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Occurrence of Leaf-Cutting and Grass-Cutting Ants of the Genus *Atta* (Hymenoptera: Formicidae) in Geographic Regions of Brazil

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Abstract

Leaf-cutting ants are widely distributed in Brazil, particularly species of the genus *Atta*. We therefore described the occurrence of leaf-cutting and grass-cutting ant species of the genus *Atta*. Five routes comprising some of the main highways in the South, Southeast, Midwest, and North of Brazil were sampled, in addition to ants received from other 82 municipalities, composing 300 municipalities sampled. This is the first comprehensive study of *Atta* in Brazil. The following species and subespecies were found: *A. laevigata*, *A. capiguara*, *A. sexdens rubropilosa*, *A. sexdens piriventris*, *A. sexdens sexdens*, and *A. cephalotes*. *Atta laevigata* and *A. capiguara* were the species present in the largest number of the Brazilian municipalities sampled. *Atta sexdens piriventris* was only recorded in the southern region of Brazil. *Atta bisphaerica* presented lower expansion than *A. capiguara*. *Atta cephalotes* and *Atta opaciceps* are species of very restricted occurrence. Southeastern region was characterized by the occurrence of *A. capiguara* and *A. laevigata*. *Atta laevigata* exhibited a generalized pattern of occurrence in the Midwest and North. Our study contributes to a better understanding of the so far unknown occurrence of leaf-cutting and grass-cutting ants within Brazil.

Introduction

Leaf-cutting ants are known in Brazil as saúvas, the genus *Atta* Fabricius (tribe Attini, subfamily Myrmicinae). *Atta* occurs throughout the Neotropical region (Mariconi, 1970) and can cause severe losses to the forest and agricultural sector of Latin American countries (Mariconi, 1970; Fowler et al., 1989; Jaffé, 1993). However, leaf-cutting ants are ecosystem engineers as they move massive amounts of soil during nest construction and remove foliage, which may change plant composition, acting as herbivores in natural systems (Farji-Brener & Illes, 2000; Urbas et al., 2007; Costa et al., 2008; Meyer et al., 2011; Leal et al., 2014; Stephan et al., 2015). In agricultural areas these alteration of the soil and the attack on plants led to the classification as pest insects (Fowler et al., 1989).

According to Mariconi (1970), leaf-cutting ants show a wide geographic distribution, occurring from the south of the United States (latitude 33° N) to central Argentina (latitude 44° S). The geographic distribution, frequency and density of Attini ants in certain habitats is related to the environmental conditions such as type of vegetation, soil type, cultivation systems, climate change (Fowler, 1983; Farji-Brener & Ruggiero, 1994; Gusmão & Loeck, 1999; Farji-Brener et al., 2016), among others.

According to Brandão et al. (2011), the genus *Atta* includes 19 species, of which nine occur in Brazil, *Atta bisphaerica* Forel, 1908, *Atta capiguara* Gonçalves, 1944,

Atta cephalotes (Linnaeus, 1758), *Atta goiana*, Gonçalves, 1942, *Atta laevigata* (Smith, F. 1858), *Atta opaciceps* Borgmeier, 1939, *Atta robusta* Borgmeier, 1939, *Atta sexdens* Linnaeus, 1758 and *Atta wollenweideri* Forel, 1893 (Bolton et al., 2006; Delabie et al., 2011). The species *A. sexdens* comprises three subspecies, *A. sexdens sexdens*, *A. sexdens piriventris* and *A. sexdens rubropilosa* (Mariconi, 1970; Della Lucia et al., 1993; Bacci et al., 2009).

The available information on the distribution of leaf-cutting ants in Brazil is found in a dispersed and unevenly updated form (Delabie et al., 2011). For the Brazilian regions, few studies on the subject have been conducted, highlighting the pioneering works of Gonçalves (1942, 1945, 1951, 1955, 1960, 1961, 1967, 1971) and Kempf (1972), who generated a broader knowledge on the distribution of species in the different regions of Brazil, and Paula (1956) for the State of Paraná and Mariconi (1966, 1970) for the State of São Paulo. More recent are the studies developed by Loeck and Grützmacher (2001) and Grürzmacher et al. (2002), for leaf-cutting ants in Rio Grande do Sul and Corrêa et al. (2005) and Brito et al. (2012) for the Northeastern region, States of Alagoas and Bahia, respectively. The contributions on timely reports of the occurrence of leaf-cutting ants, such as Carvalho and Tarragô (1982) for Rio Grande do Sul, Delabie (1989) for Bahia and Souza et al. (2009) for Alagoas are also noteworthy. Some authors have compiled the existing literature on the occurrence and/or geographic distribution of leaf-cutting ants in Brazil, such as the work of Della Lucia et al. (1993), Forti and Boaretto (1997) and Delabie et al. (2011).

In general, *A. sexdens* presents the broadest geographical distribution, occurring in all regions of Brazil, followed by *A. laevigata*, while the other species are restricted to certain Brazilian regions or states, such as *A. robusta*, which only occurs in Rio de Janeiro (Mariconi, 1970; Della Lucia et al., 1993) and Espírito Santo (Teixeira et al., 2003). It is observed that studies on the distribution of leaf-cutting ants of the genus *Atta* in Brazil date from at least five decades. The objective of this study was to describe the current occurrence of leaf-cutting and grass-cutting ants of the genus *Atta* in geographic regions of Brazil.

Material and Methods

For the survey of leaf-cutting and grass-cutting ants of the genus *Atta*, five routes comprising some of the main highways in Brazil were sampled, beginning with the city of Botucatu, São Paulo (22°50'46"S and 48°26'02"W). The sampling was performed in 218 municipalities of the five itineraries established: 1) Botucatu (São Paulo State) to Iepê (São Paulo State), covering 48 municipalities; 2) Ibiporã (Paraná State) to Quintana (São Paulo State), with 30 municipalities; 3) Oiapoque (Amapa State) to Santa Isabel do Pará (Para State), covering four municipalities, 4) Pirajuí (São Paulo State) to Avaré (São Paulo State), with 83 municipalities; 5) Aparecida do Taboado (Mato Grosso Sul State) to Ivinhema (Mato Grosso Sul State), comprising 53 municipalities (Table 1). Every 100 km, in a 500 m long by 50 m wide strip, marked at random, specimens of soldier ants were collected from the colonies found. The colonies were visually searched for and selected because of the huge size of their nests (large amount of loose soil removed). We selected the municipalities nearest to the main roads. At each sampling site, at least five exemplars of the ants found on the nests or on the foraging trails were collected. All material collected at each sampling site was stored in glass flasks containing 70% alcohol and labeled with the data obtained for subsequent analysis. Latitude and longitude of the sampling municipalities were obtained with a global positioning system (Sony GPS – 360), whenever possible. After each trip, all material collected was sent to the Laboratory of Social Insect Pests (LISP) at FCA/UNESP, Botucatu, SP.

