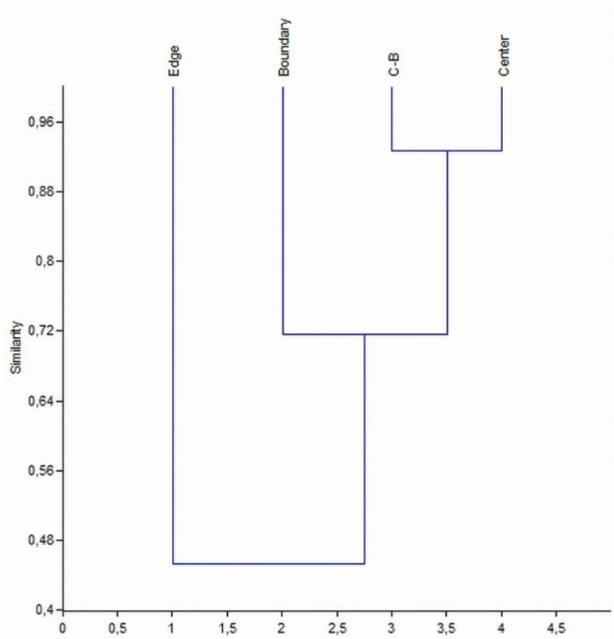

Figure 4. Cluster analysis resultant with the Bray-Curtis similarity index of the crop-edge gradient in the herbaceous level.

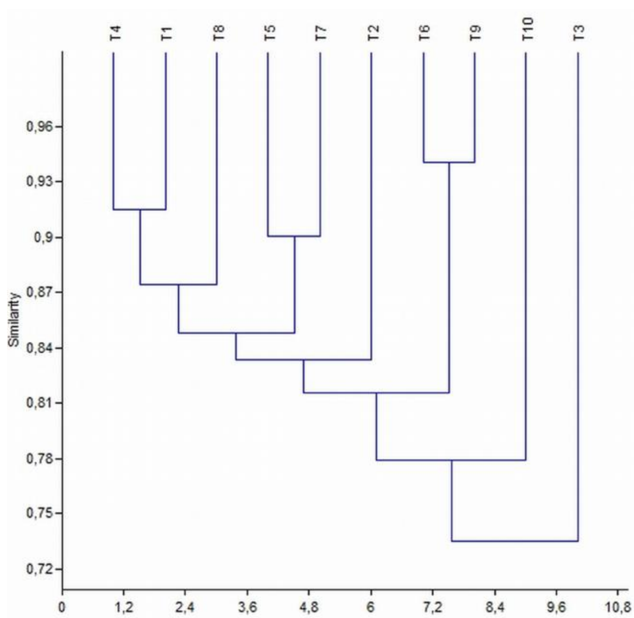

Figure 5. Cluster analysis resultant with the Bray-Curtis similarity index of the crop-edge gradient in the ground level.