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Does organic management of agroecosystems contribute to the maintenance of the richness of ants?

O sistema de manejo orgânico de agroecossistemas contribui para a manutenção da riqueza de formigas?

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Abstract

Does organic management of agroecosystems contribute to the maintenance of the richness of ants? This study assessed the richness of ant species in organically farmed crop agroecosystems of different ages located in the southern state of Paraná, Brazil. During the sampling, the pitfalls that were active during May/August 2009 and from October 2009 to February 2010 were used. A total of 11,874 ants belonging to five subfamilies was sampled, comprising 18 genera and 48 species. The subfamily Myrmicinae (S = 27) had the highest richness, followed by the genera *Pheidole* (S = 10), *Solenopsis* (S = 7), Formicinae (S = 3), *Camponotus* (S = 5), and *Brachymyrmex* (S = 5). The average difference between the observed richness (Sobs) and the estimated richness (Chao2) was 10.9%. Ant assemblages belonging to agroecosystems under organic management for long times presented the greatest richness, indicating that this system contributes to the maintenance of ant diversity.
Key words: Atlantic forest. Biodiversity. Conservation. *Pheidole*. Richness.

Resumo

O sistema de manejo orgânico de agroecossistemas contribui para a manutenção da diversidade de formigas? Este trabalho avaliou a riqueza de formigas presentes em lavouras inseridas em agroecossistemas de manejo orgânico, com tempos de integralização diferentes, localizados no sul do Estado do Paraná, Brasil. Na amostragem, foram utilizadas *pitfalls* que permaneceram ativas nos períodos de maio a agosto de 2009 e outubro de 2009 a fevereiro de 2010. Foram amostradas 11.874 formigas pertencentes a cinco subfamílias, 18 gêneros e 48 espécies. Destacou-se em riqueza a subfamília Myrmicinae (S = 27) e os gêneros *Pheidole* (S = 10) e *Solenopsis* (S = 7). Também Formicinae (S = 3) e os gêneros *Camponotus* (S = 5) e *Brachymyrmex* (S = 5). A diferença média entre a riqueza observada (Sobs) e a estimada (Chao 2) foi de 10,9%. Assembleias pertencentes aos agroecossistemas com maior tempo de manejo orgânico foram as mais ricas, indicando que este sistema contribui para a manutenção da diversidade de formigas.
Palavras-chave: Mata Atlântica. Biodiversidade. Conservação. *Pheidole*. Riqueza.

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Introduction

The research on agroecosystems management tends to use community as analysis unit (FERREIRA, 2008). The main attribute of a community is its diversity, which is strongly related to factors such as stability, trophic structure, and productivity (MAGURRAN, 2011). The most common metric among the studies on diversity is richness (WILSEY et al., 2005).

As simplified ecosystems, the agricultural areas that follow organic methods of production are considered an example of a sustainable production model (ABREU et al., 2012). This is because they seek the maintenance of viable production by using management techniques that preserve or improve the physical base and the ability to support the agroecosystem (OKUMURA; PEREIRA JÚNIOR, 2011). The measure of richness can provide important information concerning, for instance, the homogeneity of the environment, ecosystem sensitivity determination, or even the description and comparison of communities found therein (MAGURRAN, 2011). All these factors constitute relevant information for the management of agricultural systems.

In the studies on biodiversity, ants stand out because of features such as high diversity, biomass, and numerical dominance in almost every habitat, as well as the sampling facility and identification of morphospecies (ALONSO; AGOSTI, 2000). In agroecosystems, the presence of ant assemblages positively impacts the productivity (WIELGOSS et al., 2013). Studies in agricultural fields show that the presence of ant nests increases porosity, thus, facilitating water infiltration to the deeper layers (LI et al., 2014). Ants can also modify the chemical properties of the soil through ingestion and transport of mineral-origin and organic materials along the soil profile, modulating the concentration of nutrients and organic matter degradation (CERDÁ; JUNGENSEN, 2008). By increasing the environmental heterogeneity while controlling the availability of resources for the modification of materials through mechanical or other means (JONES et al., 1997), they assist in the maintenance of the species richness in different habitats (WRIGHT et al., 2002).