In addition to the collections made in routes, biological material from other 82 municipalities in different regions of Brazil were duly collected and sent for identification, making up the total of 300 sampled municipalities (Table 2).

After screening, the specimens were mounted and identified under a stereo microscope based on the data published by Gonçalves (1961) and using the identification keys of Borgmeier (1959) and Mariconi (1970). For *Atta sexdens*, the division into subspecies according to Bacci et al. (2009) was considered. All material obtained was compared with specimens stored in the Museum of Zoology, University of São Paulo, and in the Ângelo Moreira da Costa Lima Entomology Collection of Universidade Federal Rural do Rio de Janeiro. The material of this study was stored in Museum of Zoology, University of São Paulo.

Results

Considering the 300 sampled municipalities (Table 3), frequency of leaf-cutting ant species are: *Atta laevigata* (32.6%), *A. capiguara* (20.0%), *A. sexdens rubropilosa* (10.0%), *A. sexdens piriventris* (9.7%), *A. sexdens sexdens* (2.7%), *A. cephalotes* (1.6%), *A. opaciceps* (0.3%), *A. bisphaerica* (0.3%), and *A. vollenweideri* (0.3%). Our results showed that *Atta laevigata* and *A. capiguara* were the species present in the largest number of the sampled municipalities (Fig 1); *Atta sexdens piriventris* was only recorded in the South region of Brazil, with predominance in the states of Santa Catarina and Rio Grande do Sul; *Atta bisphaerica* presented restricted occurrence, only at the state of São Paulo. *Atta cephalotes* and *A. opaciceps*, were collected in the expected regions, North and Northeast, respectively. The Southeast region was characterized by the occurrence of *A. capiguara* and *A. laevigata*, in this order, with *A. laevigata* being the most frequent species in Minas Gerais and *A. capiguara* in Paraná. The occurrence of *A. laevigata* was recorded for the first time in Amapá and Rio Grande do Sul.

Table 2. Geographical location of the collect sites of material received in the laboratory of Social Insects-Prague for identification.

State	County	Longitude	Latitude
Alagoas	Maceió	-09°66’58”	-35°73’52”
Amapá	Porto Grande	-00°71’33”	-51°41’33”
Bahia	Barra do Cacau	-11°08’94”	-43°14’16”
Bahia	Barra do Rocha	-14°21’05”	-39°60’19”
Bahia	Mangue Seco	-11°13’42”	-36°29’14”
Bahia	Maraú	-14°10’30”	-39°01’47”
Bahia	Salvador	-12°97’11”	-38°51’08”
Distrito Federal	Brasília	-15°77’97”	-47°93’00”
Goiás	Caldas Novas	-17°74’16”	-48°63’05”
Maranhão	São Luís	-02°52’97”	-44°30’27”
Minas Gerais	Araxá	-19°59’33”	-46°04’05”
Minas Gerais	Itaguara	-20°30’22”	-44°48’75”
Minas Gerais	Jaíba	-15°33’83”	-43°67’44”
Minas Gerais	Piumhi	-20°46’52”	-45°95’80”
Minas Gerais	São Gonçalo do Abaeté	-18°33’83”	-45°83’33”
Mato Grosso	Campo Novo dos Parecis	-13°67’52”	-57°89’19”
Mato Grosso	Sapezal	-12°98’94”	-58°76’41”
Pernambuco	Petrolina	-09°39’86”	-40°50’08”
Paraná	Arapoti	-24°15’07”	-49°82’66”
Paraná	Bandeirantes	-23°11’00”	-50°36’75”
Paraná	Cornélio Procópio	-23°18’11”	-50°64’66”
Paraná	Curitiba	-25°42’77”	-49°27’30”
Paraná	Doutor Camargo	-23°55’58”	-52°21’80”
Paraná	Guarapuava	-25°39’52”	-51°45’80”
Paraná	Matelândia	-25°24’08”	-53°99’63”
Paraná	Palotina	-24°28’38”	-53°84’00”
Paraná	Paranaguá	-25°31’00”	-48°31’00”
Paraná	Paula Freitas	-26°20’83”	-50°93’80”
Paraná	Porto Vitória	-26°16’11”	-51°23’16”
Paraná	Telêmaco Borba	-24°32’38”	-50°61’55”
Rio de Janeiro	Angra dos Reis	-23°06’61”	-44°31’80”
Rio de Janeiro	Parati	-23°21’77”	-44°71’30”
Rio Grande do Sul	Passo Fundo	-28°26’27”	-52°40’66”
Rio Grande do Sul	Arroio dos Ratos	-30°07’72”	-51°72’91”
Rio Grande do Sul	Butiá	-30°11’97”	-51°96’22”
Rio Grande do Sul	Charqueadas	-30°73’27”	-51°64’53”
Rio Grande do Sul	Gravataí	-29°94’44”	-50°99’19”
Rio Grande do Sul	Porto Alegre	-30°03’30”	-51°23’00”
Rio Grande do Sul	Tapes	-30°67’33”	-51°39’58”
Santa Catarina	Abelardo Luz	-26°56’47”	-52°32’83”
Santa Catarina	Caibí	-27°07’16”	-53°24’77”
Santa Catarina	Cordilheira Alta	-26°95’88”	-52°76’11”
Santa Catarina	Coronel Freitas	-26°90’86”	-52°70’30”
Santa Catarina	Cunha Porã	-26°89’36”	-53°16’80”
Santa Catarina	Descanso	-26°82’61”	-53°50’16”
Santa Catarina	Dionisio Cerqueira	-26°25’05”	-53°63’97”
Santa Catarina	Galvão	-26°45’05”	-52°68’58”
Santa Catarina	Irani	-27°02’47”	-51°90’16”
Santa Catarina	Ita	-27°29’05”	-52°32’30”
Santa Catarina	Itapiranga	-27°16’94”	-53°73’22”
Santa Catarina	Jupiá	-26°39’83”	-52°72’77”
Santa Catarina	Maravilha	-26°76’08”	-53°17’25”
Santa Catarina	Nova Erexim	-26°90’25”	-52°90’58”
Santa Catarina	Palmitos	-27°06’75”	-53°16’11”
Santa Catarina	Pinhalzinho	-26°84’80”	-52°99’19”
Santa Catarina	Piratuba	-27°41’97”	-51°77’19”
Santa Catarina	Quilombo	-26°72’61”	-52°72’05”
Santa Catarina	São Carlos	-27°07’75”	-53°00’38”
Santa Catarina	São José Cedro	-26°45’05”	-53°49’41”
Santa Catarina	São Lourenço do Oeste	-26°35’91”	-52°85’11”
Santa Catarina	São Miguel do Oeste	-26°72’52”	-53°51’80”
Santa Catarina	Saudades	-26°92’41”	-53°00’30”
Santa Catarina	Vargeão	-26°86’36”	-52°15’05”
Santa Catarina	Xaxim	-26°96’16”	-52°53’47”
São Paulo	Agudos	-22°46’91”	-48°98’75”
São Paulo	Altinópolis	-21°02’55”	-47°37’38”
São Paulo	Assis	-22°66’16”	-50°41’22”
São Paulo	Cananéia	-25°01’47”	-47°92’66”
São Paulo	Eldorado	-24°52’00”	-48°10’80”
São Paulo	Franca	-20°53’86”	-47°43’03”
São Paulo	Igarapava	-20°03’83”	-47°74’69”
São Paulo	Itapetininga	-23°59’16”	-48°05’30”
São Paulo	Itatinga	-23°10’16”	-48°61’58”
São Paulo	Jaboticabal	-21°25’47”	-48°32’22”
São Paulo	Juquiá	-24°32’08”	-47°63’47”
São Paulo	Lençóis Paulista	-22°59’86”	-48°80’02”
São Paulo	Mongaguá	-24°09’16”	-46°61’77”
São Paulo	Nazaré Paulista	-23°18’11”	-46°39’05”
São Paulo	Peruíbe	-24°32’00”	-46°99’83”
São Paulo	Piracicaba	-22°72’52”	-47°64’91”
São Paulo	Santa Rosa de Viterbo	-21°47’27”	-47°36’30”
São Paulo	Ubatuba	-23°43’38”	-45°07’11”

