BioOne COMPLETE

Myrmecofauna (Hymenoptera: Formicidae) Present in Vineyards Infested with Eurhizococcus brasiliensis (Hemiptera: Margarodidae) in Southern Brazil

Authors: Nondillo, Aline, Arioli, Cristiano João, Wild, Alexander, Bueno, Odair Correa, and Botton, Marcos

Source: Florida Entomologist, 100(3) : 551-557

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.100.0310

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Myrmecofauna (Hymenoptera: Formicidae) present in vineyards infested with *Eurhizococcus brasiliensis* (Hemiptera: Margarodidae) in southern Brazil

Aline Nondillo[1,], Cristiano João Arioli[2], Alexander Wild[3], Odair Correa Bueno[4], and Marcos Botton[1]*

Abstract

Eurhizococcus brasiliensis (Wille) (Hemiptera: Margarodidae) is among the principal pests of Brazilian vineyards. Establishment and spread of this species in vineyards are associated with ants (Hymenoptera: Formicidae). This study determined the diversity of the ant fauna in *E. brasiliensis* infested vineyards in Rio Grande do Sul and Santa Catarina, the main grape-producing states in Brazil. Underground pitfall traps baited with a honey–water solution and sardines were used to sample ants in the spring–summer and fall–winter periods. Twenty-eight species of ants were identified in Rio Grande do Sul and 15 in Santa Catarina. *Linepithema micans* (Forel) (Hymenoptera: Formicidae) was the most frequent and abundant species collected in vineyards in both states. Control strategies for ants associated with the spread of *E. brasiliensis* should focus on *L. micans* in vineyards.

Key Words: survey; ant; soil scale; *Linepithema micans*

Resumo

A cochonilha de raízes pérola-da-terra *Eurhizococcus brasiliensis* (Wille) (Hemiptera: Margarodidae) é considerada uma das principais pragas da videira no Brasil. O estabelecimento e a dispersão da espécie nos parreirais estão associados à formigas (Hymenoptera: Formicidae). Neste trabalho, foi determinada a diversidade da fauna de formigas em parreirais infestados com a cochonilha nos Estados do Rio Grande do Sul e Santa Catarina, principais estados produtores de uva do Brasil. Armadilhas "pitfall" subterrâneas iscadas com solução aquosa de mel e sardinha foram colocadas no interior dos vinhedos entre os períodos da primavera/verão e outono/inverno. Vinte e oito espécies de formigas foram identificadas no Rio Grande do Sul e quinze em Santa Catarina. *Linepithema micans* (Forel) (Hymenoptera: Formicidae) foi a espécie com maior frequência e abundância nos parreirais amostrados em ambos estados amostrados. Estratégias de controle de formigas associadas à dispersão da pérola-da-terra devem ser direcionadas para esta espécie nos vinhedos.

Palavras Chave: levantamento; formiga; cochonilha; *Linepithema micans*

The presence of ants in agroecosystems may cause indirect damage to plants as a result of their symbiotic interactions with honeydew-producing hemipterans (Way 1963; Hölldobler & Wilson 1990; Delabie 2001). The honeydew excreted by these hemipterans supplements the nutritional needs of ants, providing carbohydrates and amino acids (Way 1963). In this relationship, the hemipterans might receive protection against predators and parasitoids (Moreno et al. 1987; Martinez-Ferrer et al. 2003; Daane et al. 2007). In addition to protecting them, ants can also transport the hemipterans to new protected feeding places, and can clean and remove dead individuals (Buckley 1987; Vanek & Potter 2010).

The relationship of some hemipterans with ants is mutually beneficial and can aid both groups to increase in abundance (Way 1963; Abbott & Green 2007; Daane et al. 2007). In South Africa and California, this relationship has significantly increased populations of scales from the family Pseudococcidae, which can be important virus vectors in vineyards (Addison & Samways 2000; Daane et al. 2006; Daane et al. 2007). In these regions, the main ant species associated with the spread of scale insects is the Argentine ant, *Linepithema humile* (Mayr) (Hymenoptera: Formicidae) (Addison & Samways 2000; Geiger et al. 2001; Daane et al. 2007). In southern Brazil, *Eurhizococcus brasiliensis* (Wille) (Hemiptera: Margarodidae) is the principal insect pest in vineyards (Gallotti 1976; Soria & Gallotti 1986; Botton et al. 2010; Efrom et al. 2012).

The relationship of *E. brasiliensis* to ants in Brazilian vineyards was first reported by Gallotti (1976), who observed workers of *L. humile* and *Nylanderia fulva* (Mayer) (Hymenoptera: Formicidae) carrying 1st instar nymphs of *E. brasiliensis*. Soria & Gallotti (1986), Hickel (1994), and Soria et al. (1997) also mentioned *L. humile* as the predominant ant in areas infested by *E. brasiliensis* in southern Brazil. However, more recent studies found that *Linepithema micans* (Forel) (Hymenoptera: Formicidae) was associated with *E. brasiliensis* in vineyards in the state of Rio Grande do Sul (Martins & Bueno 2009; Sacchett et al. 2009).

[1]Laboratório de Entomologia, Embrapa Uva e Vinho, 95.7000-000, Bento Gonçalves, Brazil; E-mail: alinondillo@gmail.com.br (A. N.), marcos.botton@embrapa.br (M. B.)
[2]Empresa de Pesquisa Agropecuária e Extenção Rural de Santa Catarina, 89.560-000, Videira, Brazil; E-mail: cristianoarioli@epagri.sc.gov.br (C. J. A.)
[3]University of Texas, Austin, Texas 78666-4684, USA; E-mail: myrmecos.photo@gmail.com (A. W.)
[4]Instituto de Biociências, Centro de Estudos de Insetos Sociais, Universidade Estadual Paulista, 13.506-900, Rio Claro, Brazil; E-mail: odaircb@rc.unesp.br (O. C. B.)
*Corresponding author; E-mail: alinondillo@gmail.com.br (A. N.)

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Considering that efficient management of *E. brasiliensis* should include management of ants involved in *E. brasiliensis* dispersal, knowledge of the myrmecofauna of vineyards is important. This study assessed the diversity of ants in vineyards infested by *E. brasiliensis* in Rio Grande do Sul and Santa Catarina.

