

SUCCESSION OF INVASIVE ANTS IN RESIDENTIAL ENVIRONMENTS OF SANTA ISABEL, PUERTO RICO

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Abstract The invasive ant species complex was determined within three Puerto Rican housing developments of different ages (one, four, and eight years old). Frequency and relative abundance data were collected from each site. A total of 19 different ant species were identified from the sites, with the major pest species being red imported fire ants (*Solenopsis invicta*), big-headed ants (*Pheidole spp.*), crazy ants (*Paratrechina longicornis*), and rover ants (*Brachymyrmex sp. 1*). Sampling data indicated that *S. invicta* and *Brachymyrmex sp. 1* were the first species to invade the one year old site. Both *S. invicta* and *Brachymyrmex sp. 1* had a high sampling frequency, although *S. invicta* was the most abundant species. In the four year old site, three different species (*S. invicta*, *M. destructor*, and *P. fallax*) accounted for >75% of the samples collected, another seven species, including *P. moerens*, *Tapinoma melanocephalum*, and *P. longicornis*, made up < 25%. Sampling data from the eight year old site indicated that although 12 species were present, *S. invicta* and *P. fallax* were both the most frequently sampled and the most abundant. *S. invicta* was a dominant species within all three housing developments. Many other species are able to co-exist with *S. invicta*.

Key Words *Solenopsis invicta*, *Pheidole*, *Brachymyrmex*, Puerto Rico housing

INTRODUCTION

Land use in Puerto Rico has recently undergone a major change due to the changing economy. Once based on agricultural production, Puerto Rico's economy has shifted to more industrial and manufacturing services. This shift has resulted in the expansion of cities, and the conversion of agricultural and forested land into residential and industrial landscapes (Lopez et al., 2001). As urban expansion continues, these newly developed locations are vulnerable to invasive species of plants and animals which are adapted for life in urban habitats and can survive in close proximity to humans.

Invasive ants are particularly well adapted to take advantage of urban habitats. Invasive ants, or tramp ants, typically live in close association with humans and are easily dispersed by human commerce. Tramp species typically expand their territories by budding from a central nest, and tend to be more aggressive in taking over new habitats, often resulting in the displacement of native ants and other invertebrates (Holldobler and Wilson, 1990). Ants have been identified as the most abundant invertebrate in Puerto Rico (Levins et al., 1973) and numerous studies have documented the ant fauna of the island. Torres and Snelling (1997) completed a comprehensive survey in which they identified 71 species of ants from the main island and surrounding keys. Although the list produced included ants that are known to be invasive species in other parts of the world, the authors did not specifically identify those that were non-native to Puerto Rico, or which species were collected in urban environments. No studies have documented the invasive pest ant species complex of Puerto Rico, and very little is known about their community dynamics.

In this study, pest ant sampling was conducted in residential housing developments. The specific aims of this project were to identify the pest ant species complex in residential neighborhoods, and determine species abundance and sampling frequency within housing developments of different ages.

MATERIALS AND METHODS

Study Area

Pest ant sampling was conducted in residential neighborhoods in Santa Isabel, Puerto Rico. Santa Isabel is a municipality located on the southern coast of Puerto Rico (Latitude 17.97; Longitude -66.40). The land area of Santa Isabel is 188 sq km (34.2 sq mi) with a population of 18,300 (Rivera 2007). The climate of

Santa Isabel is tropical semiarid. Average monthly temperatures range from a low of 18.9-22.8°C to a high of 30.5-32.8°C with an average temperature of 25°C. The annual rainfall of the region is 83.8 cm with the majority of precipitation occurring between August and November.

Research Sites

The study took place on land formerly used for agriculture that had been cleared for the construction of residential neighborhoods. Three housing developments of different ages were selected for sampling to evaluate differences in the pest ant species complex that might represent ecological succession in these disturbed habitats. Site 1 was a newly constructed housing development with a post construction age of less than one year. This site had a total area of 27,000 m² and included 50 houses.