The study of the ant fauna active in organic cropping systems can allow inferences about the environmental quality of the ecological matrix and the management used. It can also provide information that assists in understanding how groups of ants collaborate to undertake various activities, to maintain the sustainability and the inclusion of organic systems in conservation plans. These become more relevant if the system is a part of the Atlantic forest formation, which is considered one of the world's 34 *hotspots* (CREPALDI et al., 2014; LUTINSKI et al., 2014).

Thus, this study proposes: 1) to extend the knowledge on the richness of ants associated with agroecosystems and organic management and 2) to recognize the impact of the practice of organic management on the composition and richness of the ant assemblages under different management integration times.

Material and Methods

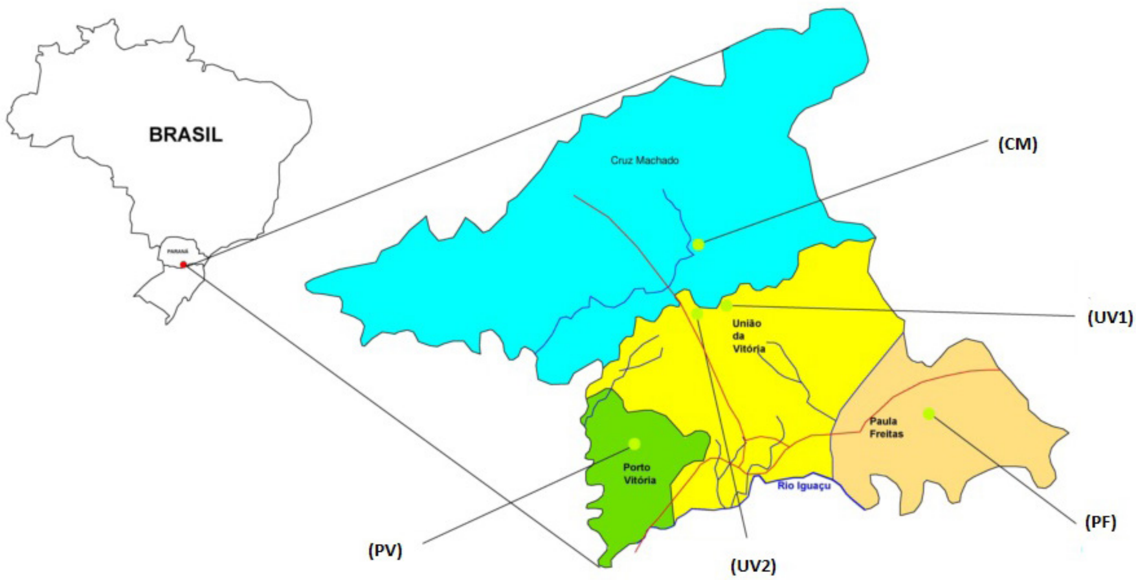
Sampling area

The sampling was carried out in five agroecosystems located in the following counties: Paula Freitas (PF) (26°09′19″S; 50°47′05″W), Cruz Machado (CM) (26°01′33″S; 51°13′23″W), Porto Vitória (PV) (26°09′22.9″S; 51°47′07.52″W), and União da Vitória (UV) (26°03′09″S; 51°13′05″W UV1 and 26°04′27″S; 51°10′36″W UV2), in the state of Paraná, southern Brazil (Figure 1).

The selected agroecosystems are characterized as agricultural systems for household production in the areas of the Atlantic forest, as a part of its mixed Ombrophilous formation. While choosing the sampling sites, it was ensured that their properties meet the Brazilian legal framework regulating organic agriculture: Law 10,831, from December 23, 2003; Decree no. 6,323, from December 27, 2007, and Normative Instruction (NI) nº 64, from December 18, 2008 (BRASIL, 2003, 2007, 2008).

The main aspects considered in the selection of these agroecosystems were: the distance from the conventional systems within a 100 m, the presence of vegetation in the form of a mosaic on the property, with fragments of size at least 200 m^2, equidistant (at least 15 m) from the crop wherein the sampling sites were inserted, use of propagating material from plant species adapted to the local conditions and photoclimatics, use of bio-fertilizers, and use of tillage and soil cover.

Figure 1. Location of the organically managed agroecosystems where ant sampling was conducted from May/August 2009 to October 2009/February 2010: CM: Cruz Machado; PF: Paula Freitas; PV: Porto Vitória; UV: União da Vitória.



