

## Ants in a hospital environment and their potential as mechanical bacterial vectors

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### ABSTRACT

**Introduction:** We studied the richness and abundance of ant species, their bacteria and the bacteria isolated from patient clinical samples. **Methods:** Ants were collected with baited traps at 64 sites in a public hospital in São Luis, State of Maranhão, Brazil. **Results:** In total, 1,659 ants from 14 species were captured. The most frequent species were *Crematogaster victima*, *Solenopsis saevissima*, *Tapinoma melanocephalum*, *Camponotus vittatus* and *Paratrechina fulva*. Forty-one species of bacteria were isolated from the ants and 18 from patients. **Conclusions:** Ants are potential vehicles for pathogenic and opportunistic bacteria, and they can represent a risk factor in nosocomial infections.

**Keywords:** Urban ants. Vectors of nosocomial infection. Formicidae.

Ants (Hymenoptera; Formicidae) represent a frequent and serious problem in Brazilian hospitals, where they are abundant and difficult to control<sup>1</sup>. Their presence in hospitals is favored by the structural characteristics of hospital buildings and their proximity to residential homes; the presence of packages of medicines, chemical products, food and water; and the large number of people circulating in the hospital with clothes and objects that could contain ant nests<sup>2,3</sup>. An association between ants and bacteria has been observed in various hospitals, leading to increased concern about the role of these insects as disease vectors<sup>4</sup>.

To our knowledge, this is the first such study performed in a hospital in the State of Maranhão (MA), Brazil. The aims were to study the richness, abundance and monthly and seasonal frequencies of ants; to identify any bacteria they carry; and to compare the bacteria with those isolated from patient clinical samples.

This study was performed in a medium-sized public hospital in São Luis, MA (02°32'S and 44°17'W) with four floors and an area of approximately 18,222m<sup>2</sup>. The collection points were selected according to Beatson<sup>5</sup> and Fowler et al.<sup>6</sup>, consisting of 64 points distributed over the first three floors (**Table 1**). Ants were captured once a month between January and December 2008 with bait traps installed between 10-12am, 2-4pm and 6-8pm. The total number of traps used each collection day

was 192, or 2,304 traps for all 12 collections throughout the year. Each trap was exposed for 2h every day, corresponding to a capture effort of 4,608h.

The ants were captured in aseptic conditions in traps assembled as follows. Plastic bottles (300ml) were cut in half at the middle of the bottle. Then, the upper half was turned upside down and placed in the bottom half to form a container with the funnel pointing inward. Each trap contained non-toxic sterile bait of a mixture of equal amounts of dried beef liver, fruit and honey-flavored cake<sup>3</sup>. Between 1 and 3 ants were collected at random from each trap using a sterile swab and transferred to a flask containing brain-heart infusion broth (BHI) and incubated at 35.5 ± 1°C for 24 to 48h for microbiological analysis. Clinical samples collected from patients were seeded in conventional culture medium<sup>7</sup>.

This descriptive study with a 1-year collection period was approved by the Ethics Committee in Research from the University Hospital, Federal University of Maranhão, under registration n° 548/2007.

During the study, 1,659 ants (14 species, 10 genera and 5 subfamilies) were captured (**Table 1**). The most abundant species were *Crematogaster victima* (42.4%), *Solenopsis saevissima* (20.7%), *Pheidole* sp.1 (19.4%), *Tapinoma melanocephalum* (5.5%) and *Paratrechina fulva* (3.7%). The ant frequencies were highest in the dry season (77.6%) (**Table 1**).