Materials and Methods

STUDY AREAS

The collections were conducted in vineyards infested with the *E. brasiliensis* in grape-producing municipalities in Rio Grande do Sul (on 55 farms in Antônio Prado, Caxias do Sul, Dois Lajeados, Farroupilha, Flores da Cunha, Garibaldi, Monte Belo do Sul, Nova Pádua, Pinto Bandeira, Sarandi, and Veranópolis) and Santa Catarina (on 9 farms in Iômere, Pinheiro Preto, Tangará, and Videira). Two ant collections were made in each vineyard: one in spring–summer and the other in autumn–winter, from 2008 through 2011.

The ants were collected using underground pitfall traps. The traps consisted of a set of two plastic pipes (3.3 cm diameter × 5.0 cm height) connected by a 50 cm string, with a cap and lateral holes (3 mm) (Morini et al. 2004), and two baits. One of the pipes contained a honey-water solution (70%) absorbed in cotton wool, and the other contained sardines in edible oil placed in the cap of the pipe.

One pitfall trap was placed at each sampling point in the vineyard, with 20 traps per farm in Rio Grande do Sul and 12 per farm in Santa Catarina. The pitfall traps were buried underground at a depth of 20 cm. The sampling depth was based on the study by Hickel et al. (2008), who found that *E. brasiliensis* was present at a depth up to 30 cm. The traps were spaced 10 m apart and distributed centrally in the vineyard to avoid edge effects, along the rows of grape plants, close to their roots. The traps remained in the field for 24 h, then were collected and taken to the laboratory. Once removed from the traps, the ants were stored in bottles containing 70% ethanol for later identification.

SPECIES IDENTIFICATION

The ant morphospecies were separated, and a sample of each was determined using the methods described by Longino (2000). The ants were identified to subfamily (Bolton 2003) and gender (Bolton 1994). The morphological identification was done in 2 stages: to the morphospecies level by comparing the samples to ones deposited in the collection of the Laboratory of Myrmecology of Alto Tietê, at the Universidade de Mogi das Cruzes, state of São Paulo and then to the species level by Alex Wild, Curator of Entomology at the University of Texas at Austin. Due to their morphological similarities, the species of *Linepithema* and *Solenopsis* (Hymenoptera: Myrmicinae) were also identified through molecular analyses of the cytochrome oxidase I mitochondrial gene. This analysis was completed at the Centro de Estudos de Insetos Sociais, Rio Claro, Brazil (Campos 2012; Martins et al. 2012).

FAUNAL ANALYSIS

Species distribution and patterns of the collected ants were based on the indices of abundance, constancy, dominance, and frequency, which were calculated using the equations proposed by Silveira Neto et al. (1976).

In order to define the abundance, the confidence interval (CI) of the arithmetic mean was calculated at 1 and 5% probability, using the formula of Silveira Neto et al. (1976):

$$CI = m \pm t \times S(m)$$

Where: CI = confidence interval; m = arithmetic mean; t = value of t at 5% and 1% levels; and S(m) = standard error of the mean.

The following abundance categories were established: rare (r) = number of individuals captured was lower than the lower CI limit at 1% probability; dispersed (di) = number of individuals captured was between the CI limits of 1% and 5% probability; common (c) = number of individuals captured was in the CI at 5% probability; abundant (a) = number of individuals captured exceeded the limits of the CI at 5% and 1% probability; and very abundant (ma) = number of individuals captured was higher than the upper CI limit at 1% probability.

Constancy was calculated using the formula:

$$C = P \times 100 / N$$

Where: C = constancy; P = number of collections containing each species; and N = total number of collections.

According to Bodenheimer (1955), species occurrence can be classified as: constant (w): when the species is present in more than 50% of the collections; incidental (y): when the species is present in 25 to 50% of the collections; and accidental (z): when the species is present in less than 25% of the collections.

The Sakagami and Laroca method, as described by Fazolin (1991), was used to determine dominance. This method considers a species as dominant if their frequency of occurrence exceeds the dominance limit, which can be calculated with the formula:

$$DL = 1 \times 100 / S$$

Where: DL = dominance limit; and S = total number of species.

The frequency was calculated with the formula:

$$F = I \times 100 / T$$

Where: F = frequency (%); I = number of specimens of the species in the sampling location; and T = total number of specimens of the group in the sampling location.

A frequency category was established for each species, based on the CI at 5% probability (Fazolin 1991). The following categories were established: low frequency (lf) = when the percentage of captured individuals was lower than the lower CI limit at 5% probability; frequent (f) = when the percentage of captured individuals was within the CI at 5% probability; and very frequent (vf) = when the percentage of captured individuals was higher than the higher CI limit at 5% probability.

The relative frequency was calculated using the following formula:

$$RF = AF \times 100 / \sum AF$$

Where: RF = relative frequency (%); and AF = absolute frequency (number of locations where the species occurred per total number of locations).

The faunal analysis calculations were based on the number of records for each species from each location. These records were calculated according to the presence or absence of ants, as proposed by Longino (2000), as the social characteristics of ants can affect these analyses if they are based on the absolute numbers of specimens collected.

Results

A total of 135,920 ants were collected in the 55 vineyards of Rio Grande do Sul. The ants in these samples represented 28 species, 15 genera, and 6 subfamilies (Table 1). In Santa Catarina, a total of 41,542 ants representing 15 species, 9 genera, and 5 subfamilies (Table 1) were collected.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Table 1. Number of ant genera, species, and individuals by subfamily collected from vineyards where *Eurhizococcus brasiliensis* occurred in Rio Grande do Sul (RS) and Santa Catarina (SC).

	Genera		Species		Individuals	
Subfamily	RS	SC	RS	SC	RS	SC
Myrmicinae	6	3	16	8	52,645	10,756
Formicinae	3	3	6	3	3,243	5,141
Ecitoninae	1	1	1	2	3	1,354
Ectatomminae	2	—	2	—	48	—
Ponerinae	2	1	2	1	81	1
Dolichoderinae	1	1	1	1	79,900	24,290
Total	15	9	28	15	135,920	41,542

In the collections from Rio Grande do Sul, the subfamily Myrmecinae showed the highest species richness, followed by Formicinae, Ecitoninae, Ectatomminae, Ponerinae and Dolichoderinae (Table 1). The collections from Santa Catarina contained the same proportion of subfamilies, except that no species of Ectatomminae were found (Table 1).