Site 1 had the least environmental complexity of the three sites because it was completely uninhabited for most of the test period with only 20 homes occupied by the end of the year. The houses themselves were structurally simple and of uniform design, and because the houses were empty, the yards had ~2 m weed growth by the end of the test. Site 1 was bordered on the south side by a working construction site. On the west side was a mulched playground. Site 1 had a four-lane highway on the northern border and another residential neighborhood on its eastern side. A four year old housing development was used as the second sampling site (Site 2). Site 2 was the residential neighborhood to the east of Site 1 and consisted of 77 houses over an area of 28,000 m². Nearly all houses in Site 2 were inhabited. Most of the houses had been customized with the addition of exterior walls, closed garages, and elaborate porches. The yards contained small trees and shrubs, fountains, and other landscaping features. Because Site 2 was inhabited, trash containers were also present. The plastic trash containers were placed into holes that had been dug in the yard so that the lids were at grade level. Site 2 was bordered on the western side by Site 1. On the north side, Site 2 was bordered by the same four-lane highway that bordered Site 1. Pastureland was on the east side, and a housing development of similar age bordered Site 2 on the southern side. The third site (Site 3) was approximately eight years old. The neighborhood had a total area of 80,000 m² contained 157 houses. Like Site 2, Site 3 was fully inhabited, resulting in an environmentally complex habitat. Nearly all the houses were customized with unique construction features and lawns that ranged from bare earth to complex landscaping with mature trees and shrubs. Site 3 was bordered by the four-lane highway on the south side and abandoned pastureland on the other three sides.

Sampling Procedure

Thirty houses were systematically selected for sampling. Food baits were used to collect ant samples. The baiting method consisted of cutting cotton rope (5.6 mm) cut into ~3.8 cm segments. Rope segments were soaked in one of two food attractants; a 25% sucrose solution or peanut oil. After soaking a single segment was inserted into a glass screw cap vial (2 dram). One vial with sugar and one with peanut oil, were placed at three locations around the front exterior of a house: 1) at the bottom corner of the front door, 2) the side corner of the house, and 3) the corner of the house adjacent to the garage. The baits were left at the sampling locations for 1 hr. Tops were placed on the vials when collected to capture ants feeding on the baits. Isopropyl alcohol (70%) was added to each vial to kill and preserve the collected ants.

The baiting regimen was conducted over a two-day period at each site in the morning between 7-10 am, and afternoon between 4-7 pm depending on seasonal daylight hours. Eight sampling trips were conducted at approximately six week intervals so that the ants were sampled two times per season. At the end of each sampling trip, all samples were transported back to the Dodson Urban Pest Management Laboratory at Virginia Tech. The number and species of ants in each vial was identified. Identifications were confirmed by Systematic Entomology Laboratory, USDA.

RESULTS

A total of 243,252 ants were collected during the course of this study. The fewest number of ants (~58,000) were collected at the one year old site. Over 89,000 ants were collected at the eight year old site, and the greatest number of ants was collected at the four year old site (~97,700). Between all three sites, a total of 19 different species were identified. The most numerous pest ant species collected were *Solenopsis invicta*,

four species of *Pheidole*: *P. fallax*, *P. moerens*, *P. subarmata*, and *P. megacephala*; *Paratrechina longicornis*, *Brachymyrmex sp. 1*, *Monomorium destructor*, and *Tapinoma melanocephalum*, *Solenopsis globularia*, and *Monomorium floricola*.

Sampling resulted in eight species collected from the one year old site, 10 species from the four year old site, and 11 species from the eight year old site. The relative abundance of each species at each site is presented in Figure 1. In the one year old site, the relative abundance of *S. invicta* was 57.4%, followed by *Brachymyrmex sp. 1* (19.9%) and *P. moerens* (11.7%). The number of *P. fallax*, *P. megacephala*, *P. longicornis*, *T. melanocephalum*, and *S. globularia* accounted for <11% of the total ants collected. The relative abundance of *S. invicta* in the four year old site was 40.8%. The second most abundant species was *M. destructor*, accounting for 21.1% of the ants collected. The third most abundant species was *P. fallax* (14.4%). *P. moerens*, *P. longicornis*, *T. melanocephalum*, and *Brachymyrmex sp. 1* all had relative abundance values between 8% and 3% in the four year old site. *P. megacephala*, *P. subarmata*, and *S. globularia* accounted for < 3% of the total ants collected. In the eight year old site, the relative abundance of *S. invicta* was 46.3%. *P. fallax* had a relative abundance value of 13.0%. *P. moerens*, *P. longicornis*, and *T. melanocephalum* had relative abundance values between 10% and 7%. The remaining six species (*P. megacephala*, *P. subarmata*, *M. destructor*, *Brachymyrmex sp. 1*, *S. globularia*, and *M. floricola*) all had relative abundance values between 5% and 1%.

