

## Ants (Hymenoptera: Formicidae) in hospitals of southern Brazil

Hormigas (Hymenoptera: Formicidae) en hospitales del sur de Brasil

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**Abstract:** Ants are among the organisms best adapted to urban environments. Those found in hospital settings have received much attention and have been described as important vectors of pathogenic organisms. This study aimed to compare the richness and abundance of ants in four hospitals in southern Brazil and to analyze the association of species in different hospitals environments. Four types of environments were sampled: wards of intensive care units (ICU's), nutrition centers, infirmaries, and warehouses. The sample richness in each of the four areas was compared using a rarefaction analysis based on number of occurrences. To assess the association between ant species and hospital environments, a Principal Component Analysis (PCA) was constructed. Twenty (20) species were identified. The nutrition sector was the environment with the highest richness (S = 14), followed by infirmaries (S = 7), warehouses (S = 7), and ICU wards (S = 4). Five species were associated with the environments evaluated, among them, *Monomorium pharaonis* and *Nylanderia fulva*. These results may serve as a warning to hospital authorities about the risks of mechanical transmission of pathogenic agents by ants in hospital environments.

**Key words:** Vector control. Hospital infection. Infestation. *Nylanderia*. Public health.

**Resumen:** Las hormigas están entre los organismos mejor adaptados a los entornos urbanos. Las que se encuentran en los hospitales han recibido más atención y se han descrito como vectores importantes de organismos patógenos. Este estudio tuvo como objetivo comparar la riqueza y abundancia de hormigas en cuatro hospitales en el sur de Brasil y analizar la asociación de especies en diferentes ambientes hospitalarios. Se tomaron muestras de cuatro tipos de ambientes: unidades de cuidados intensivos (UCI), centros de nutrición, enfermerías y almacenes. La riqueza de muestreo en cada una de las cuatro condiciones se comparó usando un análisis de rarefacción basado en el número de ocurrencias. Para evaluar la asociación entre las especies de hormigas con ambientes hospitalarios, se construyó un Análisis de Componentes Principales (PCA). Se identificaron 20 especies. El sector de la nutrición fue el ambiente con la mayor riqueza (S = 14), seguido de las enfermerías (S = 7), almacenes (S = 7) y las salas de UCI (S = 4). Cinco especies se asociaron con los ambientes evaluados, entre ellos, *Monomorium pharaonis* y *Nylanderia fulva*. Este resultado puede servir como una advertencia a las autoridades de los hospitales sobre los riesgos de transmisión mecánica de agentes patógenos por hormigas en ambientes hospitalarios.

**Palabras clave:** Control de vectores. Infección hospitalaria. Infestación. *Nylanderia*. Salud pública.

### Introduction

Ants are one of the most common insect families (Hölldobler and Wilson 1990) and are characterized by wide distribution, richness and abundance in terrestrial ecosystems (Alonso and Agosti 2000). They are among the organisms best adapted to urban environments (Bragança and Lima 2010) and can settle in locations that have hostile environmental conditions for survival (Lutinski *et al.* 2014). In the last decade, the ants found in urban areas have received more attention and been the focus of research in hospital settings, where some species have been described as important vectors of pathogens, threatening human health (Moreira *et al.* 2005; Costa *et al.* 2006; Lise *et al.* 2006; Garcia *et al.* 2011).

Part of the success of ants in urban environments is due to ability that many species have to find food and places to nest near or inside the buildings constructed by humans (Soares *et al.* 2006). Some species have become synanthropic. Polygynous species may suffer the fragmentation of their colonies which enhances its spread and colonization of urban environments and further complicates the population control

of those considered pests or capable to carry pathogens (Bueno and Campos-Farinha 1998).

Approximately 2,000 species of ants are found in Brazil and of these about 20 are considered pests in urban environments (Bueno and Campos-Farinha 1999). Damage caused by the ants range from simple bites that can trigger allergic reactions to serious public health problems when they convey pathogenic microorganisms in health facilities such as clinics, hospitals and emergency care units (Lise *et al.* 2006; Santos *et al.* 2009). Ants that nest in the area outside of hospitals can carry viruses, bacteria, protozoa, fungi and helminth eggs in their bodies and can contaminate food, equipment and utensils when they come into hospital settings (Bueno and Campos-Farinha 1998; Pereira and Ueno 2008; Bragança and Lima 2010). Bacteria such as *Staphylococcus*, *Acinetobacter*, *Streptococcus*, *Enterococcus* and *Enterobacter* have been isolated from ants sampled in hospitals, which highlights the risk to public health that some species may represent (Fowler *et al.* 1993; Lise *et al.* 2006; Rodovalho *et al.* 2007; Pesquero *et al.* 2008).