In the faunal analysis, *L. micans* was classified as abundant, dominant, and very frequent in all locations in Rio Grande do Sul and Santa Catarina. Its occurrence was constant in 18% and 25% of the locations in Rio Grande do Sul and Santa Catarina, respectively (Tables 2 and 3). This was also the species with the highest frequency found in all locations (Figs. 1 and 2).

The genus *Pheidole* (Hymenoptera: Myrmicinae) was the most species-rich in all locations in Rio Grande do Sul and Santa Catarina, where it was represented by 8 and 5 species, respectively (Tables 2 and 3). Also, it was among the genera that showed high rates in the faunal analysis (Tables 2 and 3; Figs. 1 and 2). *Pheidole subarmata* (Mayr) was very abundant, incidental, dominant, and very frequent in 81, 18, 100, and 81% of the locations in Rio Grande do Sul (Table 2; Fig. 1). In Santa Catarina, it was very abundant, dominant, and very frequent in 75% of the locations, and accidental in all municipalities (Table 3; Fig. 2). *Pheidole aberrans* (Santschi) was classified as abundant, accidental, dominant, and very frequent in 36, 81, 54, and 36% of the samples in Rio Grande do Sul; in Santa Catarina, it was very abundant, accidental, dominant, and very frequent in 50, 100, 75, and 50% of the municipalities.

Solenopsis (Hymenoptera: Myrmicinae) showed the highest species richness, with 4 species in Rio Grande do Sul (Table 2) and 2 other species in Santa Catarina (Table 3). Among these species, *Solenopsis invicta* (Buren) in Rio Grande do Sul was classified as very abundant, accidental, dominant, and very frequent in 36, 54, 36, and 36% of the collection locations. However, in Santa Catarina, it was classified as rare, accidental, not dominant, and of low frequency in 50, 75, 50, and 50% of the municipalities.

Discussion

The subfamily Myrmicinae displayed the highest species richness, comprising 57% of the species found in vineyards infested by *E. brasiliensis* in Rio Grande do Sul (Table 1) and 53% in Santa Catarina (Table 1). Myrmicinae is the largest ant subfamily with the greatest numbers of genera and species (Fernández & Sendoya 2004; AntWeb 2012). Fernández (2003) noted that the myrmicines are among the most diversified groups in their feeding and nesting habits. The subfamily includes arboreal, soil-inhabiting, and leaf-litter species; some are associated with plants, fungi, or with other ants (Fernández 2003). Myrmicine ants also are dominant in vineyards in South Africa (Addison & Samways 2000), Australia (Chong et al. 2011) and Brazil (Sacchett 2006; Picelli 2011; Rosado et al. 2012).

The second most diverse taxon was the subfamily Formicinae, with 21% of the species collected in Rio Grande do Sul and 20% in Santa Catarina being from this subfamily (Table 1). This subfamily comprises 51 genera worldwide, with approximately 2,915 described species (AntWeb 2012). Fernández and Sendoya (2004) noted that there are about 15 genera known to inhabit the Neotropical region of the world. Formicine ants are mostly generalists, but they are strongly attracted to carbohydrates such as those in extrafloral nectaries (Fowler et al. 1991; Longino 1994). They may be arboreal, or live in soil, leaf litter or underground (Fowler et al. 1991).

The most species-rich subfamilies in Rio Grande do Sul were Ectatomminae, Ponerinae and Dolichoderinae, containing 7, 7, and 3% of the species collected (Table 1). In Santa Catarina, Ponerinae and Dolichoderinae each contained 6% of the species collected (Table 1).

The single species of the subfamily Dolichoderinae was the highest in numerical abundance in both locations (Table 1). Andersen (2000) described this subfamily as both numerically and functionally dominant. Most dolichoderine species are omnivorous and forage on the soil surface, typically feeding on dead arthropods and plant secretions. These ants inhabit various microhabitats, including soil with or without plant cover, dead or living wood, and tree canopies (Cuezzo 2003).

The species richness found in this study was low compared to other surveys in vineyards. Addison and Samways (2000) found 42 ant species in 22 vineyards in South Africa, using pitfall traps and sardine bait, while Chong et al. (2011) in a 50 vineyard survey in Australia found 148 species of ants using only pitfall traps. In Brazil, Sacchett (2006), using pitfall and underground traps, recorded 41 ant species in vineyards of the Serra Gaúcha region, and Rosado et al. (2012) found 72 species in Rio Grande do Sul.

The diversity of species found in the vineyards in our study was also low compared with other surveys carried out in monocultures with perennial plants in Brazil. For example, 124 species were recorded in cocoa plantations in Bahia (Delabie & Fowler 1995), and 143 species were found in eucalyptus plantations in Minas Gerais (Marinho et al. 2002). However, the low number of species is similar to other surveys carried out in southern Brazil. For example, in São Leopoldo, 20 species were documented (Haubert et al. 1998); in Torres, 33 species (Hameister et al. 2003); and in Caçapava do Sul, 51 species (Diehl et al. 2004). Low species richness is expected for the subtropical region, where myrmecofauna is less diverse than in tropical zones due to climatic factors and the less complex habitats (Ketterl et al. 2003). The 72 species found in the region of Campanha do Rio Grande do Sul by Rosado et al. (2012) was an exception.

Ant species richness may also be influenced by habitat characteristics, such as the structure of the vegetation. A habitat with greater plant complexity provides more sites for nest building and more abun-

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Table 2. Faunal analysis of ant species (Hymenoptera: Formicidae) sampled in vineyards where *Eurhizococcus brasiliensis* occurred in cities from the state of Rio Grande do Sul.