Forty-one species of bacteria were isolated from patients and ants (18), only from ants (15) or only from patients (8). In total, 620 ants were analyzed, and bacterial growth was observed in 243 of the samples (39.2%) (**Table 1**). The bacterial positivity rate was higher in the following ants: *Atta* sp., *Camponotus* sp., *Camponotus vittatus*, *Pheidole* sp.2, *Pheidole* sp.1, *T. melanocephalum* and *P. fulva* (44.1%) (**Table 1**). The most frequent bacterial species isolated from

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the ants were *Staphylococcus* spp. (coagulase-negative), *Acinetobacter baumannii*, *A. Iwoffii* and *Staphylococcus aureus* (69.6%) (Table 2). The bacterial positivity frequencies for ant samples were highest in the dry season (62.9%) (Table 2). The most frequent bacteria isolated from the patients were *Staphylococcus* spp. (coagulase-negative), *Pseudomonas aeruginosa*, *A. baumannii* and *Klebsiella pneumoniae* (68.9%) (Table 2). The bacteria were isolated from 434 samples, and the frequency was higher in the dry season (63.1%).

The diversity of ant species observed was high, and the genera captured were the same as have been captured in hospitals in other states in Brazil<sup>2,3,6</sup>. However, *Acromyrmex* and *Odontomachus*, which were identified in this study, have not been reported from other states, showing the variation in the geographic distribution of ants associated with urban hospitals.

The abundance of ants during the dry season is of great ecological significance because it may represent a large potential vectorial mechanism. This hypothesis is supported by the seasonal pattern of patient samples positive for bacteria, which predominated in the dry season.

The ants were found on all floors and most areas of the hospital, as observed in other studies<sup>8,9</sup>, but were more abundant on the first floor (Table 3). The presence of food and other stimuli, such as chemical substances diffused in the air, diluted in wastewater and impregnated in objects, can stimulate the movement of ants within the hospital environment irrespective of where they nest, making it important to keep the different areas of the hospital clean at all times. The presence of ants,

particularly *Camponotus*, inside a hospital is indicative of structural defects in the building<sup>10</sup>, especially when the ants search for food outside the building but their nests are found inside.

The large number of bacterial species carried by ants is noteworthy. Some of the bacterial species are considered pathogenic because of the concomitant circulation of nosocomial infections, including *Serratia marcescens*, *Citrobacter freundii*, *K. ozaenae*, *Enterobacter aerogenes*, *Proteus mirabilis* and *S. epidermidis*<sup>11</sup>. Other species notable for high pathogenicity are *S. aureus*, *P. aeruginosa* and *K. pneumoniae*, all of which were isolated from ants in our study. Other species are considered opportunistic but can become pathogenic depending on the situation.

Nonetheless, it should be mentioned that *Paratrechina longicornis* is an important vector of pathogens that are considered risk factors for nosocomial infection<sup>6,10</sup>. The presence of these species puts patients at risk of nosocomial infection. Microbiological analysis of *P. longicornis* revealed their potential to act as mechanical vectors for genera such as *Staphylococcus*, *Acinetobacter*, *Serratia*, *Klebsiella*, *Enterobacter* and *Enterococcus*. Beatson<sup>5</sup>, Edwards & Baker<sup>12</sup> and Costa et al.<sup>13</sup> also observed these pathogens.

In summary, the ants were contaminated by pathogenic and opportunistic bacteria, representing a risk factor for nosocomial infection. However, additional studies are required to confirm their roles as mechanical vectors of nosocomial infections.

TABLE 1 - Numbers of ants and rates of bacterial contamination in a public hospital in São Luis, State of Maranhão, Brazil, between January and December 2008.

Species	Seasons		Total			
	rainy	dry	Cp	Ex	Po	Pr
<i>Acromyrmex rugosus</i>	7	7	14	5	1	20.0
<i>Atta</i> sp.	21	-	21	7	6	85.7
<i>Camponotus atriceps</i>	14	76	90	37	11	29.7
<i>Camponotus vittatus</i>	3	5	8	8	4	50.0
<i>Camponotus</i> sp.	4	3	7	6	5	71.4
<i>Crematogaster victima victim</i>	106	572	678	61	26	42.6
<i>Linepithema</i> sp.	-	2	2	1	1	100.0
<i>Odontomachus haematodus</i>	2	5	7	3	1	33.3
<i>Paratrechina fulva</i>	35	25	60	59	26	44.1
<i>Pheidole</i> sp. 1	71	246	317	123	59	48.0
<i>Pheidole</i> sp. 2	4	-	4	2	1	50.0
<i>Solenopsis saevissima</i>	55	276	331	207	55	26.6
<i>Solenopsis</i> sp.	3	3	6	3	1	33.3
<i>Tapinoma melanocephalum</i>	47	67	114	98	46	46.9
Individuals (number)	372	1,287	1,659	620	243	39.2
Individuals (percentage)	22.4	77.6	100.0	37.4	39.2	-