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The ant fauna found in hospital settings is not rich compared to other types of Brazilian urban environments (Lutinski *et al.* 2014). However, some taxa such as *Tapinoma melanocephalum* (Fabricius, 1793), *Paratrechina longicornis* (Latreille, 1802), *Monomorium pharaonis* (Linnaeus, 1758), *Nylanderia fulva* (Mayr, 1862), *Wasmannia auropunctata* (Roger, 1863) and species of *Camponotus*, *Solenopsis* and *Pheidole* occur more frequently in studies (Bueno and Fowler 1994; Bueno and Campos-Farinha 1999; Soares *et al.* 2006; Garcia *et al.* 2011). The number of ant species sampled in hospitals may be linked to the size of the sampling effort involving only indoors, or outdoors also, to the size of the hospital areas (Bueno and Fowler 1994) and condition of conservation of buildings (Soares *et al.* 2006).

Inside the hospital area, the ants have been sampled in many different types of environments such as of pediatrics wards, intensive care units (ICUs), infirmaries, oncology sectors, surgery rooms, emergency care sectors and nutrition sectors (Bueno and Campos-Farinha 1999; Lise *et al.* 2006; Rodovalho *et al.* 2007; Garcia *et al.* 2011). However, literature lacks studies to identify the hospital environments more susceptible to the presence of ants and relating the frequency of the most abundant species with certain hospital environments. In this perspective, this study proposes: 1) to increase knowledge about the occurrence of ants in hospital environments; 2) to compare the richness and abundance of ants in four types of hospital environments, and; 3) to determine the association between more abundant species of ants with the sampled hospitals.

### Material and methods

This study was conducted in four hospitals in southern Brazil. Hospitals included in the sample are located in the state of Rio Grande do Sul, in the cities of Alvorada (medium size: 91 beds) Canoas (large: 417 beds), Esteio (medium size: 133 beds) and Sapucaia do Sul (large size: 211 beds) (Fig. 1).

**Sampling.** Samplings were carried out monthly, from May 2007 to April 2008. They were conducted during the day between 09:00 and 17:00 hours. We focused on four types of rooms: wards of intensive care units (ICUs), nutrition center, infirmaries and warehouses. Inspections at these sites were performed, actively seeking ants. The use of attractive baits was discarded, since the objective was to identify the species naturally occurring in the environment, without any attractive component when sampling (Oliveira and Campos-Farinha 2005). For capturing ants a rod with cotton wool was used, and the samples were placed in vials containing 70% alcohol. Each sample was labeled with date, place of sampling and collector and forwarded to the Entomology Laboratory of Unilasalle for screening. The identification of the samples was carried out in the Entomology Laboratory of the Community University of the Region of Chapecó (Unochapecó), based on Fernández identification keys (2003) and Bueno and Campos-Farinha (1999). These were then compared with the specimens deposited in the Entomological Collection of the same university.

**Statistical analysis.** In each type of sampled hospital setting, data included only the presence or absence of the species in the samples and not the number of specimens (Zarzuela *et al.* 2002).

In order to display the richness of ants sampled in each hospital and to characterize the most abundant species, a table showing the relative frequency of species in each hospital was built (Lise *et al.* 2006). The richness of ants of each of the four environments of each hospital was compared in through a rarefaction analysis based on the number of occurrences (Gotelli and Colwell 2001). This analysis was performed using the software Ecosim 7 (Gotelli and Entsminger 2001), which allows comparisons between sets of samples (Melo *et al.* 2003).

The association of ant species sampled with the hospital environment was tested through a Principal Component Analysis (PCA). Seven species were excluded from this analysis due to the small number of occurrences in the study ( $\leq 2$ ). The data were previously transformed into  $\text{Log}(x + 1)$  and analyzed with the aid of the statistical program Past (Hammer *et al.* 2001).