Table 3. Percentage of municipalities (n = 300) with the occurrence of species and subspecies of *Atta* North, Northeast, Midwest, Southeast and South regions of Brazil.

Species	North	Northeast	Midwest	Southeast	South	Brazil
A. laevigata	6.0	0.3	20.3	5.0	1.0	32.6
A. capiguara	-*	-	8.7	7.0	4.3	20.0
A. sexdens rubropilosa	-	0.3	2.7	2.0	5.0	10.0
A. sexdens piriventris	-	-	-	-	9.7	9.7
A. sexdens sexdens	2.7	-	-	-	-	2.7
A. cephalotes	1.3	0.3	-	-	-	1.6
A. bisphaerica	-	-	-	0.3	-	0.3
A. opaciceps	-	0.3	-	-	-	0.3
A. vollenweideri	-	-	-	-	0.3	0.3

*No collection

Discussion

Atta laevigata

Atta laevigata was the only species found in all regions of Brazil (Fig 1). The results are consistent with previous studies that already indicated the occurrence of this species in the five Brazilian geographic regions (Castro et al., 1961; Della Lucia et al., 1993). Gonçalves (1967) reported the presence of *A. laevigata* in Manaus, Óbidos and São Gabriel (Northern region), where this species was found on roadsides and in crops, including under the shade of trees in covered areas. The Cerrado region is an adequate habitat for *A. laevigata*, as observed by high-density nests recorded in Cerrado areas also highlight the suitability of this vegetation type (Costa & Vieira-Neto, 2016).

Although in the present study the occurrence of *A. laevigata* was not recorded in the Northeast of Brazil, this species was found by Gonçalves (1951) in Ceará, Pernambuco and Bahia in dicotyledons, wild grasses, eucalyptus and cassava. Subsequently, Brito et al. (2012), recorded the occurrence of *A. laevigata* in four municipalities in southwestern Bahia, in areas of pasture, eucalyptus and forest. These municipalities are inserted in environments of Caatinga, Cerrado and deciduous seasonal forest. The Southeastern region of Brazil showed the third highest frequency of *A. laevigata* According to Antunes (1996), part of the southeastern region is occupied by Cerrado and a large area of Minas Gerais is covered with this type of vegetation. For the two states of the Southeastern Region (Minas Gerais and São Paulo), the occurrence of *A. laevigata* had already been recorded (Della Lucia et al., 1993).

The Cerrado biome (Brazilian Savanna) covers 2 million km^2 representing 23% of the area of the country. It is an ancient biome with rich biodiversity, estimated at 160,000 species of plants, fungi and animals (MMA, 2020). The predominant vegetation of the woods is composed of small trees with twisted trunks with irregular ramifications; with shrubs and sub-shrubs that may have xylopodios, underground organs, which allow regrowth after burning or cutting, this being denominate cerrado *senso stricto*, one of the various components of the physiognomy mosaic of the Cerrado biome. In the Southern region, *A. laevigata* was rarely frequent (Table 3). However, the record of its occurrence in Rio Grande do Sul (Southern Region, municipality of Tapes).

In general, *A. laevigata* partially present in many municipalities (Fig 1), mainly due to the opening of highways and expansion of livestock, which serve as means for the dispersion of the species (Vieira-Neto et al., 2016), as well as the opening of agricultural frontiers in Cerrado areas, which involve the deforestation of natural forests and the plantation of monocultures and pastures. The first reference of this species in Espírito Santo was confirmed in the work of Delabie (1998), whose author, after morphological studies of several samples of *A. laevigata* from different regions of Brazil, concluded that *Atta silvai* Gonçalves, registered in that state, is a junior synonym of *A. laevigata*. These species occurred in a greater percentage on sampled municipalities in relation to *A. sexdens*. This result is probably related to the collection sites that covered areas close to the highways and that favor the nesting of *A. laevigata* (Forti et al., 2011). *A. laevigata* is aggressive in the selection of nesting areas, since nests are built in both sunny and shady (Mariconi, 1970; Pereira da Silva, 1975; Moreira et al., 2004) and the forager workers select mono and dicotyledonous plants as growth substrate of the symbiont fungus (Della Lucia et al., 1993; Forti et al., 2011).

