POPULATION FLUCTUATIONS OF FORMICIDAE (HYMENOPTERA) AND ARANEAE (ARACHNIDA) IN TWO TILLAGE SYSTEMS IN THE REGION OF GUAÍRA-SP.

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Abstract

The objective of this study was to elucidate population fluctuations of spider and ant species in forest fragments and adjacent soybean and corn crops under no-tillage and conventional tillage systems, and their correlations with meteorological factors. From Nov 2004 to Apr 2007 sampling of these arthropods at Guaíra, Sao Paulo state was done biweekly during the cropping season and monthly during the periods between crops. To obtain samples at each experimental site, pitfall traps were distributed in 2 transects of 200 m of which 100 m was in the crop, and 100 m was in the forest fragment. Temperature and rainfall were found to have major impacts on fluctuations in population densities of ants of the genus, *Pheidole,* in soybean and corn crops both grown with conventional tillage and no tillage systems.

Key Words: population dynamics, weather, predators, biodiversity.

Resumo

O objetivo deste estudo foi obter a flutuação populacional e a correlação com fatores meteorológicos de espécies de aranhas e formigas em fragmento florestal e cultura de soja/milho sob sistemas de plantio direto e convencional. As amostragens dos insetos foram realizadas no período de novembro/2004 a abril/2007 em Guaíra, SP, sendo quinzenal durante o período de safra e mensal nas entressafras. Para a obtenção das amostras utilizou-se armadilhas de solo distribuídas em dois transectos de 200 m de comprimento, sendo 100 m na cultura e 100 m no fragmento. A influência da temperatura e da precipitação pluvial prevalece sobre formigas do gênero *Pheidole*, respectivamente, em cultura de soja/milho sob sistema de plantio convencional e sistema de plantio direto.

Palavras-Chave: dinâmica populacional, condições meteorológicas, predadores.

The growing concerns for the environment and quality of life require increasingly the adoption of agricultural production methods that are ecologically less aggressive and socially just. The increased productivity of agricultural crops required to meet the growing demand for food has driven a large consumption of pesticides (Zilli et al. 2003). From the technological point of view, ecologically based agriculture is the most appropriate choice for the sustainability of rural areas. Systems developed based on ecological improvement can help increase biodiversity (Gliessman 2001).

Forest fragments are considered natural habitats for predatory insects that can favor and promote their occurrence in crops. These components have economic value and they should be maintained or incorporated in agroecosystems (Asteraki et al. 1995). The diversity and abundance of insect predators is related to the farm type, and the presence of forest and other habitats in the vicinity of crops (Carcamo et al. 1995; Kromp 1999; Pfiffner & Luka 2000). The occurrence of arthropod predators in agroecosystems is also related to microclimatic conditions (Döring & Kromp 2003), especially the temperature and soil moisture (Camero 2003; Mircea 2004; Álvarez Duarte & Barrera-Catano 2007).

Studies on the species composition, distribution and habitat preferences of insect predators in crops and forest fragments are fundamental to understand the role that these organisms can play in biological control through habitat manipulation in agro-ecosystems (Holland et al. 1999.).

In this study we performed a population survey of spiders and ants in two areas, which consisted of (i) a forest fragment and soybean/corn under no-tillage and (ii) a forest fragment and soybean/corn under conventional tillage. The objective of this study was to evaluate the population fluctuations of ants and spiders, and the influence on their populations of weather and habitat preferences.

Materials and Methods

The study was conducted at 2 experimental sites located near Guaira City, Sao Paulo State, and at the Laboratório de Ecologia de Insetos-Faculdades de Ciências Agrárias e Veterinárias (FCAV), Universidade Estadual Paulista (UNESP), Jaboticabal Campus, Sao Paulo State .

Experimental Site 1 (Forest Fragment and Adjacent No-Tillage Field)

Experimental Site 1 was located on a farm known as "Shed" at latitude S 20° 21' 10' W 48° 14 47' with a Hapludox soil type. The experimental site consisted of a 48-ha fragment of semi-deciduous forest, and an 88.6-ha field that has been devoted to a no-till system for the past 10 yr. A summer soybean *Glycine max* (L.) Merrill crop and a winter corn (*Zea mays* (L.)) crop are regularly grown in this field.