### Results

A number of 1,899 ants were sampled and it was recorded. It was identified a total richness of 20 species, belonging to five subfamilies, seven tribes and 10 genera. In the hospital of Canoas, it was identified the greatest richness ( $S = 13$ ), followed by the hospital in Sapucaia do Sul ( $S = 9$ ), the hospital in Esteio ( $S = 4$ ) and the hospital in Alvorada ( $S = 3$ ). The most frequently sampled species in hospitals were: Alvorada: *Pheidole* sp. 4 (76.8%) and *Pheidole* sp. 1 (22.8%); Canoas: *Monomorium pharaonis* (37.6%) and *Pheidole* sp. 4 (29.6%); Esteio: *Nylanderia fulva* (67.9%) and *Pheidole* sp. 1 (30.8%); Sapucaia do Sul: *Brachymyrmex* sp. (64.1%) and *Paratrechina longicornis* (16.2%) (Table 1).

The nutrition sector of the evaluated hospitals was the environment with the highest infestation by ants ( $S = 14$ ). At that place, 42 occurrences of ants were recorded (42.4%) and a total of 1,041 ants were sampled. At infirmaries ( $S = 7$ ), there were 29 occurrences (29.3%) and 490 ants. In warehouses sector ( $S = 7$ ), 20 occurrences were recorded (20.2%) and 294 ants; while in the sector of the ICU ( $S = 4$ ), there were eight instances (8.1%) and 125 ants. The richness gap between the assemblies of ants of each type of environment was significant (Fig. 2).



**Figure 1.** Geographical location of municipalities in the state of Rio Grande do Sul, Brazil, in whose hospitals ant sampling was carried out (May 2007 to April 2008). ALV: Alvorada CAN: Canoas; EST: Esteio; SSU: Sapucaia do Sul. Software used: DIVA GIS.

**Table 1.** Ant species with their relative frequencies of occurrence in hospitals of southern Brazil (May 2007 to April 2008).

Taxon	Alvorada	Canoas	Esteio	Sapucaia do Sul
<b>Subfamily Dolichoderinae</b>				
<b>Tribe Dolichoderini</b>				
<i>Dorymyrmex</i> sp.		0.002		
<b>Subfamily Dorylinae</b>				
<b>Tribe Ecitonini</b>				
<i>Labidus coecus</i> (Latreille, 1802)		0.002		
<b>Subfamily Formicinae</b>				
<b>Tribe Camponotini</b>				
<i>Camponotus crassus</i> Mayr, 1862				0.005
<i>Camponotus diversipalpus</i> Santschi, 1922	0.004			
<i>Camponotus mus</i> Roger, 1863		0.005		
<i>Camponotus rufipes</i> (Fabricius, 1775)		0.005		
<i>Camponotus</i> sp.				0.005
<b>Tribe Plagiolepidini</b>				
<i>Brachymyrmex</i> sp.				0.641
<i>Nylanderia fulva</i> (Mayr, 1862)		0.216	0.679	0.084
<i>Paratrechina longicornis</i> (Latreille, 1802)				0.162
<b>Subfamily Myrmicinae</b>				
<b>Tribe Pheidolini</b>				
<i>Pheidole</i> sp. 1	0.228	0.014	0.308	0.003
<i>Pheidole</i> sp. 2		0.019	0.005	
<i>Pheidole</i> sp. 3		0.009		
<i>Pheidole</i> sp. 4	0.768	0.296		0.005
<i>Pheidole</i> sp. 5		0.012		
<i>Pheidole</i> sp. 6				0.003
<i>Pheidole</i> sp. 7		0.040		
<b>Tribe Solenopsidini</b>				
<i>Monomorium pharaonis</i> (Linnaeus, 1758)		0.376		0.094
<i>Solenopsis</i> sp.			0.008	
<b>Subfamily Ponerinae</b>				
<b>Tribe Ponerini</b>				
<i>Hypoponera</i> sp.		0.002		
<b>Richness</b>	<b>3</b>	<b>13</b>	<b>4</b>	<b>9</b>

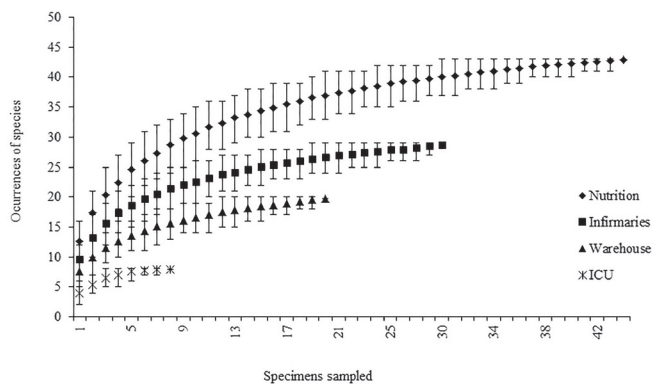
The occurrences of the species *Camponotus diversipalpus* Santschi, 1922, *Dorymyrmex* sp., *P. longicornis*, *Pheidole* sp. 2, *Pheidole* sp. 3, *Pheidole* sp. 5, *Pheidole* sp. 6, and *Solenopsis* sp. are independent of the type of the sampled environment. The principal component analysis (Fig. 3) showed a strong association of the species *Pheidole* sp. 4 with the nutrition sector, *Pheidole* sp. 1 with the sector of warehouses, *Brachymyrmex* sp. and *M. pharaonis* with the sector of infirmaries and *N. fulva* with the sectors of nutrition and warehouse.