Atta capiguara

The species *A. capiguara*, commonly known as brown leaf-cutting ant, exploits monocotyledon plants, basically grasses, and is economically important in sugarcane fields and pastures (Amante, 1967; Mariconi, 1970; Forti, 1985). *Atta capiguara* was found in the Southeast, Mid-west and South regions in 7.0%, 8.7% and 4.3% of sampled municipalities more restricted in its Brazilian distribution range. Its occurrence had already been reported for the states of São Paulo, Mato Grosso and Minas Gerais (Della Lucia et al., 1993) and also for Paraná, Mato Grosso do Sul and Goiás (Forti & Boaretto, 1997).

The highest concentration of *A. capiguara* was observed in the State of Paraná (Southern Region) (Fig 1). The common

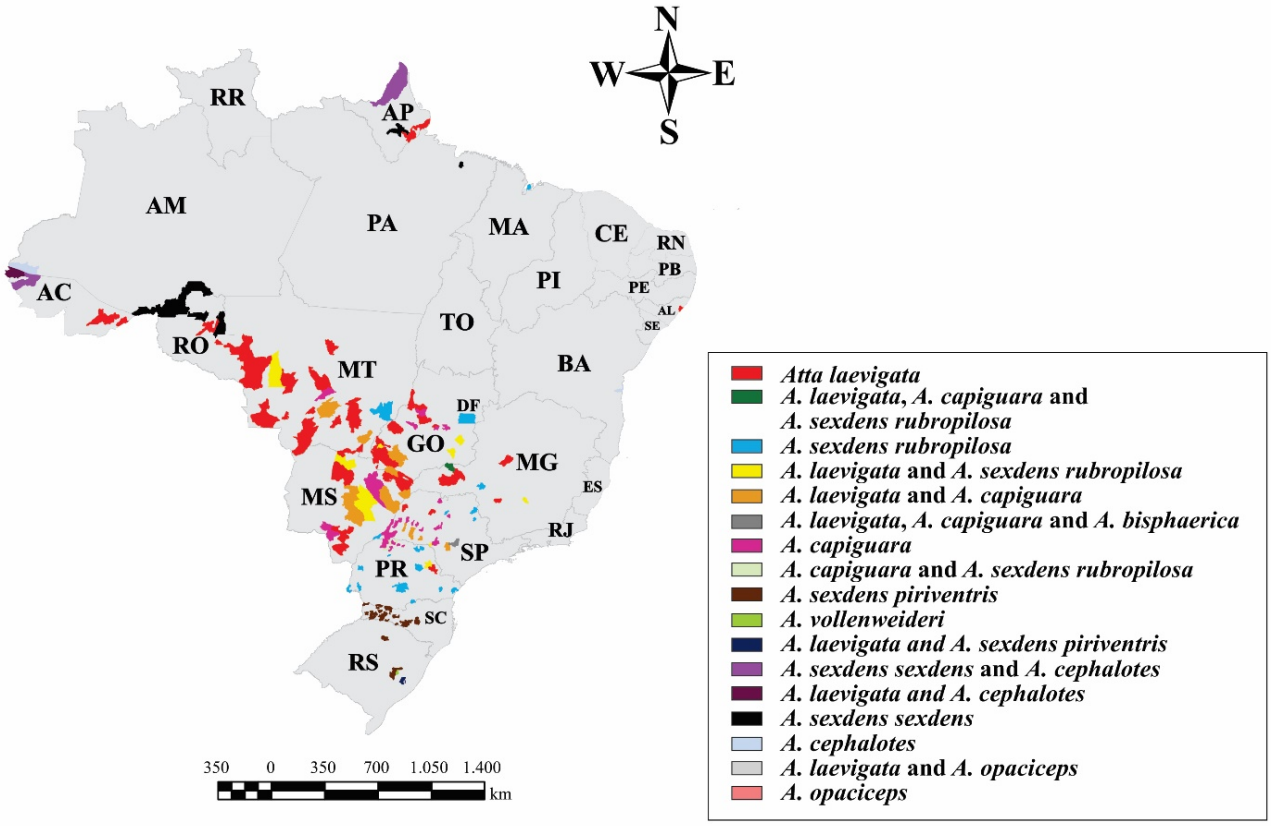

Fig 1. *Atta s*pecies recorded in the municipalities of the North, Northeast, Midwest, Southeast and Southern regions of Brazil.

characteristics of municipalities where *A. capiguara* was found are sandy soil and plant nutrient deficiency, as well as the native vegetation classified as Tropical Forest (BRAZIL, 1998).

Smaller size forests resembling secondary forests occur in these soils were naturally fertility is poor and used as pasture lands (Wons, 1985). The characteristics of the Cerrado are typical in most parts of this ecoregion, but gradual changes are observed due to climatic influences of neighboring regions (Adámoli et al., 1986). Two parameters should be highlighted since they define the characteristics of the seasonal regime of this region: the average annual rainfall of 1,200 to 1,800 mm and the duration of the dry season that ranges from 5 to 6 months. The average annual temperature is 22 °C in the southern part of this ecoregion and 27 °C in the northern part. Its vegetation consists of isolated or groups of winding small trees on a continuous grass rug (BRAZIL, 1998).

The importance of *A. capiguara* has been known since the 1940s, with observations of nests in some localities with predominance of grasses in municipalities of the State of São Paulo (Gonçalves, 1945). Surveys conducted in other municipalities increased the occurrence of this species to 17 municipalities (Mariconi et al., 1961). Mariconi (1966b) also recorded the occurrence of *A. capiguara* in 104 municipalities in the western region of the State of São Paulo. Amante (1967) cited the occurrence of *A. capiguara* in Mato Grosso do Sul and Minas Gerais. Although not mentioning the municipalities, Thomas (1990) reported that *A. capiguara* had become a serious problem in two municipalities of the northwestern region of Paraná after 1975 and, by 1990, this species had damaged pastures in more than 32 municipalities of that state.