Soybean crops were grown in both experimental sites during the 2004/05, 2005/06 and 2006/07 seasons with 0.50 m spacing between rows. Corn

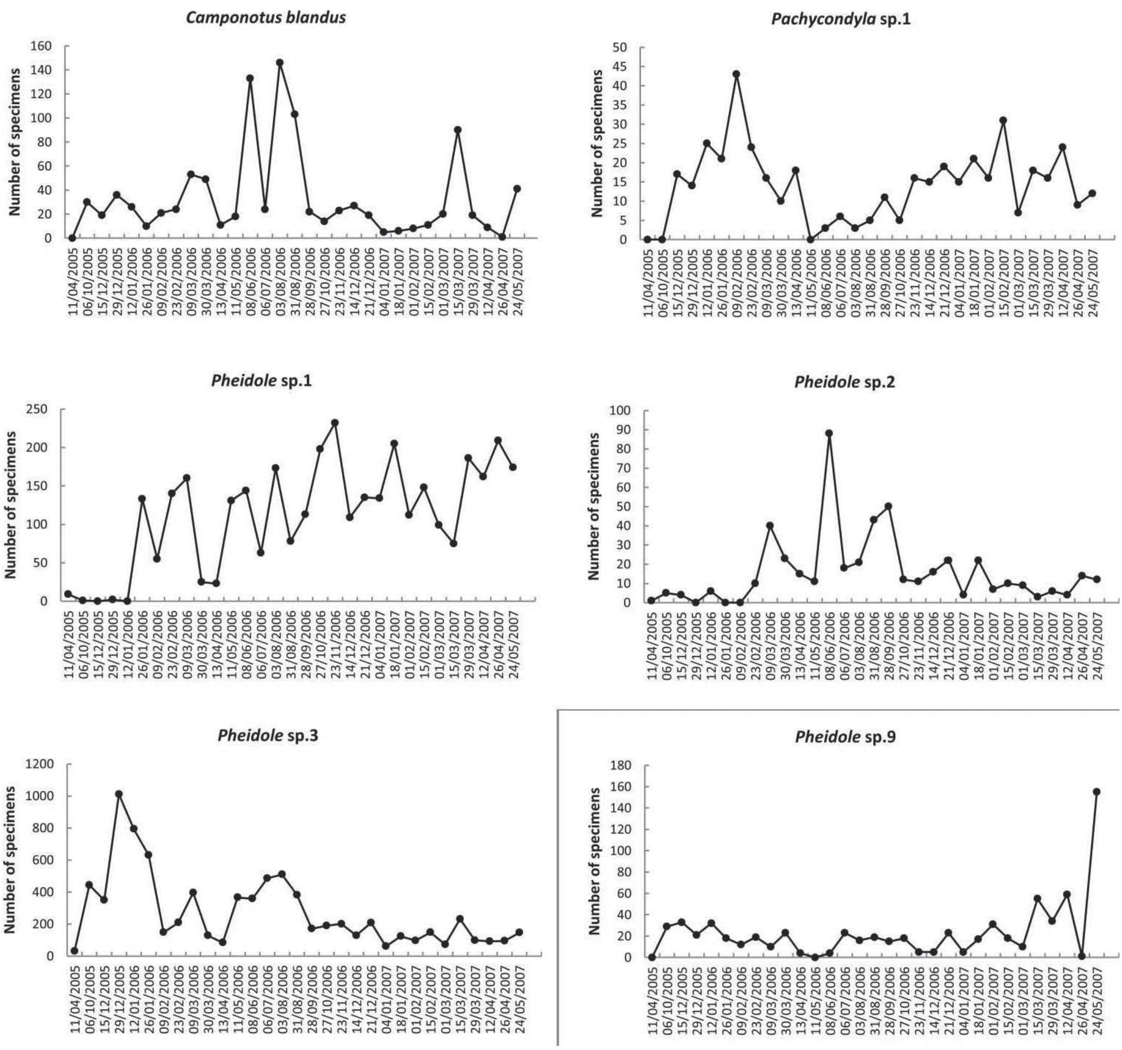

Fig. 1. Fluctuation of Formicidae species populations near Guiara-SP in Experimental Site 1 consisting of a forest fragment and a no-tillage field with soybean was grown in the rainy season (sowing in mid-Nov and harvesting in Apr or early Mar) and corn was grown in the drier off-season (sowing in early Mar and harvest from early to late June). Each data point in the charts represents the combined catch over a 7-d period of 104 pitfall traps, i.e., 48 in the forest fragment, 48 in the cropped field and 8 in the interface between the forest and the field.