	City in Rio Grande do Sul																																			
	Antônio Prado				Caxias do Sul				Dois Lajeados				Farroupilha				Flores da Cunha				Garibaldi				Monte Belo				Nova Pádua				Pinto Bandeira				Sarandi				Veranópolis			
Species	A	C	D	F	A	C	D	F	A	C	D	F	A	C	D	F	A	C	D	F	A	C	D	F	A	C	D	F	A	C	D	F	A	C	D	F	A	C	D	F	A	C	D	F
Acromyrmex cf. *nigrosetosus*	r	z	nd	pf	—	—	—	—	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	pf	—	—	—	—	r	z	nd	pf
Brachymyrmex aphidicola	r	z	nd	pf	—	—	—	—	c	z	nd	f	di	z	nd	pf	c	z	nd	f	c	z	nd	pf	r	z	nd	pf	r	z	nd	pf	r	z	nd	pf	—	—	—	—	—	—	—	—
Brachymyrmex obscurior	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	ma	z	d	mf	—	—	—	—
Brachymyrmex sp. 4	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	pf	—	—	—	—	—	—	—	—	r	z	nd	pf	c	z	d	f	ma	z	d	mf	—	—	—	—	—	—	—	—
Camponotus melanoticus	—	—	—	—	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	pf	r	z	nd	pf	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—
Camponotus sp. 6	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	pf	—	—	—	—	r	z	nd	pf	r	z	nd	pf	—	—	—	—	r	z	nd	pf	—	—	—	—	—	—	—	—
Crematogaster quadriformis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	z	—	pf	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ectatomma edentatum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—
Gnampotogeny striatula	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	c	z	nd	f	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	pf	—	—	—	—	r	z	nd	pf
Hypoponera opaciceps	r	z	nd	pf	—	—	—	—	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	pf	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—
Labidus predator	—	—	—	—	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Linepithema micans	ma	z	d	mf	ma	w	d	mf	ma	y	d	mf	ma	y	d	mf	ma	y	d	mf	ma	z	d	mf	ma	z	d	mf	ma	y	d	mf	ma	w	d	mf	ma	z	d	mf	ma	y	d	mf
Nylanderia fulva	ma	z	d	mf	r	z	nd	pf	r	z	nd	pf	—	—	—	—	—	—	—	—	ma	z	d	mf	c	z	—	f	c	z	d	f	di	z	nd	pf	—	—	—	—	—	—	—	—
Oxypoecus sp. 4	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	nd	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pachycondyla striata	—	—	—	—	—	—	—	—	r	z	nd	pf	r	z	nd	pf	r	z	nd	pf	r	z	nd	pf	c	z	nd	f	—	—	—	—	c	z	nd	f	—	—	—	—	r	z	b	pf
Pheidole aberrans	r	z	nd	pf	c	z	d	f	ma	z	d	mf	c	z	d	f	r	z	nd	pf	ma	z	d	mf	—	—	nd	—	c	z	nd	f	r	z	nd	pf	ma	z	d	mf	ma	z	d	mf
Pheidole cf. *dione*	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	pf	r	z	nd	pf	r	z	—	pf	r	z	nd	pf	r	z	nd	pf	—	—	—	—
Pheidole nr. *triconstricta*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	pf	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pheidole sp. 15	r	z	nd	pf	r	z	nd	pf	—	z	nd	pf	r	z	nd	pf	—	—	—	—	—	—	—	—	r	z	d	pf	—	—	d	—	di	z	nd	pf	—	—	—	—	r	z	nd	pf
Pheidole sp. 17	ma	z	d	mf	ma	z	d	mf	ma	z	d	mf	c	z	nd	f	ma	z	d	mf	c	z	nd	f	ma	z	d	mf	r	z	nd	pf	ma	z	d	mf	ma	z	d	mf	c	z	nd	pf
Pheidole sp. 30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	pf	r	—	nd	pf	—	—	—	—	—	—	—	—	r	z	nd	pf	—	—	—	—
Pheidole sp. 33	r	z	nd	pf	r	z	nd	pf	c	z	d	f	r	z	nd	pf	r	z	nd	—	r	z	nd	pf	c	z	nd	f	r	z	nd	pf	c	z	nd	f	r	z	nd	pf	c	z	d	f
Pheidole subarmata	ma	z	d	mf	ma	z	d	mf	—	z	d	f	ma	z	f	mf	ma	z	d	mf	ma	y	d	mf	ma	z	d	mf	ma	z	d	mf	c	z	d	f	ma	y	d	mf	ma	z	d	mf
Solenopsis invicta	—	—	—	—	ma	z	d	mf	ma	z	d	mf	r	z	nd	pf	—	—	—	—	ma	z	d	mf	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—	ma	z	d	mf
Solenopsis magergates	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	ma	z	d	mf
Solenopsis saevissima	—	—	—	—	ma	z	d	mf	—	—	—	—	r	z	nd	pf	c	z	nd	f	—	—	—	—	—	—	—	—	ma	z	d	mf	c	z	nd	f	—	—	—	—	—	—	—	—
Solenopsis sp.4	—	—	—	—	—	—	—	—	r	z	nd	pf	r	z	nd	pf	—	—	—	—	—	—	—	—	r	z	nd	pf	—	—	—	—	—	—	—	—	—	—	—	—	di	z	d	f
Wasmannia sp.	r	z	nd	pf	r	z	nd	pf	ma	z	d	mf	—	—	—	—	—	—	—	—	ma	z	d	mf	ma	z	d	mf	ma	z	d	mf	—	—	—	—	—	—	—	—	a	z	nd	f

A = Abundance: ma = very abundant, a = abundant, c = common, di = dispersed, r = rare; C = Constancy: w = constant, y = incidental, z = accidental, D = Dominance: d = dominant, nd = not dominant; F = Frequency: vf = very frequent, f = frequent, lf = infrequent, - = absent.

Table 3. Faunal analysis of ant species sampled in vineyards with the presence of *Eurhizococcus brasiliensis*, in cities from the state of Santa Catarina.