Cp: captured; Ex: examined; Po: positive; Pr: positivity rate.

TABLE 2 - Numbers of ant and clinical patient samples positive for bacteria in a public hospital in São Luis, State of Maranhão, Brazil, between January and December 2008.

Bacteria	Ants				Patients			
	seasons		total		seasons		total	
	rainy	dry	n	%	rainy	dry	n	%
<i>Staphylococcus coagulase-negative</i>	14	33	47	22.4	36	53	89	20.5
<i>Acinetobacter baumannii</i>	17	27	44	21.0	20	51	71	16.4
<i>Acinetobacter lwoffii</i>	10	19	29	13.8	-	2	2	0.5
<i>Staphylococcus aureus</i>	12	14	26	12.4	13	26	39	8.9
<i>Enterobacter cloacae</i>	8	8	16	7.6	2	6	8	1.8
<i>Klebsiella pneumonia</i>	-	11	11	5.2	17	40	57	13.1
<i>Pantoea agglomerans</i>	4	2	6	2.9	-	4	4	0.9
<i>Stenotrophomonas maltophilia</i>	-	5	5	2.4	3	4	7	1.6
<i>Enterobacter aerogenes</i>	1	4	5	2.4	9	10	19	4.4
<i>Pseudomonas aeruginosa</i>	2	3	5	2.4	31	51	82	18.9
<i>Escherichia coli</i>	2	2	4	1.9	9	9	18	4.1
<i>Enterococcus faecalis</i>	2	1	3	1.4	3	-	3	0.7
<i>Enterococcus faecium</i>	1	1	2	0.9	-	1	1	0.2
<i>Kluyvera</i> sp.	1	1	2	0.9	-	1	1	0.2
<i>Burkholderia cepacia</i>	2	-	2	0.9	-	3	3	0.7
<i>Serratia marcescens</i>	1	-	1	0.5	6	-	6	1.4
<i>Providencia stuartii</i>	-	1	1	0.5	4	4	8	1.8
<i>Proteus mirabilis</i>	1	-	1	0.5	7	9	16	3.9
Ant bacteria (number of positive samples)	78	132	210	100.0	160	274	434	100.0
Species (number)	15	15	18	-	13	16	18	-

TABLE 3 - Numbers of ants captured in different areas of a public hospital in São Luis, State of Maranhão, Brazil, between January and December 2008.

	Area	Seasons		Total	
		rainy	dry	n	%
1 <sup>st</sup> floor	Garden	282	1,127	1,409	90.5
	Solid waste disposal area	34	60	94	6.0
	Laundry	30	20	50	3.2
	Kitchen	1	3	4	0.3
	total	347	1,210	1,557	93.9
2 <sup>nd</sup> floor	Clinical pathology laboratory	2	-	2	10.5
	Sterilization center	-	1	1	5.3
	Medical center ward 13	1	-	1	5.3
	Medical center ward 28	7	8	15	78.9
	total	10	9	19	5.0
3 <sup>rd</sup> floor	Pharmacy	-	7	7	8.4
	General intensive care unit	6	6	12	14.5
	Cardiac intensive care unit	1	4	5	6.0
	Operating rooms	1	-	1	1.2
	Surgical clinic ward 17	5	29	34	41.0
	Surgical clinic ward 4	2	22	24	28.9
	total	15	68	83	11.1
Total		372	1,287	1,659	-

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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