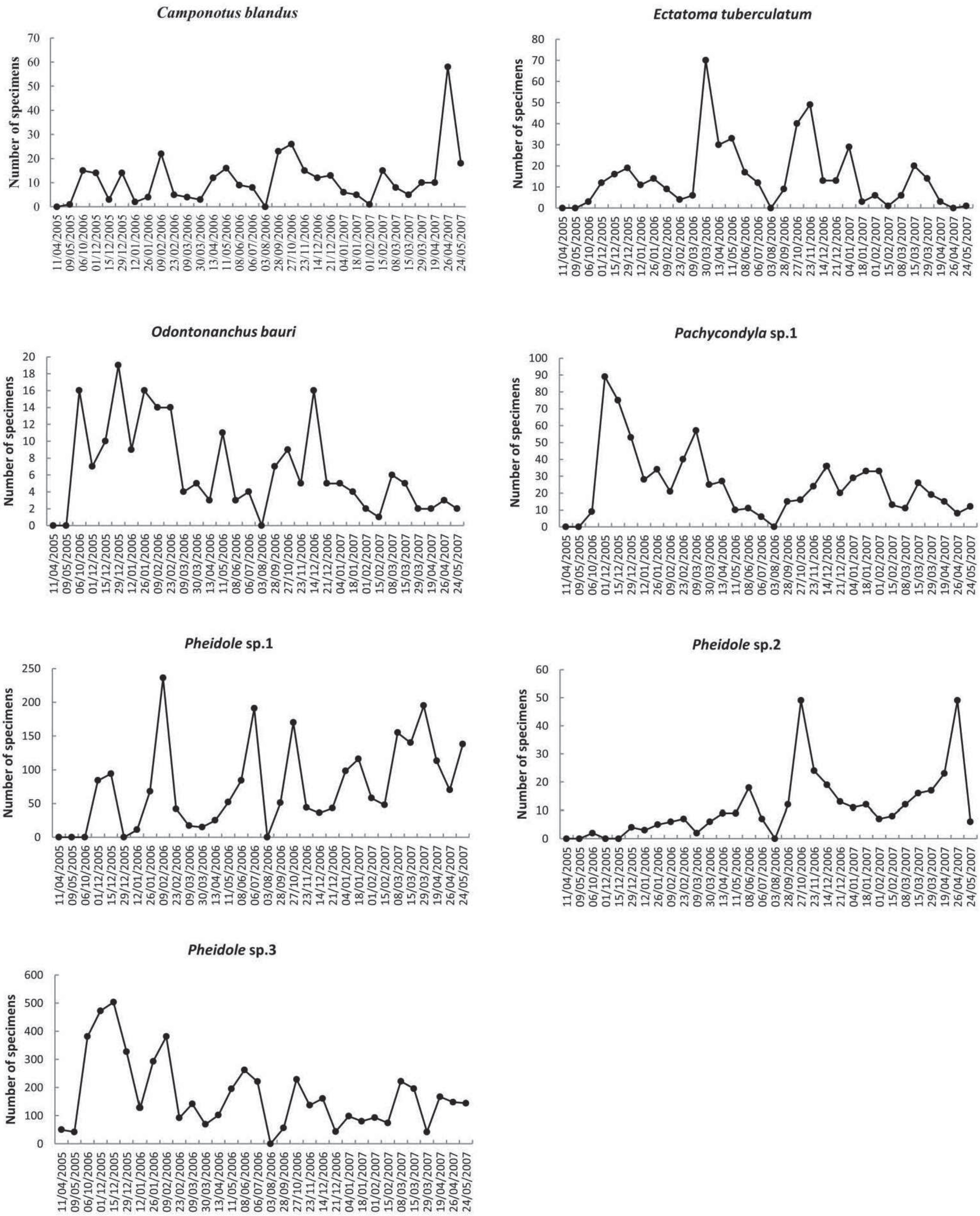

Fig. 2. Fluctuation of Formicidae species populations near Guiara-SP in Experimental Site 2 consisting of a forest fragment and a conventional-tillage field with soybean grown in the rainy season (sowing in mid-Nov and harvesting in Apr or early Mar) and corn was grown in the drier off-season (sowing in early Mar and harvest from early to late June). Each data point in the charts represents the combined catch over a 7-d period of 104 pitfall traps, i.e., 48 in the forest fragment, 48 in the cropped field and 8 in the interface between the forest and the field.

was grown in the dry season with 0.80 m spacing between rows. In the 2004/05 season sowing was accomplished on 16 Nov 2004 and harvesting occurred on 2 Mar 2005. During this growing season 2 applications of insecticides were made on 8 Dec 2004, i.e., monocrotophos on (40% - the dose of

0.41 L/ha) to control the soybean caterpillar -(*Anticarsia gemmatalis* Hueb.) and methamidophos (60% - dose 0.62 L/ha) applied on to control the hemipteran pests, *Nezara viridula* L., *Euschistus heros* (F.), and *Piezodorus guildinii* (Westwood). In the off-season corn crop seeding occurred on 3 Mar 2005 and harvesting on 05/08/2005. One application of lufenuron (50%) at a rate of 310 mL/ha was made on 27 Mar 2005 to control the fall Armyworm, *Spodoptera frugiperda* (J. E. Smith). In the 2005/06 season soybean sowing and harvesting occurred on 27 Nov 2005 and on 15 Mar 2006, respectively. Two applications of insecticides were made, i.e., methamidophos (60% - dose 1.0 L/alq [= 413 mL/ha]) on 13 Jan 06 and agrophos (1.5 L/alq [= 620 mL/ha]) on 15 Feb 