Within each agroecosystem, amidst the crop, a sampling site of 1 ha was established. In all such sites, the maintenance of soil biological activity and the balance of nutrients were guaranteed by uniform application of the same organic management techniques: the soil was disc plowed in May 2009 and rock dust was incorporated at a dosage of 1.5 t/ha. Green manure was used for seeding, which comprised 80% *Avena strigosa* Schrebe – Poaceae (black oat) and 20% *Vicia villosa*, Roth – Fabacea (hairy vetch). The crop remained on the ground until complete development and the chaff formed a cover over it. In November 2009, *Phaseolus vulgaris* L. (Fabacea) of the butter bean variety was planted with no tillage. Seeds that had been selected and improved according to the criteria for assemblage use (creole seeds) were supplied from the agroecosystem, União da Vitória 2 (UV2), where one of the sampling sites was set up.

The criteria for characterization of the five agroecosystems, in terms of the extent and duration of soil use, and the time of organic management at the time of collecting ants, are provided in Table 1.

The agroecosystems located in the municipality of Paula Freitas (PF) have historically undergone conventional management, with *Phaseolus vulgaris*, *Zea mays*, and *Citrullus lanatus* (Thunb.) Matsum. & Nakai (watermelon) as the main crops. The structure found in their lithographic Neosol is 0 m to 0.10 m smoky horizon, below which, until a depth of 0.90 m, soil coming from the valley bottom mixed with the sediment deposited by fluvial action during the Quaternary period. High sandy concentrations are found at isolated sites. From a depth of 0.90 m until 1.20 m, residual blocks with gravimetric deposition are found. In 2008, the sampling site constituted the fraction of the property that had undergone clearing of vegetation and conventional planting of *Citrullus lanatus*, in 2009, the same area saw a conversion to organic management system. In accordance with IN 64 of December 18, 2008 (BRASIL, 2008), this fraction of the total area was separated, by a road, from the region that is still under conventional management, with vegetation areas and windrow soil piles covered by undergrowth. In addition, implements and equipment used in the conventional area were not used in the area of conversion.

Table 1. Characterization of the five agroecosystems (PF, CM, UV2, PV, and UV1) in four municipalities in the state of Paraná, Brazil, in terms of the extent and time of land use, and time of organic management integration, on *Phaseolus vulgaris* crops between May 2009 and February 2010, when the ants were collected.

Municipality of location (denomination of the sample area)	Extent (Hectares)	Time of land use (years) of the agrocecosystem where the sampling site was set up	Time of organic management integration (years) in the area of institution of the sampling site
Paula Freitas (PF)	19.36	02	01
Cruz Machado (CM)	48.4	28	03
União da Vitória (UV)	24.2	04	04
Porto Vitória (PV)	58.08	40	08
União da Vitória (UV)	29.04	35	09

In the Cruz Machado agroecosystem (CM), the main cultivar throughout the years has been *Phaseolus vulgaris*, which was cultivated throughout the region in a conventional way until 2004. As of this date, the region is undergoing progressive conversion to the organic production system, with no-tillage and soil cover. The sampling site was set up in an area with three years of organic management. The evaluation of the soil showed that it was a littoral Neosol, where limestone-sand rock and semi-flooded lava products, as well as high concentrations of clay-sandy granules in gutters of pluvial origin are found below the humid horizon, up to a depth of 0.60 m. Between 0.60 m and 1.20 m, quaternary residual blocks with gravimetric deposition are found.

The management in the agroecosystem located in Union da Vitória (UV2) has always been organic with no-tillage, for a wide variety of crops: *Manihot esculenta* Crantz (cassava), *Cucumis sativus* L. (cucumber), *Nicotiana tabacum* L (smoke), *Phaseolus vulgaris* (bean), *Zea mays*. L (corn), and *Cucurbita pepo* var. *Cylindrica* (zucchini). The sampling site was set up in an area usually used for bean culture. The soil evaluation showed that it was a littoral Neosol, where, below the humid horizon up to a depth of 0.30 m, the soil surface is thin with the presence of residual blocks, generating a pedological amphitheater. Between the depth of 0.30 m and 1.10 m, residual quaternary blocks with gravimetric deposition are found, reaching up to 1 m in diameter.

The agroecosystem of Porto Vitória (PV), until 1999, employed both conventional and organic techniques, involving minimum tillage, no-tillage, and minimum use of pesticides. The main cultivars of the property are *Phaseolus vulgaris* and *Zea mays*. L. From the year 2000, all its extension started to count on its integrity with the organic management with no-tillage. The area where the sampling site was set up had been under this management for eight years, being one of the first to be converted.