	City in Santa Catarina															
	Iomerê				Pinheiro Preto				Tangará				Videira			
Species	A	C	D	F	A	C	D	F	A	C	D	F	A	C	D	F
Brachymyrmex aphidicola	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	lf
Camponotus melanoticus	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	lf
Labidus cuecos	—	—	—	—	—	—	—	—	—	—	—	—	r	z	nd	lf
Labidus predator	—	—	—	—	—	—	—	—	—	—	—	—	c	z	d	lf
Linepithema micans	ma	z	d	vf	ma	w	d	vf	ma	z	d	vf	ma	z	d	vf
Nylanderia fulva	ma	w	d	vf	—	—	—	—	ma	z	d	vf	ma	z	d	vf
Pachycondyla striata	—	—	—	—	—	—	—	lf	r	z	nd	lf	r	z	nd	lf
Pheidole aberrans	c	z	nd	F	c	z	d	f	ma	z	d	vf	ma	z	d	vf
Pheidole sp. 17	—	—	—	—	r	z	nd	f	r	z	nd	lf	—	—	—	—
Pheidole sp. 30	—	—	—	—	r	z	nd	lf	ma	z	d	vf	r	z	nd	lf
Pheidole subarmata	ma	z	d	vf	c	z	nd	f	ma	z	d	vf	ma	z	d	vf
Solenopsis invicta	—	—	—	—	r	z	nd	lf	ma	z	d	lf	r	z	nd	f
Solenopsis saevissima	—	—	—	—	r	z	nd	lf	—	—	—	—	—	—	—	—

A = Abundance: ma = very abundant, a = abundant, c = common, di = dispersed, r = rare; C = Constancy: w = constant, y = incidental, z = accidental, D = Dominance: d = dominant, nd = not dominant; F = Frequency: vf = very frequent, f = frequent, lf = infrequent, - = absent.

dant food sources (Albuquerque & Diehl 2009). In places where there is no variety of vegetation, the number of species is more uniform.

Thus, the manner in which vineyards in southern Brazil are managed can influence the low species richness, as a large proportion of vineyards are maintained without plant cover, leaving the ground permanently exposed (Emater 2001). Moreover, the application of insecticides to the ground in order to control *E. brasiliensis* may potentially affect the assemblage of ants present in the vineyard. These common agricultural practices can result in a reduction of the ant diversity (Queiroz et al. 2006). According to Lobry De Bruyn (1993), a decrease of 50% in ant species richness can be related to these practices.

In agroecosystems, insecticide application heavily impacts the invertebrate distribution in the environment. Pesticide impacts include reduction of species diversity, occurrence of secondary pests, and reduction of natural predators (Theiling & Croft 1988). Peck et al. (1998) showed meaningful effects of soil management and insecticide application on the ant assemblage structure for species that inhabit the plant litter-soil interface. In coffee plantations, Perfecto & Vandermeer (2002) found greater species richness in organic culture compared with traditional culture. Picelli (2011) also attributed low ant diversity found in vineyards of São Paulo to insecticide application.

However, in a study done in vineyards in Australia, Chong et al. (2007) showed that the ant assemblage structure in these locations was insensi-

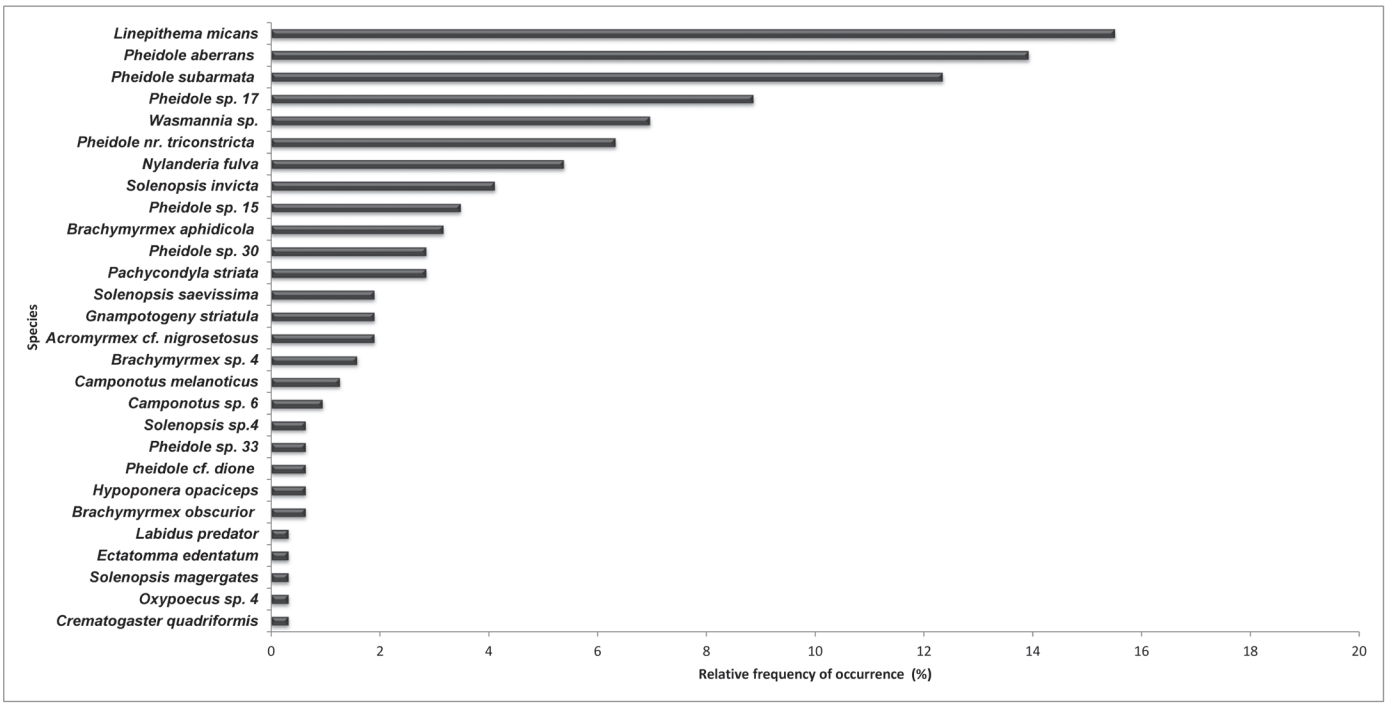


Fig. 1. Relative frequencies of occurrence of the main ant species in vineyards where *Eurhizococcus brasiliensis* occurred in Rio Grande do Sul.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