2006, to control the soybean looper, *A. gemmatalis*. In the offseason corn sowing took place on 17 Mar 2006 and the harvesting on 21/06 / 2006 with no insecticide applications being made during this period. In the 2006/07 season, soybean seeding was performed on 13 Nov 2006 and harvesting on 28/02/2007, Methamidophos (60% - dose 1.0 L / alq) was applied on 11 Jan 2007 and on 11 Feb 2007 to control the soybean looper, *A. gemmatalis*. The subsequent corn sowing and harvesting occurred on 02 Mar 2007 and 08 Jun 2007, respectively; and during this period the insecticide, Spinosad (120 mL/alq [= 50 mL/ha]) was applied on 25 Mar 2007 to control *S. frugiperda*.

Experimental Site 2 (Forest Fragment and Adjacent Conventional Tillage Field)

Experimental Site 2 was located in a wetlands area at S 20° 19' 29' W 48° 15' 06' with a Hapludox soil type. This site was about 2 km distant from site 1, and consisted of a 6-ha fragment of semideciduous forest and a 12-ha field with conventional tillage used to produce a soybean summer crop of and a winter corn crop.

All agronomic operations were conducted on this site in the same manner and on the same dates as at Experimental Site 1.

Sampling Ant and Spider Populations

Insects were sampled with pitfall traps, each consisting of a plastic cup (8 cm diam and 14 cm high) filled up to one third of its height with a solution of water, 1% formaldehyde and detergent. The trap was placed into another similar plastic cup that had been installed in the soil so that its rim was about 1 cm below the soil surface; the upper rim of the trap was level with the soil surface. The bottom of the lower cup was perforated