The management of the agroecosystem (UV1) located in União da Vitória is similar: combination of conventional and organic techniques with minimum soil preparation, no-tillage, and minimal use of agrochemicals. Historically, the main cultivars of this agroecosystem are *Phaseolus vulgaris* and *Zea mays*. When the sampling site was set up, its entire extension used, at nine years, totally organic management. The area where the sampling site was set up had a predominant culture of *Phaseolus vulgaris*. The evaluation of the soil indicated that it is a littoral Neosols, where, below the humid horizon to a depth of 0.60 m, high concentration of basaltic rock mixed with clay-sandy sediment in river gutters are found, yielding a highly productive pediplanar surface. Between the depths of 0.60 m and 1.30 m, residual quaternary blocks with gravimetric deposition are found.

Sampling

In each agroecosystem, a sampling site of 1 ha was delimited, whose external margins were located at least 15 m from the edge of the cropland. In the center of the sampling site, arranged in the shape of the letter X, eight pitfall-type traps were installed; containers of approximately 10 cm in height and 10 cm in diameter were buried with their edges at ground level and at equidistant spacing of 10 m from each other. (BESTELMEYER et al., 2000; LUTINSKI et al., 2013).

Approximately 200 mL of 4% formaldehyde was used in the traps, which remained in the field for a period of 7 days, after which the ants were collected. The samples were carried out from May to August 2009 and from October 2009 to February 2010. The specimens were transported to the Ecology Lab of the State University of Paraná (UNESPAR), União da Vitória Campus, for sorting and separation into morphospecies. For the identification, keys proposed by Bolton (1995); Della Lucia (1993); Fernandez (2003); Gonçalves (1961); Kempf (1964, 1965); Longino and Fernandez (2007); Taber (1998); Watkins (1976); Wild (2007) were used, based on the classification proposed by Bolton et al. (2006).

Analysis of the data

The raw data were organized into record of occurrence for each trap and agroecosystem (LONGINO et al., 2002). The ant assemblages present in each agroecosystem were estimated and compared with each other through estimator Chao2, calculated by the software EstimateS, version 9.1 (COLWELL, 2006).

The ant assemblages were compared by means of rarefaction analysis based on samples (GOTELLI; COLWELL, 2001). This analysis allows for richness comparisons between assemblages that differ with respect to the occurrence of species (MELO et al., 2003). The statistical software used was EcoSim 7.72 (GOTELLI; ENTSMINGER, 2005).

The degree of relationship between the richness observed in each agroecosystem and time of organic management was subjected to Pearson correlation analysis. The percentage of richness variation explained by the variation in the management time was determined by means of linear regression analysis (GOTELLI; ELLISON, 2011).

Results

A total of 11,874 ants belonging to 48 species, 18 genera, and 5 subfamilies was sampled. The subfamily that presented the greatest richness was Myrmicinae, with eight genera and 24 species, followed by Formicinae with 11 species, Ponerinae with two genera and seven species, Dolichoderinae with two genera and three species, and Dorylini with three genera and three species. Among the genera, *Pheidole,* had 10 morphospecies, while *Solenopsis* had seven. *Camponotus* (S = 5), *Brachymyrmex* (S = 5), and *Hypoponera* (S = 4) were also predominant. The genera represented by a single species were *Linepithema*, *Ection*, *Labidus*, *Neivamyrmex*, *Nylanderia*, *Wasmannia*, *Strumigenys* and *Cyphomyrmex* (Table 2).

Table 2. Ant species sampled and their respective frequencies between May 2009 and February 2010 in *Phaseolus vulgaris* crops, managed organically and set up in agroecosystems located in the southern state of Paraná, Brazil. PF: Paula Freitas; CM: Cruz Machado; UV: União da Vitória; PV: Porto Vitória,

