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Distribution of Ant (Hymenoptera: Formicidae) Nests in the Santiago Forest, Metropolitan Region, Chile

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Abstract

In the Santiago Forest, Metropolitan Region of Chile (33º 22' S and 70º 36' W), with xerophytic vegetation, mainly shrubs of *Quillaja saponaria* Molina, *Acacia caven* (Molina), *Lithraea caustica* (Molina) Hook. & Arn., and *Olea europaea* L. at 678 m altitude, only the ants *Linepithema humile* Mayr and *Solenopsis gayi* (Spinola) were determined, the first species the most abundant and its nests associated with *Q. saponaria*, the predominating plant in the area. Other plants present were *Colliguaja odorifera* Molina, *Baccharis linearis* (Ruiz & Pav.) Pers., *Trevoa trinervis Miers., Solanum ligustrinum* Lodd, and *Muehlenbeckia hastulata* I.M. Johnston. Both ant species seem to have a distribution type that would adjust to the Poisson model, that is, of a contagious type.

Keywords: Ant nests; *Linepithema humile*; *Solenopsis gayi*; Xerophytic shrubs

Introduction

The Formicidae includes some 12.000 described extant species [1], of which only 79 are recognized in Chile [2,3], from sea level to 3000 m altitude above sea level [4]. The activity working center of ants is the nest, where 80-90% of the members of the colony live [5]. Ants play many important roles in agroforest ecosystems, where the Formicidae are plant feeding collectors and sap feeders, in addition to being zoophagous and detritus recoverers, necrophagous an coprophagous [6]; some species are considered pests, as they have impact over the ecology of other animal species and in the ecosystem as well. Moreover, some ants feed on the honeydew produced by aphids and scare away their natural enemies [7,8]. Understanding the factors underlying distribution of nests can be useful in developing scientifically-sound management decisions.

The spatial distribution of ant nests may be related to food and space availability, and with competition with the same and other species of Formicidae [9-11]. Other factors may include the availability of substrates to build the nests and the physicochemical characteristics of the soil [5,12,13].

The objective of this study was to determine the ant species and the distribution of their nests coexisting in a location with native and introduced flora in the Santiago Forest, Metropolitan Region, the frequency and spatial distribution of their colonies, and also the eventual relationship with the main plant species in the area [14].

Materials and Methods

The study was done in the Santiago Forest, Huechuraba, at the northern border of the Metropolitan Park, Metropolitan Region at 678 m elevation (33º 22' S and 70º 36' W),with a Mediterranean climate, arid summer and rains in winter and xerophytic vegetation, mainly shrubs of *Quillaja saponaria* Molina, *Acacia caven* (Molina), *Lithraea caustic* (Molina) Hook. & Arn., *Olea europaea* L., and *Cryptocarya alba* (Molina) Looser. A 2000 m^2 site was selected in the area, and divided into 10×10 m^2 quadrants, that were marked with the letters A-T, where ant nests were counted carefully, inspecting under all branches, stones and dead leaves [14]. Ants were sampled in the spring and summer from each nest during the hours with most formicid activity (10:00 to 18:00) [15], with hair brushes, tweezers, and a hand vacuum sampler, and were set in Eppendorf tubes with 70% alcohol, and identified later in the Zoology and Ethology Laboratory, College of Agroforest Sciences, Universidad Mayor, in Santiago, Chile, using the works of Snelling and Hunt [3], Bolton [2], and Bolton et al. [16]. The plants present on each quadrant were identified using the study of Hoffmann [17].

The abundance and frequency, density per quadrant, global density in the area, and adjusted density (nests in the occupied quadrants) were determined for each formicid species. The counts were analyzed through the dispersion index (the relationship between the mean and variance), and are presented with the typical deviation, a measure of how spaced are the nests with respect to the mean. Also, the frequencies observed were registered to determine if the spatial distributions were random, and the association between the nests of each formicid species with the plants found on each quadrant were verified with the $\chi 2$ test.

Results and Discussion

Species census and distributional pattern

In the area were found only two ant species, the fire ant *Solenopsis gayi* (Spinola) and the Argentinian ant *Linepithema humile* Mayr. The fire ants of the *Solenopsis* genus are mainly predators of other insects and affect birds nests in contact with the soil [18], but may damage the stems, roots, and fruits of certain plants [19]. The Argentinian ant, a species native from northeast Argentina, Paraguay, Uruguay, and southern Brazil, has invaded the other continents, and is considered a pest because it attacks and displace colonies of other species [20,21], besides rearing aphids, from which it obtains honeydew as food.

The number of nests in the quadrants are presented in Table 1,

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and those of the plants in Table 2. Total nests, means of the global and adjusted density, and the frequency of the quadrants occupied by both ant species are presented in Table 3.

The nests with the greatest global and adjusted densities in Table 3 are those of *L. humile*, which occurred in 80% of the quadrants, whereas those of *S. gayi* were found only on 15% of them. No nests were found on four quadrants (5%). The greatest number of nests in a quadrant (8) was also of *L. humile*, probably related with the great level of stones.

The mean of 3.1 nests per quadrant was used to calculate the frequencies of the quadrants with a determined number of nests, that are presented in Table 4. As the frequencies were under 5 and did not allow for a χ^2 test, they were grouped and the test is presented in Table 5.

The 0.2722 total χ^2 value was not significant for 2 degrees of freedom, from which the distribution of the nests only approach the Poisson distribution. To deepen the analysis the Dispersion Coefficient was also calculated. If the quadrants fitted the Poisson distribution, where the mean equals the variance, it would be expected that the proportion between the S^2 calculated with the results and the mean would be close to 1. Thus, if the proportion between both values is <1, it means that there occurs repulsion, and that if the proportion is >1 it means that there is aggregation. In our study, the S calculated was 2.198, which gives an S^2 value of 4.8315. If the Dispersion Coefficient = S^2/mean = 8.832/3.1 = 1.56, it means a possible aggregation of nests, and in effect, one quadrant had 8 nests. This rejects the Poisson distribution as a model adequate for the results.