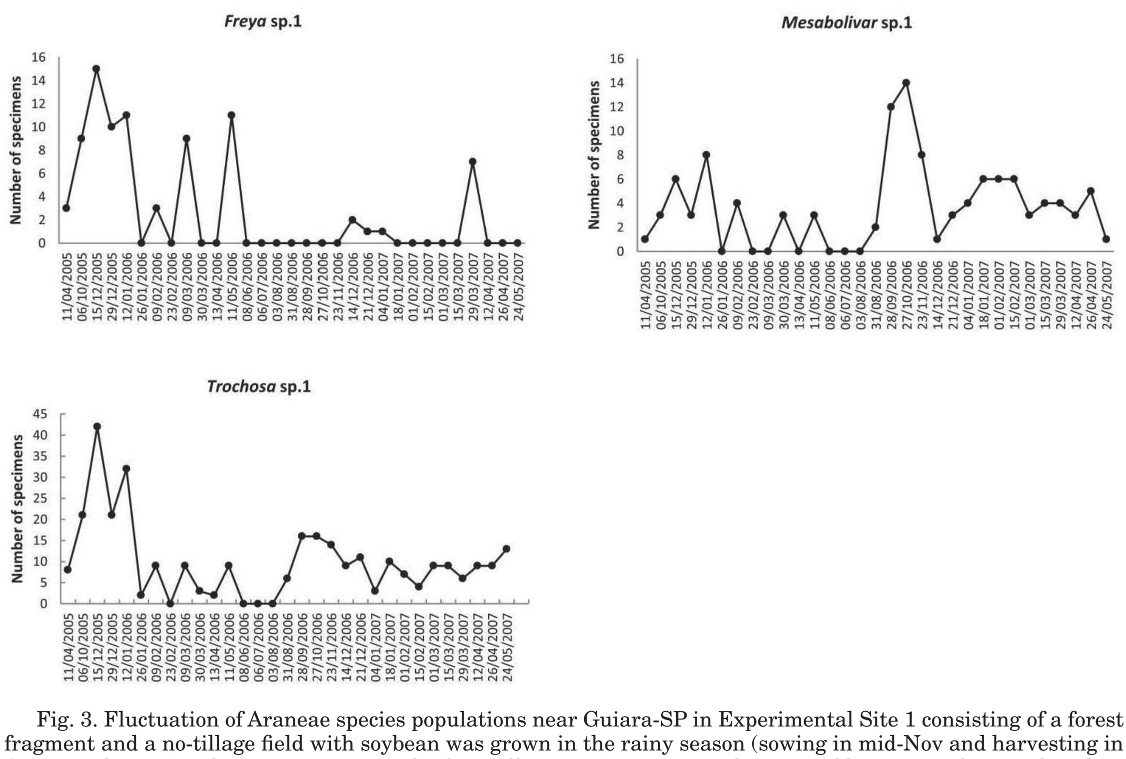

Fig. 3. Fluctuation of Araneae species populations near Guiara-SP in Experimental Site 1 consisting of a forest fragment and a no-tillage field with soybean was grown in the rainy season (sowing in mid-Nov and harvesting in Apr or early Mar) and corn was grown in the drier off-season (sowing in early Mar and harvesting from early to late June). Each data point in the charts represents the combined catch over a 7-d period of 104 pitfall traps, i.e., 48 in the forest fragment, 48 in the cropped field and 8 in the interface between the forest and the field.

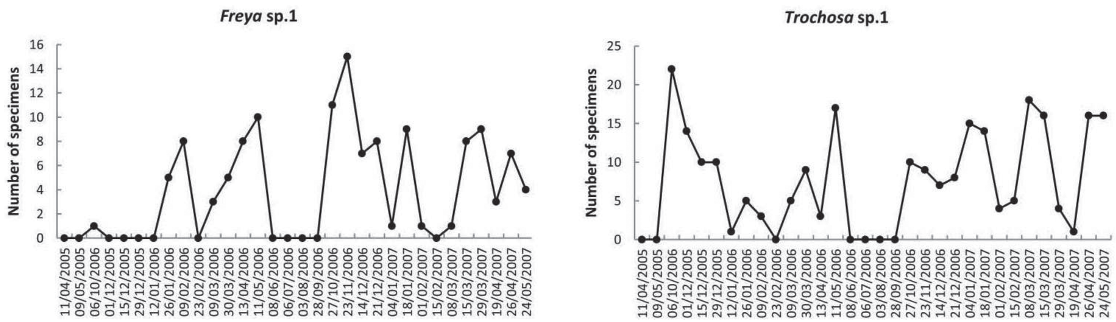

Fig. 4. Fluctuation of Araneae species populations near Guiara-SP in Experimental Site 2 consisting of a forest fragment and a conventional-tillage soybean was grown in the rainy season (sowing in mid-Nov and harvesting in Apr or early Mar) and conventional-tillage corn was grown in the drier off-season (sowing in early Mar and harvesting from early to late June). Each data point in the charts represents the combined catch over a 7-d period of 104 pitfall traps, i.e., 48 in the forest fragment, 48 in the cropped field and 8 in the interface between the forest and the field.

to allow drainage and a 15 cm diam plastic cover affixed to 3 legs was placed at 7.6 cm (3 in) above each trap to prevent rain from filling the trap.