Agroecosystems (organic management time – years)	PF (01)	CM (03)	UV2 (04)	PV (08)	UV1 (09)
Taxon Taxon	%	%	%	%	%
Subfamily Dolichoderinae					
Tribe Leptomyrmecini					
Dorymyrmex brunneus Forel, 1908	17	8	20	0,6	17,3
Dorymyrmex pyramicus Roger, 1863	7,8	20	0,5	1,3	5,2
Linepithema sp.	2,3	1,4	3	7,9	11,5
Subfamily Dorylinae					
Eciton sp.				0,1	
Labidus coecus (Latreille, 1802)		3,5			0,2
Neivamyrmex sp.			0,5	0,3	0,5
Subfamily Formicinae					
Tribe Camponotini					
Camponotus crassus Mayr, 1862				0,6	0,2
Camponotus melanoticus Emerry, 1894					0,2
Camponotus rufipes (Fabricius, 1775)	0,8			2,6	2,2
Camponotus sp. 1	16,6	0,4	4,1	2,6	1,5
Camponotus sp. 2			0,2	0,1	
Tribe Lasiini					
Nylanderia fulva (Mayr, 1862)	7,2			0,6	
Tribe Plagiolepidini					
Brachymyrmex sp. 1		1		1,6	2,4
Brachymyrmex sp. 2		6,4	1,1	2,4	4,7
Brachymyrmex sp. 3			0,2	0,3	1,1
Brachymyrmex sp. 4		10,3	0,5	2	1
Brachymyrmex sp. 5				1,9	
Subfamily Myrmicinae					
Tribe Attini					
Acromyrmex lobicornis (Emery, 1888)	4,3	0,4	10,8	7,1	3,2
Atta sexdens Linnaeus, 1758		0,4	1,1		
Cyphomyrmex rimosus (Spinola, 1853)			0,8	3,7	0,2
Pheidole sp. 1	1,7	11	7,5	5,9	2
Pheidole sp. 2	2	5,4	2,7	18,4	3,6
Pheidole sp. 3	0,3	1,2	0,1	0,8	
Pheidole sp. 4	3,7		0,8		0,3
Pheidole sp. 5	0,3		0,3	0,1	0,2
Pheidole sp. 6	5,4		0,5	12,9	8
Pheidole sp. 7		0,4		1,8	0,7
Pheidole sp. 8		0,2			1
Pheidole sp. 9	0,3	0,2			0,2
Pheidole sp. 10					0,3
Strumigenys sp.			0,2		
Wasmannia auropunctata (Roger, 1863)					2
Tribe Pogonomyrmecini					
Pogonomyrmex naegelii Emery, 1878		2	1,9	0,6	3,4
Pogonomyrmex sp.		0,4			0,3
Tribe Solenopsidini					

continue

continuation

Agroecosystems (organic management time – years)	PF (01)	CM (03)	UV2 (04)	PV (08)	UV1 (09)
Taxon Taxon	%	%	%	%	%
Solenopsis sp. 1	3,6	3,7	20,9	13,6	4,2
Solenopsis sp. 2	0,3			0,5	2,4
Solenopsis sp. 3	2,6	2,7	0,5	0,9	2
Solenopsis sp. 4	0,5	0,4	1,8	1	2,7
Solenopsis sp. 5	5,1	10,4	2,5	2,3	3,8
Solenopsis sp. 6	14,5	8,1	14	3	8,9
Solenopsis sp. 7	1,1	0,8		0,9	0,8
Subfamily Ponerinae					
Tribe Ponerini					
Hypoponera sp. 1			1,6	0,3	0,2
Hypoponera sp. 2	0,8		0,6		
Hypoponera sp. 3					0,2
Hypoponera sp. 4	0,2	0,2			
Pachycondyla striata (Smith, 1858)	1,4	0,8	0,5	1,5	1,1
Pachycondyla sp.	0,2			0,4	0,3
Neoponera marginata (Roger, 1861)		0,3	0,2		

Of the species sampled, 13 presented high occurrence frequencies and were found in all five agro-ecosystems: *Dorymyrmex brunneus* (Forel, 1908), *D. pyramicus* Roger, 1863, *Linepithema* sp., *Camponotus* sp.1, *Acromyrmex lobicornis* (Emery, 1887), *Pheidole* sp.1 and sp.2, *Solenopsis* sp.1, sp.3, sp.4, sp.5, sp.6, and *Pachycondyla striata* (Fr. Smith, 1858). Those found only at a single agroecosystem and with frequencies below 2% were: *Eciton* sp. (PV), *Camponotus melanoticus* Emery, 1894 (UV1), *Wasmannia auropunctata* (Roger, 1863) (UV1) *Hypoponera* sp.3 (UV1), and *Strumigenys* sp. (UV2).