### Discussion

The richness of ants obtained in this study is higher than that seen in other studies done in hospitals of southern Brazil, such as Lise *et al.* (2006) in Chapecó (SC), Bicho

*et al.* (2007) in Bage (RS) and Garcia *et al.* (2011) in Porto Alegre (RS). Of all environments, the nutrition department was the most infested, followed by the environments of the infirmaries, warehouse and at the other end, the environment of the ICUs. Five species were associated with the evaluated environments, among them, *M. pharaonis* and *N. fulva*.

The *Pheidole* genus was the one which had the highest diversity ( $S = 7$ ), or 35% of the total number of species. *Pheidole* sp. 1 was the only species occurring in the four hospitals. The occurrence of species of this genus totaled 99.6% in the hospital in Alvorada, 39.1% in the hospital in Canoas, 31.3% in the hospital in Esteio and only 1% of cases in the hospital of Sapucaia do Sul. The species of this genus build their nests in walls and floors of human constructions, taking advantage of defects or structural failure (Silva and Loeck 2006). The occurrence of species of *Pheidole* in



**Figure 2.** Comparison, by rarefaction method, of the richness of ants sampled in four types of hospital environments in municipalities of southern Brazil (May 2007 to April 2008). Software used: Ecosim 7.

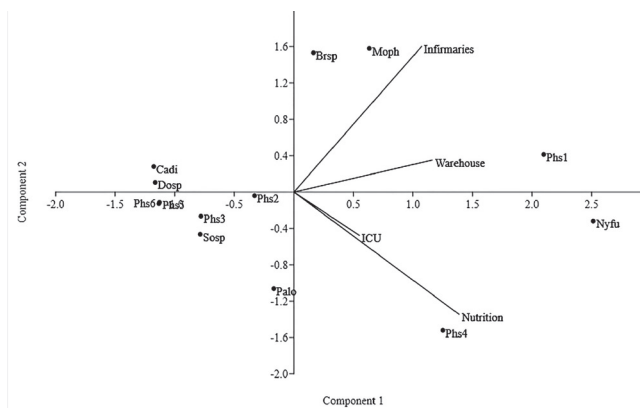
hospital settings has been reported in other studies involving hospital settings (Lise *et al.* 2006; Bicho *et al.* 2007; Gazeta *et al.* 2007; Pesquero *et al.* 2008; Santos *et al.* 2009; Garcia *et al.* 2011).

*Nylanderia fulva* was present in three of the four hospitals, and was also one of the most frequent in the study. At the hospital in Canoas, its frequency was 21.6%; in Esteio, it reached 67.9% and in Sapucaia do Sul, 8.4%. Other species of the tribe Plagiolepidini, *Brachymyrmex* sp. and *P. longicornis* occurred only in one hospital (Sapucaia do Sul) with a frequency of 64.1% and 16.2%, respectively. Both species of genera *Nylanderia* and *Paratrechina* are often registered in faunal studies of urban environments ants. *Paratrechina fulva* and *P. longicornis* are important pests infesting homes and hospitals (Fowler *et al.* 1993; Zarzuela *et al.* 2002). Ants of the genus *Brachymyrmex* sp. nest in crevices tiles, plugs and small cracks or crevices in floors and walls of buildings. They are common in hospital settings (Oliveira and Campos-Farinha 2005; Lise *et al.* 2006).

*Monomorium pharaonis* was registered in two hospitals Canoas (37.6%) and Sapucaia do Sul (9.4%). This species is distributed virtually in all continents (Olaya-Masmela *et al.* 2005) and make nests in cavities and in homes; its ability to disperse pathogens was proven by Eichler (1990) and Zarzuela *et al.* (2002). Its frequency in hospitals can be attributed to their habits and ecological characteristics. It is a dominant species in this type of environment and exhibits rapid colony growth (Bueno and Campos-Farinha 1999; Campos-Farinha *et al.* 2002).