Frequency data was based on the average number of houses where a species was collected over the course of eight sampling periods. In the one year old site, *Brachymyrmex sp. 1* was collected at 22.0 houses making it the most frequently collected species in the site. *S. invicta* was collected at 20.0 houses and *P. moerens* was collected at 9 houses. The average number of houses where *P. fallax*, *P. longicornis*, and *S. globularia* were collected was between 3.0 and 5.0. *T. melanocephalum* and *P. megacephala* were collected on average at <1.0 house. In the four year old site, *S. invicta* was the most frequently collected species (19.6 houses). *P. fallax* and *Brachymyrmex sp. 1* were collected at 16.4 and 15.1 houses, respectively. The average number of houses where *P. moerens* and *P. longicornis* was collected was between 11.0 and 13.0. *M. destructor* was collected at 3.9 houses and *T. melanocephalum* was collected at 6.5 houses. *P. megacephala*, *P. subarmata*, and *S. globularia* were all found at approximately 1.0 house per sampling period. In the eight year old site, *S. invicta* and *P. fallax* were the most frequently collected species (21.3 houses and 19.8 houses, respectively). *P. moerens* and *Brachymyrmex sp. 1* were found at an average of 11.5 houses. The average number of houses where *P. longicornis*, *T. melanocephalum*, and *P. subarmata* were collected was between 4.5 and 10.0. *P. megacephala*, *M. destructor*, *S. globularia*, and *M. floricola* were collected at between 1.0 and 3.0 houses in the eight year old site.

DISCUSSION AND CONCLUSIONS

The housing developments represented three distinct stages of ant succession within disturbed environments. The one year old site represented an early successional stage with a few pioneer species and the least amount of biomass (fewest number of ants collected). The four-year old site was representative of the aggradation stage of succession, as indicated by the increase in biomass and increasing species richness. The eight year old site showed a slight decrease in biomass but an increase in species richness. These differences observed in biomass and species richness when comparing the four year old to the eight year old site may represent a transition phase from the aggradation phase of succession to a steady state (Molles, 2005).

Relative abundance data indicated that *S. invicta* was the most abundant pest species in all three sites. In the one year old site, *Brachymyrmex sp. 1* was the second most abundant species. The abundance of *Brachymyrmex sp. 1* indicated that it was also a founding species, and could quickly invade a newly disturbed environment. In the four year old site, *M. destructor* was the second most abundant species collected, while *P. fallax* was the second most abundant species in the eight year old site.

Frequency data supports that *S. invicta* was the dominant species in these disturbed urban habitats. In each site, *S. invicta* was one of the most frequently collected species, with the exception of the one year old site. In this site, *Brachymyrmex sp. 1* was collected, on average, in two additional houses. When comparing the data from the one year old site to the four year old site, there was not only an increase in each species abundance, but the frequency of most species increased. The frequency of all species (other than *S. invicta*)

increased by at least one additional sampling location in the four year old site and some by as many as 11 (*P. fallax*). In the eight year old site, more species were found in more locations while the frequency of *S. invicta* remained constant at ~20 houses. The increased abundance and frequency of all ant species in the eight year old site indicate that many species can become established and expand their territories even in the presence of a dominant species like *S. invicta*.

This study indicates that *S. invicta* is a founding species in urban succession. Other species of ants were still able to become established in urban habitats as demonstrated by the correlated increase in species richness with increasing housing development age. Specific species were able to challenge *S. invicta* for territory. While *Brachymyrmex sp. 1* had far inferior numbers in terms of abundance, this species was found at more houses than *S. invicta* in the one year old site. *P. fallax*, was also able to rival the frequency of *S. invicta* in the eight year old site.

ACKNOWLEDGMENTS

The authors wish to thank Don Bieman of the San Pedrito Institute for assistance in Santa Isabel; Alan Harms of Mycogen Seeds for weather data; Matthew Buffington of the Systematic Entomology Laboratory, USDA, and Roy Snelling for assistance with ant identifications.

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