The highest richness was observed in UV1 (S = 38), followed by PV (S = 33), UV2 (S = 30), CM (S = 28), and PF (S = 25) (Table 1). The species estimates demonstrate that the richness in the agroecosystems assessed can be, on an average, 10.9% higher than observed in an average of 10.9%. The smallest difference (3.4%) was observed in PV and the largest difference (18.7%) was found in PF (Table 1).

It is observed in the rarefaction curve that the richness increases with management time. The sampling site of União da Vitória 1 (UV1), with a long time of organic management integration, presented the greatest richness and differed statistically from the others. This site was followed by Porto Vitória (PV), with eight years of organic management, which, in the same way as the first, differed statistically from the others. The sites located in União da Vitória 2 (UV2) and Cruz Machado (CM) did not present differences between each other, and they both differed from the other sites. Paula Freitas (PF) was the environment with the least ant richness, and its difference from the other sites was significant (Figure 2).

The relationship established between the observed richness and the time of organic management was direct and positive (correlation coefficient $r = 0.80$; $p < 0.05$) (Figure 3), and 64.6% of the variation noted in the richness of the group was explained by the variation in the management time.

The five sampling sites were organized along gradients of management time, based on the observation that the increase in expected species richness was directly proportional to the management time (Figure 4).

Figure 2. Rarefaction curve of the ant assemblages present in *Phaseolus vulgaris* crops in agroecosystems with different times of organic management integration. PF (Paula Freitas), CM (Cruz Machado), UV2 (União da Vitória 2), PV (Porto Vitória), and UV1 (União da Vitória 1). The vertical bars represent the standard deviation.

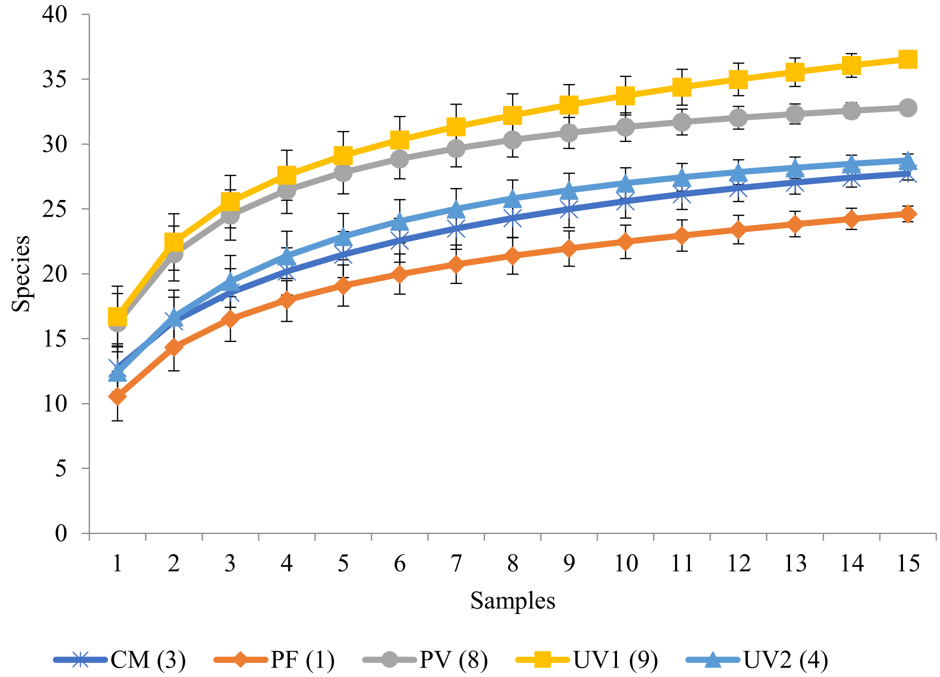


Figure 3. Relationship between the observed ant richness and organic handling in *Phaseolus vulgaris* crops in agroecosystems located in the South of Paraná, Brazil, between May and August 2009, and between October 2009 and February 2010.