We highlight the diversity of the genus *Camponotus* ( $S = 5$ ) in the evaluated hospitals. At the hospital in Alvorada a species (*C. diversipalpus*) was recorded; in the hospital in Canoas two were recorded (*C. mus* and *C. rufipes*) and in the hospital in Sapucaia do Sul, two species were also recorded (*C. crassus* and *Camponotus* sp.). Despite the low frequency in hospitals, some species of *Camponotus* have the habit of building their nests in the very building, such as in wooden ceilings, door frames and windows and even in electronics (Campos-Farinha *et al.* 2002). Species of this genus are considered important mechanical vectors of pathogens in hospitals (Zarzuela *et al.* 2002; Lise *et al.* 2006; Santos *et al.* 2009).

The occurrence of the species *L. coecus* and *Hypoponera* sp. in the hospital in Canoas is probably accidental, as



**Figure 3.** Spatial projection of the ordination of principal components of ant species and types of hospital environments in municipalities of southern Brazil (May 2007 to April 2008). Brsp: *Brachymyrmex* sp.; Cadi: *Camponotus diversipalpus*; Dosp: *Dorymyrmex* sp.; Moph: *Monomorium pharaonis*; Nyfu: *Nylanderia fulva*; Palo: *Paratrechina longicornis*; Phs1: *Pheidole* sp. 1; Phs2: *Pheidole* sp. 2; Phs3: *Pheidole* sp. 3; Phs4: *Pheidole* sp. 4; Phs5: *Pheidole* sp. 5; Phs6: *Pheidole* sp. 6; Sosp: *Solenopsis* sp. Software used: Past.

evidenced by their low frequency in the samples (0.2%). Species of the genus *Labidus* are known as army ants and forage soil of forests or preserved environments in search of their prey (Fernández 2003). The species of predatory ants *Hypoponera* are associated with environments with the presence of litter (Silvestre *et al.* 2003).

The activities, materials and products present in each type of hospital environment may be related to the richness of ants associated with each. The results of this study show that the richness differs significantly from one environment to another. Being the hospital a place where as much attention to hygiene and the risk of transmission of pathogens between patients should prevail, the occurrence of any vector, ant or another, is undesirable. However, the presence of food in the sectors of nutrition may be attracting them and explain a greater number of ant species found in this type of environment. The transit of materials, food and products in the infirmary wards and warehouses may explain the presence of ants, even in a smaller number of species than in nutrition environments. Among the evaluated environments, UTIs are those where it is expected that the greatest care to the dispersal of pathogens. However, the occurrence of four species (*Pheidole* sp. 1, *Pheidole* sp. 2, *Pheidole* sp. 4 and *Pheidole* sp. 5) in this type of environment is indicative of carelessness with the relevant health standards to the environments of this nature.

The generalist characteristics of the genus *Pheidole* (Silvestre *et al.* 2003) may explain the association of *Pheidole* sp. 4 with the sector of nutrition and *Pheidole* sp. 1 with the sector of warehouses. The possible presence of food scraps on the floor or dumps in these environments may be attracting these ants to these food sources. The small size of the species *Brachymyrmex* sp. and *M. pharaonis* (Oliveira and Campos-Farinha 2005; Silvestre *et al.* 2003) may indicate that these species are finding places to nest in the sectors of the infirmaries. It also represents the adaptation of these species to cohabitate in human constructions (Zarzuela *et al.* 2002). *Nylanderia fulva* is a common species in urban environments in southern Brazil (Lutinski *et al.* 2014). It is generalist (Silvestre *et al.* 2003) and invades indoors during

their foraging. Possible sources of food in the sectors of nutrition and warehouse may explain the association of this species with these environments.

This study extends the knowledge about the occurrence of ants in hospital environments of southern Brazil. The record of 20 species of ants in four hospitals is one of the largest riches ever sampled in this type of establishment. This result can serve as a warning to the hospital authorities about the risks of mechanical transmission of pathogens in hospitals and health risks to patients undergoing treatment. It was also found that the ant fauna varies in richness, composition and abundance of a type of hospital to another. The presence and handling of food as found in the nutrition sector may be attracting the ants into the hospitals. The study also showed that some species of ants may be finding easier to colonize certain hospital environments than others.

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