Many factors could have contributed to the population explosion of this species, such as disturbances caused by humans when they replaced the natural vegetation with grass monocultures (Forti & Boaretto, 1997). According to Thomas (1990), the reduction of areas with natural vegetation and the substitution of crops such as coffee, peanuts and other crops for pastures facilitated the rapid growth of *A. capiguara* infestation in Paraná. The increased availability of monocotyledonous plants, especially exotic grasses, allows grass-cutting ants to expand their distribution and increase population density (Cherrett, 1981).

Atta sexdens

The subspecies *A. sexdens rubropilosa* was registered in all Brazilian regions (Fig 1), except in the North, while *A. sexdens piriventris* and *A. sexdens sexdens* were of more restricted occurrence, only in the South and North regions, respectively. This result reflects the adaptability de *A. sexdens rubropilosa* to the different environmental conditions of the country (Farji-Brener & Ghermandi, 2008). A large number of studies on this leaf-cutting ant subspecies are available and its occurrence has been reported in several states, including Minas Gerais, Espírito Santo, Goiás, Mato Grosso, São Paulo, Paraná, Rio de Janeiro and Distrito Federal (Gonçalves, 1945; Della Lucia et al., 1993). *Atta sexdens piriventris* was observed in the South region. The occurrence of this subspecies was

predominant in Santa Catarina. In the state of Rio Grande do Sul, *A. sexdens piriventris* occurred in most of the sampled municipalities, corroborating the studies by Loeck and Grützmacher (2001) and Grürzmacher et al. (2002).

The main environmental characteristics that distinguish this region from other areas are lower average temperatures (16° C and 20° C) and uniform rainfall throughout the year, which are typical of subtropical climates (Antunes, 1996). Associated with this climate, the vegetation ranges from Atlantic Rainforest, Tropical Forest and Araucaria Forest to fields and coastal vegetation (Carraro, 1994). Supporting the hypothesis that this species tends to occupy climate environments such as those described above, in the State of Paraná this species was only found in the municipality of Paula Freitas, located at the southern end of the state (Fig 1). The north of Paraná, where a significant number of the municipalities visited are located, is found in an intertropical transition zone characterized by high average temperatures and a rainy period concentrated in the summer months (Antunes, 1996).

This distribution in Paraná resembles that observed in the Southeast and, within this region, in the State of São Paulo (Fig 1). This fact is possibly associated with the similar environmental conditions in these border states, since the municipalities sampled in Paraná are concentrated in the northern and northwestern regions of the state as mentioned above.

The subspecie *Atta sexdens sexdens* was exclusively recorded in the northern region (Fig 1). However, the occurrence of this subspecies has already been reported by Della Lucia et al. (1993) for the Mid-west, Northeast and Southeast regions. According to Delabie (1989), this leaf-cutting ant occurs in the State of Bahia (Northeast Region of Brazil) in more open areas and is more generalist in its foraging, attacking several dicotyledonous plants of economic importance (cacao, cassava and citrus) and also forage grasses, being more abundant in pastures. The occurrence of this ant in the state of Alagoas (Northeast Region of Brazil) was recorded by Souza et al. (2009).

Atta cephalotes

Atta cephalotes was found in the North region, in 1.3% of sampled municipalities. The State of Amazonas (North Region) was represented by only one locality (Guajará) where *A. cephalotes* was collected. The occurrence of *A. cephalotes* was recorded during the travels in Oiapoque (Amapá) and in Cruzeiro do Sul and Mâncio Lima (Acre) (Fig 1), as well as in material sent for identification from Maraú in Bahia (North region) (Fig 1), sites of occurrence of this species already cited in the literature. This result was expected, because *A. cephalotes* is a species easily found in the forests of Amazonia and is the most demanding leaf-cutting ant in terms of soil moisture (Gonçalves, 1960). In the Northeast region, this ant had already been reported to the States of Maranhão, Pernambuco, Bahia (Mariconi, 1970; Kempf, 1972) and Alagoas (Corrêa et al., 2005).

Atta bisphaerica

In this work, *A. bisphaerica* occurred only in the Southeast region (Fig 1), in the municipality of Botucatu, São Paulo, which was not expected, considering that the possibilities of expansion of this ant, as well as in *A. capiguara*, are associated with the substitution of natural vegetation and agricultural crops by pasture and sugarcane, since this species preferentially cuts monocotyledonous plants, it was expected an increase of its occurrence. For example, in the state of São Paulo, *A. capiguara* (Amante, 1972) and *A. bisphaerica* (Precetti et al., 1988) are of great economic importance in sugarcane and pasture, but only *A. capiguara* has high occurrence. Nevertheless, *A. bisphaerica* has been more associated to sugarcane and *A. capiguara* to pasture areas. In sugarcane crops, the chemical control of leaf-cutting ants is quite intense, with the systematic use of thermonebulization, contributing to a significant reduction of nest density, which usually does not occur in pastures, which could explain the lower expansion of *A. bisphaerica* in relation to *A. capiguara*.

The occurrence of *A. bisphaerica* had already been reported in other states of Southeastern Brazil (Minas Gerais and Rio de Janeiro), as well as in the Mid-western region (Mato Grosso) (Della Lucia et al., 1993).

Atta opaciceps

The occurrence of *A. opaciceps* was observed in the Northeast region, state of Alagoas (municipality of Maceió) (Fig 1), a finding also reported by Souza et al. (2009), but was distributed in the Caatinga region. The occurrence of this species was also reported for the states of Sergipe (Delabie et al., 1997) and Bahia (Delabie et al., 1997; Brito et al., 2012) for the North and Southweste regions of Brazil. The hypothesis raised by Fowler et al. (1990) that this leaf-cutting ant could be in extinction has not been confirmed.

Atta vollenweideri

Atta vollenweideri, which usually cuts the leaves of grasses and dicotyledons, was recorded only in the South region, in the municipality of Arroio dos Ratos, state of Rio Grande do Sul (Fig 1). This species is of very restricted occurrence, being recorded only for two Brazilian states, Rio Grande do Sul (Gonçalves, 1960; 1971; Jonkman, 1978; Della Lucia et al., 1993) and Mato Grosso (Della Lucia et al., 1993).