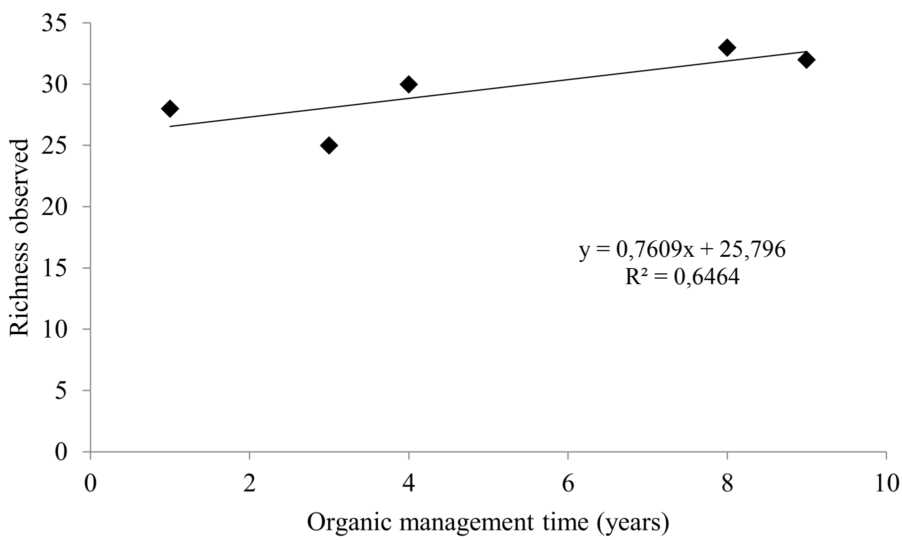
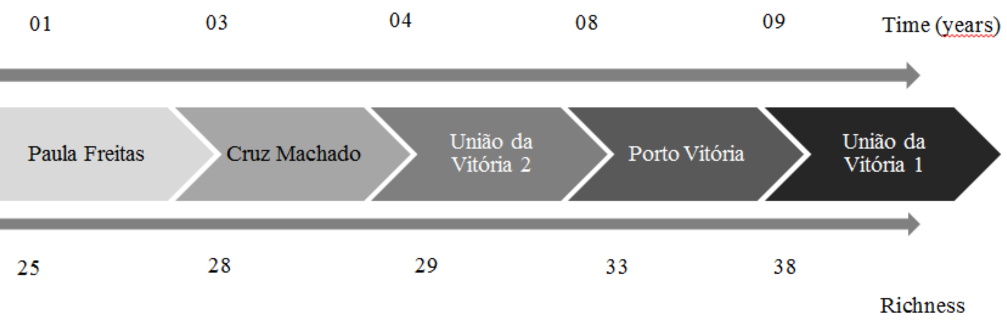


Figure 4. Organization of sampling sites of Paula Freitas, Cruz Machado, União da Vitória 2, Porto Vitória, and União da Vitória 1 along a gradient, in light of the expected increase in richness with the time of organic management integration.



Discussion and Conclusion

The results obtained herein extend the knowledge on the richness of ants associated with agro-ecosystems under organic management. Lutinski et al. (2016), in a first record of species in Paraná agroecosystems under intensive and conventional management, verified the presence of 55 species and emphasized the need to increase the State studies. The dominance of Myrmicinae can be primarily explained by the diversification of food and nesting habits used by its species (FERNANDEZ, 2003). The crop development generates an open environment that favors Formicinae (HÖLLDOBLER; WILSON, 1990), while the presence of chaff on the soil, which is characteristic of no-tillage, might have provided the necessary resources for the nesting of Ponerinae (DELABIE et al., 2000).

The genera *Pheidole, Solenopsis*, and *Camponotus* are usually prevail on the global scale, as they present the greatest diversity of species and adaptations that promote greater extents of geographic distribution and site frequencies (HÖLLODOBLER; WILSON, 1990). Among these adaptations, are aggressive behavior and high capacity of recruitment (FERNANDEZ, 2003).

The management techniques employed could promote favorable conditions for some species. The soil cover in this study was composed of *A. strigosa* and *V.villosa* chaff, which might have provided favorable conditions for the nesting of the species in genera *Camponotus, Dorymyrmex, Pheidole, Pachycondyla*, and *Solenopis* (CUEZZO; GUERRERO, 2012; DELABIE et al., 2000). It also seemed to have facilitated the access of predatory species, as indicated in the agroecosystem with long-term organic management, to food supply (UV2, PV, and UV1), *Eciton* sp., *Labidus coecus* (Latreille, 1802), *Neivamyrmex* sp., and *P. striata, P*. sp. (HÖLLODOBLER; WILSON, 1990), and especially *Strumigenys* sp., a predator that specializes in burlap microfauna (WILSON, 1953).