To complete the analysis, the relationship was studied between the nests and the plant cover in the study area. The nearest shrub to each nest was identified, and the distances between them were measured.

The χ^2 value as an indication of the level of association between the nests of *L. humile* and *S. gayi* (0.82), indicates no association between both ant species. The study revealed a greater number of *L. humile* ants. The Argentinian ant affects the density and behavior of other ant species, in a greater or lesser way from its place in the hierarchy of dominance. So, they eliminate first the dominant species (those with

Quadrants	Number of nests for single species		Total number of nests	
	Solenopsis gayi	*Linepithema humile*	Total	Frequency (%)
A	0	4	4	6.5
B	0	3	3	4.8
C	0	0	0	0.0
D	0	2	2	3.2
E	0	3	3	4.8
F	0	3	3	4.8
G	0	0	0	0.0
H	0	0	0	0.0
I	0	2	2	3.2
J	0	2	2	3.2
K	0	4	4	6.5
L	0	5	5	8.1
M	0	8	8	12.9
N	1	3	4	6.5
O	0	5	5	8.1
P	0	3	3	4.8
Q	1	6	7	11.3
R	0	0	0	0.0
S	1	2	3	4.8
T	0	4	4	6.5
TOTAL	3	59	61	100.0

Table 1: Nests of each ant species per quadrant, total nests and frequency.

Quadrants	Number of plants						Total
	Quillaja saponaria	*Olea europaea*	*Acacia caven*	*Lithraea caustica*	*Eucalyptus camaldulensis*	*Cryptocarya alba*	
A	2	0	0	0	0	0	2
B	2	0	0	0	0	0	2
C	0	0	0	0	0	0	0
D	1	0	1	0	0	0	2
E	1	2	0	0	0	0	3
F	0	0	0	2	0	0	2
G	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0
I	0	0	0	2	0	0	2
J	1	0	1	0	0	0	2
K	0	2	0	0	0	0	2
L	2	0	0	0	0	3	5
M	1	0	0	0	2	0	3
N	3	1	0	0	0	0	4
O	0	0	3	2	0	0	5
P	1	0	0	0	2	0	3
Q	0	2	3	0	0	0	5
R	0	0	0	0	0	0	0
S	3	0	0	0	0	0	3
T	2	2	0	0	0	0	4
Total	19	9	8	6	4	3	49
Frequency (%)	38.78	18.37	16.33	12.25	8.16	6.12	100.00

Table 2: Plant species on each quadrant.

Ant species	Nests	Global density		Adjusted density		Occupied	Frequency
		Means	S	Means	S		
S. gayi	3	0.15	0.37	1.00	0.00	3	15
L. humile	59	2.95	2.11	3.69	1.26	16	80
Total	62	3.10	2.48	4.69	1.26	19	100

Table 3: Total number of nests, means of global and adjusted densities, and frequency of the quadrants occupied by the two ant species.

Nests per quadrant	Quadrants observed	Quadrants expected*
0	4	0.9010
1	0	2.7931
2	3	4.3292
3	5	4.4735
4	4	3.4670
5	2	2.1496
6	0	1,1106
7	1	0.4918
8	1	0.2842

*Quadrants expected for the Poisson distribution, with an estimated mean of 3.1 nests per quadrant.

Table 4: Distribution of the quadrants according to the number of nests observed in the study area, and the numbers expected for the Poisson distribution.

Nests per quadrant	Frequency observed	Frequency expected	Σ(freq. obs.- exp.)²/exp.
0-2	7	8.0233	0.1305
3-4	9	7.9405	0.1414
5 and more	4	4.0362	0.0003
Total	20	20	χ^2 = 0.2722

Table 5: Fitting test of the nest results to the Poisson distribution.

aggressive behavior, territorial, etc.), and tolerate some more time those subordinate ants with a less aggressive behavior, smaller colonies, etc.) [22]. Several studies [22,23] have reported that *L. humile* is capable of displacing or eliminating native species by competition, both by exploitation (for example, being very tolerant to temperature changes) and interference, and is very aggressive as it presents a numerous body of workers, a key factor for its dominance [23].

Plants sampled in the study

There occurred 49 shrubs in the study area, distributed in 19 quillayes (*Q. saponaria*), 9 olives (*O. europaea*), 9 acacias (*A. caven*), 6 litres (*L. caustica*), 4 eucalypts (*E. camaldulensis*), and 3 peumos (*C. alba*). This composition was very different to that in Ipinza-Regla et al. [20] in San Carlos de Apoquindo, also in the Metropolitan Region, where the plants predominating were litre, quillay, colliguay (*Colliguaja odorifera* Molina), romerillo [*Baccharis linearis* (Ruiz & Pav.) Pers.], trevo (*Trevoa trinervis* Miers.), tomatillo (*Solanum ligustrinum* Lodd.), and quilo (*Muehlenbeckia hastulata* I.M. Johnston).

The abundance of quillay shrubs in our study indicates a possible association of this plant species with the nests of *L. humile* (χ^2= 3.933). Only three nests of *S. gayi* were found, two in a quadrant with olive shrubs and one with quillay.

Conclusions

Only two species of ants, *L. humile* and *S. gayi*, were found in the study area. The nests of *L. humile* were the most abundant, and occurred in 80% of the quadrants, associated with *Q. saponaria*, the predominating plant in the area. Both ant species seem to have an aggregate distribution type.

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