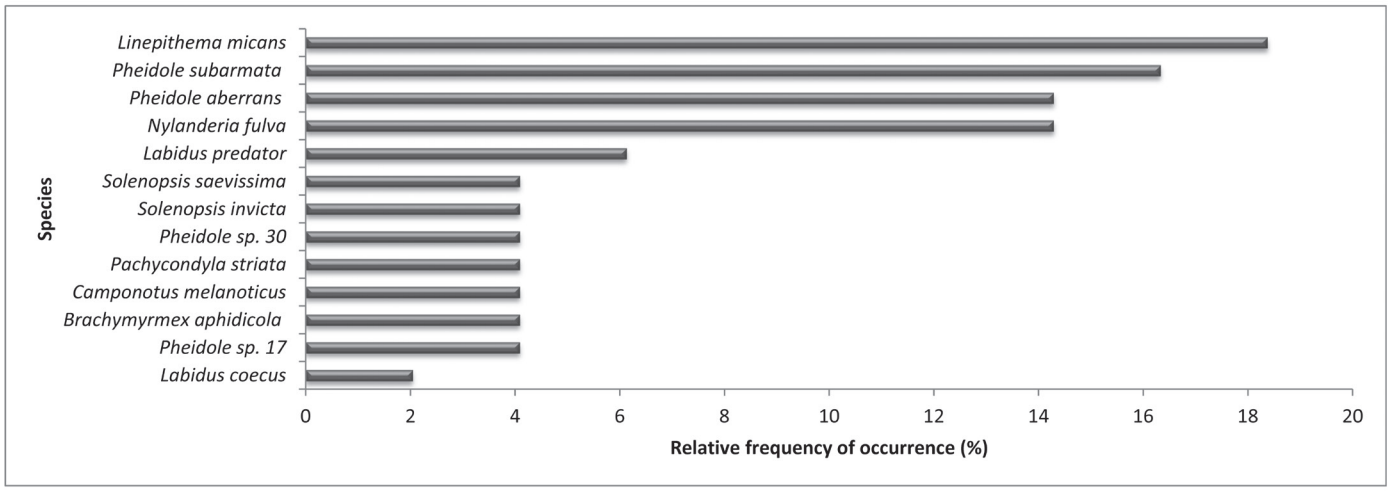


Fig. 2. Relative frequencies of occurrence of the main ant species in vineyards where *Eurhizococcus brasiliensis* occurred in Santa Catarina.

tive to the pesticide application. However, the authors highlighted that the presence of shelter in these vineyards probably influenced the ant assemblage structure. An organism's sensitivity to a pesticide depends on its toxicity and degree of exposure (Thomson & Hoffmann 2006). This may explain the low ant diversity of the vineyards in southern Brazil, because in most vineyards there, the ground is permanently exposed, which facilitates increased ant–pesticide contact.

In relation to the low species richness found in our study, the use of underground pitfall traps, which was different from other studies could have influenced the final species richness, making standardization of these methods necessary for a more valid comparison. According to Bestelmeyer et al. (2000), the use of pitfall traps is more effective, because they remain longer in the field, resulting in an increased number of species being collected.

The most representative genera in number of species in the 2 states were *Pheidole* and *Solenopsis*. In surveys carried out in vineyards of Australia (Chong et al. 2011) and in the Serra Gaúcha (Sacchett 2006), the genus *Pheidole* also had the highest species richness. This genus is comparatively widely distributed, with about 900 species known worldwide (Hölldobler & Wilson 1990), with 620 species occurring in the Americas (Wilson 2003).

Among the ant species collected in the 2 states, *L. micans* was found in most of the vineyards infested by *E. brasiliensis*, and it was the dominant ant species where it occurred. This species was also one of most important in vineyards in the Campanha do Rio Grande do Sul region, although in this region, *E. brasiliensis* was not detected. The presence of the ant in different locations shows its adaptability to different conditions and ecological roles. According to Wild (2009), this is due to its close phylogenetic relationship with *L. humile*, indicating that this species may also be invasive (Martins et al. 2012).

The information that *L. micans* is the predominant species in vineyards infested by *E. brasiliensis* is a new discovery, as until recently *L. humile* was considered the main dispersive agent of cochineal in Brazil (Gallotti 1976; Soria & Gallotti 1986; Hickel 1994; Botton et al. 2000). This potential misidentification in previous reports may be a result of the close similarity between the workers of both species, the notoriety of *L. humile* as a pest, and identification errors related to the morphological characteristics (Wild 2007). Because *L. micans* is the most frequently found species in vineyards infested *by E. brasiliensis*, *L. micans* must be considered the principal species related to *E. brasiliensis*, and should be an important target of control actions to reduce the spread of *E. brasiliensis*.

Acknowledgments

The authors thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and FAPERGS (Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul) for financial support and for the award of scholarships.

References Cited

Abbott KL, Green PT. 2007. Collapse of an ant-scale mutualism in a rainforest on Christmas Island. Oikos 116: 1238–1246.

Addison P, Samways MJ. 2000. A survey of ants (Hymenoptera: Formicidae) foraging in Western Cape vineyards of South Africa. African Entomology 8: 251–260.

Albuquerque EZD, Diehl E. 2009. Análise faunística das formigas epígeas (Hymenoptera, Formicidae) em campo nativo no Planalto das Araucárias, Rio Grande do Sul. Revista Brasileira de Entomologia 53: 398–403.

Andersen AN. 2000. Global ecology of rainforest ants: functional groups in relation to environmental stress and disturbance, pp. 25–34 *In* Agosti D, Majer JD, Tennant A, Schultz T [eds.], Ants: Standard Methods for Measuring and Monitoring Biodiversity. Smithsonian Institution Press, Washington, District of Columbia, USA.

AntWeb. California Academy of Sciences, http://www.antweb.org (last accessed 2 Oct 2012).

Bestelmeyer BT, Agosti D, Leeanne F, Alonso T, Brandão CRF, Brown WL, Delabie JHC, Silvestre R. 2000. Field techniques for the study of ground-living ants: an overview, description, and evaluation, pp. 122–144 *In* Agosti D, Majer JD, Tennant A, Schultz T [eds.], Ants: Standard Methods for Measuring and Monitoring Biodiversity. Smithsonian Institution Press, Washington, District of Columbia, USA.

Bolton B. 1994. Identification Guide to the Ant Genera of the World. Harvard University Press, Cambridge, Massachusetts, USA.

Bolton B. 1995. A New General Catalogue of the Ants of the World. Harvard University Press, London, United Kingdom.

Bolton B. 2003. Synopsis and classification of Formicidae. Memoirs of the American Entomological Institute 71: 1–370.