In general, the results expand the knowledge about leaf-cutting ants of the *Atta* genus in Brazilian regions, since the work encompassed many municipalities until then not sampled. The first record of the occurrence of *A. laevigata* in Amapá and Rio Grande do Sul, as well as the presence of *A. opaciceps* in municipalities of Alagoas, a quite what positive aspect once it were already raice possibility treat of being a species extinction. *Atta laevigata, A. sexdens* (considering its subspecies) and *A. capiguara* are species of wide occurrence in the Brazilian territory. *Atta cephalotes, A. bisphaerica, A. opaciceps and A. vollenweideri* are species of very restricted occurrence.

We consider that the data presented in this work can be integrated into the databases on leaf-cutting ants, the example of created and used by Delabie et al. (2011), to expand the studies of regional clusters with identification of the main associated vectors and that allow the prediction of the occurrence of *Atta* species.

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Table 1. Geographical location of the collect sites visited by routes (I to V), during the trips.

State	Route	County	Longitude	Latitude
São Paulo	I	Botucatu	-22°50’46”	-48°26’02”
São Paulo	I	Bauru	-22º31’47”	-49º06’05”
São Paulo	I	Marília	-22º21’38”	-49º94’58”
São Paulo	I	Rancharia	-22°25’50.8”	-50°59’33.7”
São Paulo	I	Presidente Prudente	-22°21’42.4”	-51°08’09.4”
São Paulo	I	Ourinhos	-23°00’16.2”	-49°51’31.2”
São Paulo	I	Santa Cruz do Rio Pardo	-22°89’88”	-49°63’25”
São Paulo	I	Iepê	-22°66’05”	-51°07’61”
Paraná	I	Santo Inácio	-22°42’59.7”	-51°46’09,8”
Paraná	I	Colorado	-22º83’75”	-51º97’30”
Paraná	I	Paranacity	-22°55’00”	-52°09’09.4”
Paraná	I	Inajá	-22º74’91”	-52º19’80”
Paraná	I	São João do Caiuá	-22°56’25.5”	-52°22’32.4”
Paraná	I	Santo Antonio do Caiuá	-22º73’47”	-52º 34’22”
Paraná	I	Tamboara	-23°13’29.2”	-52°35’19.9”
Paraná	I	Santa Helena	-24º86’02”	-54º33’27”
Paraná	I	Umuarama	-23º76’63”	-53°32’05”
Paraná	I	Assis Chateaubriand	-24º42’00”	-53°52’13”
Paraná	I	Toledo	-24º71’36”	-53°74’30”
Paraná	I	Vera Cruz do Oeste	-25º05’77”	-53°87’69”
Paraná	I	Missal	-25º09’19”	-54º24’75”
Paraná	I	São Miguel do Iguaçú	-25º34’80”	-54º23’77”
Paraná	I	Foz do Iguaçú	-25°54’77”	-54°58’80”
Paraná	I	Cascavel	-24º95’58”	-53º45’52”
Paraná	I	Ampere	-25º91’05”	-53º47’27”
Paraná	I	Capitão Leônidas Marques	-25º47’91”	-53º61’41”
Paraná	I	Rio Negro	-26°06’00”	-49°48’00”
Paraná	I	Campo do Tenente	-25°97’80”	-49°68’27”
Paraná	I	Ponta Grossa	-25°06’00”	-50°10’00”
Paraná	I	Ortigueira	-24º20’83”	-50º94’94”
Paraná	I	Imbaú	-24°44’05”	-50°76’08”
Paraná	I	Astorga	-23º23’25”	-51°66’55”
Paraná	I	Maringá	-23º42’52”	-51°93’86”
Paraná	I	Londrina	-23°31’02”	-51°16’27”
Paraná	I	Assaí	-23°37’33”	-50°84’13”
Paraná	I	Ibaiti	-23°84’86”	-50°18’77”
Paraná	I	Santo Antônio da Platina	-23°29’05”	-50°07’72”
Santa Catarina	I	Chapecó	-27°07’00”	-52°37’00”
Santa Catarina	I	Cunhaporã	-26º89’36”	-53°16’80”
Santa Catarina	I	Xanxerê	-26°56’02.2”	-52°29’55.4”
Santa Catarina	I	Catanduvas	-27°07’05”	-51°66’16”
Santa Catarina	I	Campos Novos	-27°40’16”	-51°22’05”
Santa Catarina	I	Curitibanos	-27°18’10.7”	-50°42’24.4”
Santa Catarina	I	Blumenau	-26°55’00”	-49°03’00”
Santa Catarina	I	Lages	-27°81’61”	-50°32’61”
Santa Catarina	I	Pouso Redondo	-27°15’29”	-49°46’02”
Santa Catarina	I	Ibirama	-27º05’69”	-49°51’77”
Santa Catarina	I	Corupá	-26°42’52”	-49°24’30”
Paraná	II	Ibiporã	-23º26’91”	-51°04’80”
Paraná	II	Sertanópolis	-23°05’86”	-51°03’63”
Paraná	II	Bela Vista do Paraíso	-22°99’66”	-51°19’05”
Paraná	II	Florestópolis	-22°86’33”	-51°38’72”
Paraná	II	Jaguapitã	-23º11’27”	-51°53’19”
Paraná	II	Guaraci	-22°97’30”	-51°64’97”
Paraná	II	Santa Fé	-23°03’75”	-51°80’52”
Paraná	II	Flórida	-23°08’72”	-51°95’36”
Paraná	II	Atalaia	-23°10’50.6”	-52°05’50.7”
Paraná	II	Nova Esperança	-23°12’41”	-52°11’31”
Paraná	II	Paranavaí	-23°07’30”	-52°46’52”
Paraná	II	Presidente Castelo Branco	-23°27’80”	-52°15’16”
Paraná	II	São Jorge do Ivaí	-23°43’27”	-52°29’30”
Paraná	II	Cianorte	-23°66’33”	-52°60’05”
Paraná	II	Campo Mourão	-24°04’55”	-52°38’30”
Paraná	II	Jaguariaíva	-24°79’11”	-50°01’19”
Paraná	II	Guaíra	-24°08’00”	-54°25’58”

Table 1. Geographical location of the collect sites visited by routes (I to V), during the trips. (Continuation)