In each experimental area 2 parallel transects were installed separated 10 meters from each other. Each transect had 24 traps distributed along a 100 m line in the crop and 24 traps along a 100 m line in the forest fragment; hence a total of 48 traps/site.

Within the crop and the forest fragment, the traps were placed every 10 m, while at the interface the traps were spaced every 1 m. Thus 4 traps/transect were installed at the interface.

Samples were taken every other wk during the rainy season and monthly in the dry season, corresponding to the period between 6 Oct 2005 to 24 May 2007, totaling 30 sampling dates. During each sampling event traps remained installed in the field for a wk. After this period the traps were removed and sent to the laboratory for sorting, assembly and subsequent identification of insects.

In order to compare the influence of the forest fragment on ant and spider populations in the 2 tillage systems throughout the growing season, the trap catch data were charted. Thus, each data point in the charts represents the combined catch over a 7-d period of 104 pitfall traps, i.e., 48 in the forest fragment, 48 in the cropped field and 8 in the interface between the forest and the field.

The population dynamics study considered only the dominant species of ants and spiders found in the study presented in Haddad et al. (2011). The influence of meteorological factors on the abundance of adult ants and spiders were evaluated by "stepwise" multiple regression analysis with a 5% significance level. The meteorological factors considered were maximum and minimum temperatures (°C) and precipitation (mm) recorded at the Meteorological Station of the Agronomic Institute - Regional Office Guaira-Sao Paulo, 5 km distant from the study sites. Temperatures were represented by the monthly average, while rainfall was considered the sum recorded monthly. Only species of ants and spiders with 10 or more individuals captured during the sampling period were considered in the analysis.

Results and Discussion

Fluctuation of the population of the ant, *Pheidole* sp. 3 (big-headed ants, Formicidae: Myrmicinae), in the site with the no-tillage system reached a peak on 29 Dec 2005 and again on 03 Aug 2006 (Fig. 1). Also at this site, *Pheidole* sp. 1 and sp. 2 presented several population peaks during the study period but the highest peak of *Pheidole* sp. 1 occurred on 23 Nov 2006 and the major peak of *Pheidole* sp. 2 was observed on 08

Table 1. Multiple correlation coefficients between meteorological factors and ants captured in soybean/corn in a conventional tillage field adjacent to a forest fragment at Guaíra, Sao Paulo State from Nov 2004 through Apr 2007.

Species	Intercept	Temp. Maximum	Temp. Minimum	Precpitation Rain	*F*	R^2
Pheidole sp.4	-31,2883	1,0399	—	—	3,62*	0,1108
Pheidole sp.9	-37,1329	1,1662	—	—	4,67*	0,1823

*Significant at 5% probability.

TABLE 2. MULTIPLE CORRELATION COEFFICIENTS BETWEEN METEOROLOGICAL FACTORS AND ANTS CAPTURED IN A FOREST FRAGMENT ADJACENT TO A CLEARED FIELD PLANTED TO SOYBEAN/CORN UNDER CONVENTIONAL TILLAGE AT GUAÍRA, SAO PAULO STATE FROM NOV 2004 THROUGH APR 2007.

Specie	Intercept	Temp. Maximum	Temp. Minimum	Precipitation Rain	*F*	R^2
Pheidole sp.9	51,0078	-2,2337	2,5490	—	7,91**	0,3609

** Significant at 5% probability.

TABLE 3. MULTIPLE CORRELATION COEFFICIENTS BETWEEN METEOROLOGICAL FACTORS AND ANTS CAPTURED IN A SOYBEAN/CORN FIELD UNDER NO-TILLAGE ADJACENT TO A FOREST FRAGMENT AT GUAÍRA, SAO PAULO STATE FROM NOV 2004 THROUGH APR 2007.