Bodenheimer FS. 1995. Precis Décologie Animale. Payot, Paris, France.

Botton M, Schuck E, Hickel ER, Soria SJ. 2000. Bioecologia e controle da pérola-da-terra *Eurhizococcus brasiliensis* (Hempel, 1922) (Hemiptera: Margarodidae) na cultura da videira. Embrapa Uva e Vinho, Bento Gonçalves (Circular Técnica, 27).

Botton M, Teixeira I, Bavaresco A, Pastori PL. 2010. Use of soil insecticides to control the Brazilian ground pearl in vineyards. Revista Colombiana de Entomología 36: 20–24.

Buckley RC. 1987. Interactions involving plants, Homoptera, and ants. Annual Review of Ecology and Systematics 18: 111–135.

Campos T. 2012. Análise da distribuição dos subtipos de *Linepithema micans* (Formicidae: Dolichoderinae) na região Sul do Brasil através da ferramenta

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

molecular barcode. Monografia (Trabalho de conclusão de curso em Ciências Biológicas), Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, Brazil.

Chong CS, Hoffmann AA, Thomson LJ. 2007. Commercial agrochemical applications in vineyards do not influence ant communities. Environmental Entomology 36: 1374–1383.

Chong C, Thomson LJ, Hoffmann AA. 2011. High diversity of ants in Australian vineyards. Australian Journal of Entomology 50: 7–21.

Cuezzo F. 2003. Subfamilia Dolichoderinae, pp. 291–297 *In* Fernandéz, F. [ed.], Introducción a las Hormigas de la Región Neotropical. Instituto de Investigación de Recursos Biológicos Alexander Von Humbolt, Bogotá, Colombia.

Daane KM, Sime KR, Hogg BN, Cooper ML, Bianchi ML, Rust MK, Klotz JH. 2006. Effects of liquid insecticide baits on Argentine ants in California's coastal vineyards. Crop Protection 25: 592–603.

Daane KM, Sime KR, Fallon J, Cooper ML. 2007. Impacts of Argentine ants on mealybugs and their natural enemies in California's coastal vineyards. Ecological Entomology 32: 583–596.

Delabie JHC. 2001. Trophobiosis between Formicidae and Hemiptera (Sternorryncha and Auchenorryncha): An overview. Neotropical Entomology 30: 501–516.

Delabie JHC, Fowler HG. 1995. Soil and litter cryptic ant assemblages of Bahian cocoa plantations. Pedobiologia 39: 423–433.

Diehl E, Sanhudo CED, Diehl-Fleig E. 2004. Ground-dwelling ant fauna of sites with high levels of copper. Brazilian Journal of Biology 64: 33–39.

Efrom CFS, Botton M, Meyeri GA. 2012. Brazilian ground pearl damaging blackberry, raspberry and blueberry in Brazil. Ciência Rural 42: 1545–1548.

Emater (Empresa de Assistência Técnica e Extensão Rural). 2001. Manejo ecológico de solo com plantas de cobertura. Emater, Porto Alegre, Brazil.

Fazolin M. 1991. Análise faunística de insetos coletados com armadilha luminosa em seringueira no Acre. Tese (Doutorado), Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Piracicaba, Brazil.

Fernández F. 2003. Subfamília Myrmicinae, pp. 307–330 *In* Fernandéz, F. [ed], Introducción a las Hormigas de la Región Neotropical. Instituto de Investigación de Recursos Biológicos Alexander Von Humbolt, Bogotá, Colombia.

Fernández F, Sendoya S. 2004. Lista de las hormigas neotropicales. Biota Colombiana 5: 3–109.

Fowler HG, Forti LC, Brandão CRF, Delabie JHC, Vasconcelos HL. 1991. Ecologia nutricional de formigas, pp. 131–223 *In* Panizzi AR, Parra JRP [eds.], Ecologia Nutricional de Insetos e Suas Implicações no Manejo de Pragas. Manole, São Paulo, Brazil.

Gallotti BJ. 1976. Contribuição para o estudo da biologia e para o controle químico do *Eurhizococcus brasiliensis* (Hempel, 1922). Dissertação (Mestrado), Universidade Federal do Paraná, Curitiba, Brazil.

Geiger CA, Daane KM, Bentley WJ. 2001. Development of a sampling program for improved management of the grape mealybug. California Agriculture 55: 19–27.

Hameister TM, Diehl-Fleig ED, Diehl E. 2003. Comunidades de formigas (Hymenoptera: Formicidae) epígeas no morro de Itapeva, município de Torres, Rio Grande do Sul. Acta Biológica Leopoldensia 25: 187–196.

Haubert F, Diehl-Fleig E, Mayhé-Nunes AJ. 1998. Mirmecofauna de solo no município de São Leopoldo, Rio Grande do Sul: levantamento preliminar. Acta Biologica Leopoldensia 20: 103–108.

Hickel ER. 1994. Reconhecimento, coleta, transporte e depósito de ninfas da pérola-da-terra, *Eurhizococcus brasiliensis* (Hempel), pela formiga Argentina *Linepithema humile* (Mayr). Anais da Sociedade Entomológica do Brasil 23: 285–290.

Hickel ER, Peruzzo EL, Schuck E. 2008. Pirâmide etária e distribuição espacial da pérola-da-terra no Meio-Oeste Catarinense. Agropecuária Catarinense 22: 61–68.

Hölldobler B, Wilson EO. 1990. The Ants. Belknap Press of Harvard University Press, Cambridge, Massachusetts, USA.

Ketterl J, Verhaagh M, Bihn JH, Brandão CRF, Engels W. 2003. Spectrum of ants associated with *Araucaria angustifolia* trees and their relations to hemipteran trophobionts. Studies on Neotropical Fauna and Environment 38: 199–206.

Lobry De Bruyn LA. 1993. Ant composition and activity in naturally-vegetated and farmland environments on contrasting soil at Kellerberrin, Western Australia. Soil Biology and Biochemistry 25 (8): 1043–1056.

Longino JT. 2000. What to do with the data, pp. 186–203 *In* Agosti D, Majer JD, Tennant A, Schultz T [eds.], Ants: Standard Methods for Measuring and Monitoring Biodiversity. Smithsonian Institution Press, Washington, District of Columbia, USA.