State	Route	County	Longitude	Latitude
Paraná	II	Pérola	-23°80’47”	-53°68’36”
Paraná	II	Cafezal do Sul	-23°90’22”	-53°51’25”
Paraná	II	Santa Isabel do Ivaí	-23°00’27”	-53°19’66”
São Paulo	II	Porto Primavera	-22°29’08”	-52°35’43”
São Paulo	II	Teodoro Sampaio	-22°53’25”	-52°16’75”
São Paulo	II	Mirante do Paranapanema	-22°29’19”	-51°90’63”
São Paulo	II	Presidente Epitácio	-21°76’33”	-52°11’55”
São Paulo	II	Presidente Venceslau	-21°54’24”	-51°48’08”
São Paulo	II	Dracena	-21°48’25”	-51°53’27”
São Paulo	II	Flórida Paulista	-21°61’47”	-51°17’36”
São Paulo	II	Osvaldo Cruz	-21°79’66”	-50°87’86”
São Paulo	II	Universo	-22°16’27”	-50°68’15”
São Paulo	II	Quintana	-22°07’25”	-50°87’86”
Amapá	III	Oiapoque	-03°84’30”	-51°83’05”
Amapá	III	Clevelândia do Norte	-03°92’21”	-51°84’10”
Amapá	III	Macapá	-00°03’88”	-51°06’64”
Pará	III	Santa Isabel do Pará	-01°29’86”	-48°16’05”
São Paulo	IV	Pirajuí	-21°99’86”	-49°45’72”
São Paulo	IV	Penápolis	-21°41’97”	-50°07’05”
São Paulo	IV	Andradina	-20°89’61”	-51°37’94”
Mato Grosso do Sul	IV	Três Lagoas	-20°75’11”	-51°67’83”
Mato Grosso do Sul	IV	Água Clara	-20°31’30”	-52°35’43”
Mato Grosso do Sul	IV	Mutum	-20°17’23”	-52°39’51”
Mato Grosso do Sul	IV	Ribas do Rio Pardo	-20°44’30”	-53°75’91”
Mato Grosso do Sul	IV	Campo Grande	-20°29’55”	-54°36’39”
Mato Grosso do Sul	IV	Anhanduí	-20°37’65”	-54°13’49”
Mato Grosso do Sul	IV	Nova Alvorada do Sul	-21°46’58”	-54°38’38”
Mato Grosso do Sul	IV	Jaraguari	-19°46’27”	-54°21’42”
Mato Grosso do Sul	IV	Bandeirantes	-19°36’35”	-54°23’17”
Mato Grosso do Sul	IV	São Gabriel do Oeste	-19°03’03”	-54°47’58”
Mato Grosso do Sul	IV	Rio Verde de Mato Grosso	-18°91’80”	-54°84’41”
Mato Grosso do Sul	IV	Coxim	-18°50’66”	-54°76’00”
Mato Grosso do Sul	IV	Piúva	-18°27’33”	-54°15’02”
Mato Grosso do Sul	IV	Sonora	-17°57’69”	-54°75’77”
Mato Grosso	IV	Anhumas	-17°23’47”	-54°45’27”
Mato Grosso	IV	Pedra Preta	-16°62’30”	-54°47’38”
Mato Grosso	IV	Jaciara	-16°42’13”	-54°72’57”
Mato Grosso	IV	Juscimeira	-16°05’05”	-54°88’44”
Mato Grosso	IV	São Pedro da Cipa	-16°00’05”	-54°92’13”
Mato Grosso	IV	São Vicente	-15°49’20”	-55°25’00”
Mato Grosso	IV	Cuiaba	-15°23’32”	-55°59’11”
Mato Grosso	IV	Jangada	-15°23’55”	-56°48’91”
Mato Grosso	IV	Rosário Oeste	-14°17’25”	-55°33’68”
Mato Grosso	IV	Nobres	-14°36’10”	-55°14’36”
Mato Grosso	IV	Posto Gil	-14°26’42”	-55°11’36”
Mato Grosso	IV	Nova Mutum	-13°37’57”	-52°02’04”
Mato Grosso	IV	Piúva	-13°18’45”	-56°24’21”
Mato Grosso	IV	Lucas do Rio Verde	-13°05’02”	-55°91’11”
Mato Grosso	IV	Sorriso	-12°54’52”	-55°71’13”
Mato Grosso	IV	Sinop	-11°86’41”	-55°50’25”
Mato Grosso	IV	Chapada dos Guimarães	-15°26’04”	-55°46’49”
Mato Grosso	IV	Campo Verde	-15°39’27”	-55°12’29”
Mato Grosso	IV	Coronel Ponce	-15°18’45”	-53°44’07”
Mato Grosso	IV	Primavera do Leste	-16°10’21”	-56°28’54”
Mato Grosso	IV	Poxoréo	-16°10’20”	-56°28’54”
Mato Grosso	IV	Presidente Murtinho	-15°37’59”	-53°57’49”
Mato Grosso	IV	Paredão Grande	-15°48’73”	-53°22’81”
Mato Grosso	IV	Coronel Meruri	-15°44’23”	-53°19’67”
Mato Grosso	IV	Alto Araguaia	-17°31’47”	-53°21’52”
Mato Grosso	IV	Barra do Garças	-15°46’36”	-52°33’44”
Goiás	IV	Bom Jardim de Goiás	-16°19’43”	-51°56’35”
Goiás	IV	Piranhas	-16°26’52”	-51°38’31”
Goiás	IV	Arenópolis	-16°38’61”	-51°56’02”
Goiás	IV	Iporá	-16°44’19”	-51°11’77”
Goiás	IV	Israelândia	-16°31’77”	-50°90’80”
Goiás	IV	Jussara	-15°85’05”	-50°86’80”
Goiás	IV	Fazenda Nova	-16°04’58”	-50°48’11”
Goiás	IV	Santa Fé de Goiás	-15°76’91”	-51°10’55”
Goiás	IV	Juscelândia	-15°40’67”	-51°43’58”
Goiás	IV	Aruanã	-15°02’40”	-51°05’54”
Goiás	IV	Araguapaz	-15°09’08”	-50°63’22”
Goiás	IV	Faina	-15°44’61”	-50°36’05”
Goiás	IV	Goiás	-15°09’08”	-50°63’22”
Goiás	IV	Itaberaí	-16°02’02”	-49°81’02”
Goiás	IV	Itauçú	-16°11’20”	-49°36’29”
Goiás	IV	Inhumas	-16°18’26”	-49°31’30”

Table 1. Geographical location of the collect sites visited by routes (I to V), during the trips. (Continuation)