Specie	Intercept	Temp. Maximum	Temp. Minimum	Precipitation Rain	*F*	R^2
Pheidole sp.3	212,643	—	—	-1,3826	5,85*	0,1678
Camponotus blandus	109,8012	-4,9989	—	—	8,31**	0,2227
Odontomachus bauri	79,1981	-2,1375	—	—	5,44*	0,1578

**,* Significant at 5% probability.

TABLE 4. MULTIPLE CORRELATION COEFFICIENTS BETWEEN METEOROLOGICAL FACTORS AND ANTS CAPTURED IN A FOREST FRAGMENT ADJACENT TO A CLEARED FIELD PLANTED TO SOYBEAN/CORN UNDER NO-TILLAGE AT GUAÍRA, SAO PAULO STATE FROM NOV 2004 THROUGH APR 2007.

Specie	Intercept	Temp. Maximum	Temp. Minimum	Precipitation Rain	*F*	R^2
Camponotus blandus	109,7491	—	-4,9530	—	12,90**	0,3007
Pseudomyrmex sp.	33,8691	—	-1,4545	—	4,74*	0,1365

**,* Significant at 5% probability.

June 2006. *Pheidole* sp. 9 only showed 1 peak on 24 May 2007 (Fig. 1). The species *Camponotus blandus* Smith (Formicidae: Formicinae) had the highest population peak on 3 Aug 2006, and soon thereafter there was a decline in density until the population peaked again on 15 Mar 2007.

In regard to the site under conventional tillage, *Pheidole* sp. 1 and *Pheidole* sp. 3 showed numerous population peaks (Fig. 2). The highest peaks of *Pheidole* sp. 1 occurred on 09 Feb 2006, 06 Jul 2006 and 29 Mar 2007, whereas *Pheidole* sp. 3 was more abundant on 15 Dec 2005. *Pheidole* sp. 2 had only two population peaks (27 Oct 2006 and 26 Apr 2007). Another dominant ant species, *Odontomachus bauri* Emery (a trap jaw ant, Formicidae: Ponerinae), had many population peaks, especially large were those observed on 29 Dec 2005 and 14 Dec 2006. *Pachycondyla* sp. 1 (Formicidae: ponerinae) had the highest population peak on 01/12/2005 and *Ectatoma tuberculatum* (Formicidae: Ectatomminae) on 30 Mar 2006.

The results of the population dynamics of spiders indicated that the wolf spider species *Troshosa* sp. 1 (Araneae: Lycosidae) had the highest population peaks in the no-tillage site on 10 June 2005 and 28 Sep 2006 (Fig. 3). The highest peak of the species *Mesaboliver* sp. 1 (Araneae: Pholcidae) was found on 27 Oct 2006, while *Freya* sp. 1 (Araneae: Salticidae) presented its population peak on 06 Oct 2005. In conventional tillage, the species *Troshosa* sp. 1 remained abundant, showing several population peaks especially on 06 Oct 2005, 11 May 2006 and 08 Mar 2007 (Fig. 4). The population of *Freya* sp. 1 fluctuated sporadically showing a population peak on 09 Feb 2006.

The analysis of meteorological factors and arthropods showed significant coefficients only for ant species. In the site cultivated under conventional tillage the abundance densities of *Pheidole* sp. 4 and *Pheidole* sp. 9 each had a positive and significant correlation with the maximum temperature (Table 1). These results suggest that the population density of these ants increased with the increase of temperature. In contrast, the abundance of *Pheidole* sp. 9 in the forest fragment was negatively correlated with maximum temperature and positively correlated with minimum temperature (Table 2).

In the site with the annual crops in a no-tillage system, the species *Pheidole* sp. 3 was negatively correlated with precipitation, suggesting a reduction in the occurrence of this species during rainy periods. *Camponotus* species *Odontomachus bauri and blandus* was negatively correlated with maximum temperature (Table 3). In forest fragments, the species *C. blandus* and *Pseudomyrmex* sp. were negatively correlated with the minimum air temperature (Table 4).

Conclusion

Temperature and precipitation strongly influence the population densities of ants of the genus *Pheidole* in soybean and corn crops under conventional and no tillage systems adjacent to forest fragments.

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