The genus *Brachymyrmex,* which forages on the ground next to the straw coverage, and has been shown to be sensitive to changes in its habitat (DELABIE et al., 2000), was not registered in the agroecosystem with the shortest time of organic management integration and lowest ant richness. Its presence was detected with increasing frequency in the richer and organically longer managed agroecosystems of CM, PV, and UV1.

The presence of the crop might have supported species such as *Pogonomyrmex naegelli* (Emery, 1878) and *Pogonomyrmex* sp., which are seed gatherers (HÖLLODOBLER; WILSON, 1990). The crop also appeared to have been favorable to the genus *Camponotus,* whose nests are often associated to plants with trophobiont insects or nectaries, as is the case of *P. vulgaris, A. strigosa,* and *V. villosa*, and which function as a source of resource and access to liquids for the colony with less energy expenditure in foraging (OLIVEIRA et al., 2002).

The open structure provided by the crop might have supported *A. lobicornis*, a field species (GONÇALVES, 1961) that has been commonly recorded in studies in the southern region (LOECK; GRÜTZMACHER, 2001). Its highest frequency was observed in UV2, an environment with four years of conversion of forest area into the crops under organic management.

The proximity of the vegetation to the agroecosystems tends to encourage the existence and maintenance of an assembly of diverse ants in its environment, serving as a repository of species (PACHECO et al., 2013; CREPALDI et al., 2014). This can assist in explaining the occurrence of legionary species *Labidus coecus*, and the genera *Hypoponera* and *Pachycondyla*, in these areas.

The results of this study indicate that the practice and the maintenance of organic management features affect the richness of ants. These are proportional to the time of organic management. Although the PF agroecosystem presented the shortest time of soil and organic management with the least richness, the one named UV2, which had a similar land use time, presented richness results closest to those of the agroecosystems with higher organic management and land use time, i.e., PV and UV1. Studies such as those of Urrutia-Escobar and Armbrecht's (2013) suggest that the management based on ecological principles can be the determining factor in the conservation of the fauna.

In most studies that involve the use of ant diversity, it is proposed that such diversity increases as the structural complexity of the habitat increases (CORRÊA et al., 2006; VARGAS et al., 2007; DIAS et al., 2008; SCHMIDT; DIEHL, 2008; MIRANDA et al., 2013; MARTINS et al., 2011; SOARES et al., 2010;). It was observed that there was an increase in the richness and abundance of ant species with increasing time. It can be inferred that the ant assemblages of an organic management system help increase the structural complexity of the agroecosystem. According to the hypothesis of habitat heterogeneity, structurally complex habitats promote a greater diversity of niches, allowing the organisms to explore the capabilities of the environment in diverse ways, which results in an increased diversity of species (TEWS et al., 2004).

For ants, this complexity generates an increase in nesting sites, food, foraging area, and interactions between species (HÖLLDOBLER; WILSON, 1990). The presence of nesting sites is an important factor that increases the diversity of ant species in tropical regions (BENSON; HARADA, 1988). The techniques involved in organic management would be responsible for a gradual increase of environmental conditions that favor ant groups.

Little attention has been paid to the effective role of agroecosystems in maintaining diversity (GLIESSMAN, 2009). However, it is possible to compare the observed richness of ants in this study (48 species) with the species list of the State of Santa Catarina (366 species) (ULYSSÉA et al., 2011). Paraná, in that the organically managed agroecosystems might contain 13.11% of the ants fauna referred to here. It can then be inferred that the maintenance of organic practices tends to be important for the conservation of diversity. It can then be inferred that the maintenance of organic practices tends to be important to the conservation of diversity. However, according to Ulysséa et al. (2011), for the northern region of the state of Santa Catarina, which borders the region sampled in this study, there is a record of 70 ant species.

The highest richness observed in agroecosystems UV2, PV, and UV1, as well as the presence of many species with low frequency, such as *Eciton* sp.*, L. coecus, Neivamyrmex* sp.*,* and *Strumigenys* sp., is indicative that the organic management maintained over time opens up possibilities for colonization and species maintenance.

It is also observed that the recognition of the richness of ant assemblages opens up the possibility of evaluating production systems from a biological point of view. In addition, the organic management system contributes to the maintenance of diversity, and can be recommended as an alternative to conventional methods of cultivation. It also opens up the possibility of future studies involving other cultivated plant species, longer sampling time, or sampling in different phenological states of the plant species that constitute the crop.

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