State	Route	County	Longitude	Latitude
Goiás	IV	Anápolis	-16°32’66”	-48°95’27”
Goiás	IV	Leopoldo de Bulhões	-16°61’91”	-48°74’36”
Goiás	IV	Silvania	-16°65’88”	-48°60’80”
Goiás	IV	Vianópolis	-16°74’19”	-48°51’63”
Goiás	IV	Ourizona	-17°10’23”	-48°18’35”
Goiás	IV	Urutaí	-17°46’36”	-48°20’16”
Goiás	IV	Ipameri	-17°72’19”	-48°15’97”
Goiás	IV	Catalão	-18°16’58”	-47°94’63”
Minas Gerais	IV	Araguari	-18°64’72”	-48°18’72”
Minas Gerais	IV	Uberlândia	-18°43’54”	-48°13’22”
Minas Gerais	IV	Tupassiguara	-18°53’36”	-48°39’41”
Minas Gerais	IV	Monte Alegre de Minas	-18°87’05”	-48°88’08”
Minas Gerais	IV	Prata	-19°23’42”	-48°53’49”
Minas Gerais	IV	Frutal	-20°02’47”	-48°94’05”
São Paulo	IV	Nova Granada	-20°53’38”	-49°31’41”
São Paulo	IV	São José do Rio Preto	-20°81’97”	-49°37’94”
São Paulo	IV	Catanduva	-21°13’77”	-48°97’27”
São Paulo	IV	Santa Adélia	-21°24’27”	-48°80’41”
São Paulo	IV	Ururaí	-21°39’62”	-48°29’34”
São Paulo	IV	Matão	-21°60’33”	-48°36’58”
São Paulo	IV	Boa Esperança do Sul	-21°50’38”	-49°34’52”
São Paulo	IV	Barra Bonita	-22°49’47”	-48°55’80”
São Paulo	IV	Espírito Santo do Turvo	-22°69’22”	-49°43’02”
São Paulo	IV	Avaré	-23°89’06”	-48°92’58”
Mato Grosso do Sul	V	Aparecida do Taboado	-20°08’66”	-51°09’36”
Mato Grosso do Sul	V	Raimundo	-19°25’22”	-51°23’03”
Mato Grosso do Sul	V	Mâncio Lima	-07°34’09”	-72°49’42”
Mato Grosso do Sul	V	Guajará	-07°03’23”	-72°34’24”
Mato Grosso do Sul	V	Dourados	-22°15’40”	-54°69’18”
Mato Grosso do Sul	V	Caarapó	-22°63’41”	-54°82’22”
Mato Grosso do Sul	V	Amambai	-23°04’58”	-55°08’41”
Mato Grosso do Sul	V	Sanga Puitã	-22°58’35”	-55°87’29”
Mato Grosso do Sul	V	Ponta Porã	-22°53’61”	-55°72’55”
Mato Grosso do Sul	V	Jateí	-22°48’19”	-54°30’25”
Mato Grosso do Sul	V	Deodápolis	-22°31’52”	-54°12’30”
Mato Grosso do Sul	V	Ivinhema	-22°30’47”	-53°81’52”
Goiás	V	Paranaíba	-19°47’06”	-52°06’54”
Goiás	V	Itajá	-19°05’46”	-51°37’50”
Goiás	V	Cassilândia	-19°04’58”	-51°42’33”
Goiás	V	Aporé	-19°02’42”	-51°48’51”
Goiás	V	Serranópolis	-18°30’61”	-51°96’22”
Goiás	V	Jataí	-17°88’13”	-51°71’44”
Goiás	V	Mineiros	-17°56’94”	-52°55’11”
Goiás	V	Perolândia	-17°52’86”	-52°06’41”
Mato Grosso	V	Portelândia	-17°35’36”	-52°67’86”
Mato Grosso	V	Santa Rita do Araguaia	-17°32’55”	-53°20’52”
Mato Grosso	V	Alto Garças	-16°94’38”	-53°52’80”
Mato Grosso	V	Poconé	-16°01’11”	-56°39’06”
Mato Grosso	V	Cangas	-16°23’47”	-56°12’65”
Mato Grosso	V	Cáceres	-16°07’05”	-57°67’88”
Mato Grosso	V	Mirassol D’Oeste	-15°49’47”	-58°11’03”
Mato Grosso	V	Porto Esperidião	-15°85’27”	-58°46’02”
Mato Grosso	V	Pontes e Lacerda	-15°22’61”	-59°33’52”
Rondônia	V	Vila Bela da Santíssima Trindade	-15°00’80”	-59°95’05”
Rondônia	V	Comodoro	-13°66’30”	-39°78’58”
Rondônia	V	Padronal	-12°55’57”	-60°02’35”
Rondônia	V	Vilhena	-12°74’05”	-60°14’58”
Rondônia	V	Marco Rondon	-12°11’32”	-60°49’38”
Rondônia	V	Cacoal	-11°43’86”	-61°44’72”
Rondônia	V	Castanhal	-01°29’38”	-47°92’63”
Rondônia	V	Ji-Paraná	-10°87’55”	-61°94’91”
Rondônia	V	Ouro Preto do Oeste	-10°71’63”	-62°24’77”
Rondônia	V	Jaru	-10°43’88”	-62°46’63”
Rondônia	V	Nova Vida	-10°27’30”	-62°15’28”
Rondônia	V	Ariquemes	-09°49’47”	-58°11’03”
Rondônia	V	Porto Velho	-08°44’50”	-63°53’08”
Rondônia	V	Jamari	-08°45’44”	-63°44’41”
Rondônia	V	José Bonifácio	-09°43’46”	-64°08’37”
Rondônia	V	Jaci Paraná	-09°18’05”	-64°36’16”
Rondônia	V	Mutum Paraná	-09°18’05”	-64°36’16”
Rondônia	V	Abunã	-09°40’58”	-65°05’27”
Pará	V	Pimenta Bueno	-11°67’25”	-61°19’36”
Acre	V	Vista Alegre do Abunã	-09°38’45”	-65°09’32”
Acre	V	Extrema de Rondônia	-09°44’56”	-67°03’42”
Acre	V	Plácido de Castro	-10°14’46”	-67°40’43”
Acre	V	Rio Branco	-10°61’07”	-67°45’24”
Amazonas	V	Cruzeiro do Sul	-07°36’07”	-72°43’23”

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