Longino JT. 1994. Subfamília Ponerinae. *In* Solis A. [ed.], Las familias de insectos de Costa Rica. Instituto Nacional de Biodiversidad, Costa Rica, http://www.inbio.ac.cr/papers/insectoscr/ (last accessed on: 17 Nov 2012).

Marinho CGS, Zanetti R, Delabie JHC, Schlindwein MN, Ramos LS. 2002. Diversidade de formigas (Hymenoptera: Formicidae) da serapilheira em eucaliptais (Myrtaceae) e área de cerrado de Minas Gerais. Neotropical Entomology 31: 187–195.

Martinez-Ferrer MT, Grafton-Cardwell EE, Shorey HH. 2003. Disruption of parasitism of the California red scale (Homoptera: Diaspididae) by 3 ant species (Hymenoptera: Formicidae). Biological Control 26: 279–286.

Martins C, Bueno OC. 2009. Ocorrência de três haplótipos de *Linepithema micans* (Formicidae: Dolichoderinae) no Rio Grande do Sul e seu provável status de praga *In* Simpósio de Mirmecologia – 1º Simpósio Franco-Brasileiro de Mirmecologia, 2009, Ouro Preto. Anais do XIX Simpósio de Mirmecologia – 1º Simpósio Franco-Brasileiro de Mirmecologia. Ouro Preto, Minas Gerais, Brazil.

Martins C, Nondillo A, Martins VG, Botton M, Bueno OC. 2012. Occurrence of three haplotypes of *Linepithema micans* (Forel) (Hymenoptera: Formicidae) in Southern Brazil. Neotropical Entomology 41: 57–61.

Moreno DS, Haney PB, Luck RF. 1987. Chlorpyrifos and diazinon as barriers to Argentine ant (Hymenoptera: Formicidae) foraging on citrus trees. Journal of Economic Entomology 80: 208–214.

Morini MSC, Yashima M, Zene FY, Silva RR, Jahyny B. 2004. Observations on the *Acanthostichus quadratus* (Hymenoptera: Formicidae: Cerapachyinae) visiting underground bait and fruits of the *Syagrus romanzoffiana* in an area of the Atlantic forest, Brazil. Sociobiology 439: 573–578.

Peck SL, McQuaid B, Campbell CL. 1998. Using ant species (Hymenoptera: Formicidae) as a biological indicator of agroecosystem condition. Environmental Management 27: 102–1110.

Perfecto I, Vandermeer J. 2002. The quality of the agroecological matrix in a tropical montane landscape: ants in coffee plantations in southern Mexico. Conservation Biology 16: 174–182.

Picelli A. 2011. Comunidade de formigas (Hymenoptera: Formicidae) em cultivo de videiras no município de São Roque – São Paulo. Monografia (Trabalho de Conclusão de Curso em Ciências Biológicas), Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, Brazil.

Queiroz JM, Almeida FS, Pereira MPS. 2006. Conservação da biodiversidade e o papel das formigas (Hymenoptera: Formicidae) em agroecossistemas. Floresta e Ambiente 13: 37–45.

Rosado JLO, Gonçalves MG, Dröse W, Silva EJE, Krüger R, Feitosa RM, Loeck AE. 2012. Epigeic ants (Hymenoptera: Formicidae) in vineyards and grassland areas in the Campanha region, state of Rio Grande do Sul, Brazil. Check List 8: 1184–1189.

Sacchett F. 2006. Comunidades de formigas em vinhedos e espécies associadas com a dispersão de cistos da pérola-da-terra *Eurhizococcus brasiliensis* (Wille, 1922) (Hemiptera: Margarodidae). Dissertação (Mestrado em Biologia (Diversidade e Manejo da Vida Silvestre), Universidade do Vale do Rio dos Sinos, São Leopoldo, Brazil.

Sacchett F, Botton M, Diehl E. 2009. Ant species associated with the dispersal of *Eurhizococcus brasiliensis* (Hempel in Wille) (Hemiptera: Margarodidae) in vineyards of the Serra Gaúcha, Rio Grande do Sul, Brazil. Sociobiology 54: 943–954.

Silveira Neto S, Nakano O, Barbin D, Villa Nova VA. 1976. Manual de Ecologia dos Insetos. Editora Agronômica Ceres, São Paulo, Brazil.

Soria SJ, Camargo UA, Fraguas JC, Hochmuller DP, Braghini LC. 1997. Resultados de 12 anos de pesquisa no controle da pérola-da-terra no Sul do Brasil *In* Reunião Sul-Brasileira sobre pragasdo-solo, 1997, Santa Maria. Anais da XI Reunião Sul-Brasileira sobre pragasdo-solo, Santa Maria, Rio Grande do Sul, Brazil.

Soria SJV, Gallotti BJ. 1986. O margarodes da videira *Eurhizococcus brasiliensis* (Homoptera: Margarodidae): biologia, ecologia e controle no sul do Brasil. EMBRAPA/Centro Nacional de Pesquisa de Uva e Vinho, Bento Gonçalves, Brazil.

Theiling K, Croft BA. 1988. Pesticide side-effects on arthropod natural enemies: a database summary. Agriculture Ecosystems & Environment 21: 191–218.

Thomson LJ, Hoffmann AA. 2006. Field validation of laboratory-derived IOBC toxicity ratings for natural enemies in commercial vineyards. Biological Control 39: 507–515.

Vanek SJ, Potter DA. 2010. Ant-exclusion to promote biological control of soft scales (Hemiptera: Coccidae) on woody landscape plants. Environmental Entomology 39: 1829–1837.

Way MJ. 1963. Mutualism between ants and honeydew-producing Homoptera. Annual Review of Entomology 8: 307–344.

Wild AL. 2007. Taxonomic Revision of the Ant Genus *Linepithema* (Hymenoptera: Formicidae). University of California Press, Los Angeles, California, USA.

Wild AL. 2009. Evolution of the Neotropical ant genus *Linepithema.* Systematic Entomology 34: 49–62.

Wilson EO. 2003. *Pheidole* in the New World: a Dominant, Hyperdiverse Ant Genus. Harvard University Press, Cambridge, Massachusetts, USA.

Downloaded From: https://complete.bioone.org/journals/Florida-Entomologist on 28 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use