LIQUID BAIT FORMULATIONS for CONTROLLING the ODOROUS HOUSE ANT (HYMENOPTERA: FORMICIDAE)

Win Higgins[1,2], David Bell[2], Chuck Silcox[3], and Glen Holbrook[2]

[1]Western Pest Services, 1000 White Horse Rd., Voorhees, NJ 08043
[2]Department of Entomology, The Pennsylvania State University, University Park, PA 16802
[3]Agricultural Division, Bayer Corporation, 512 Concord Place, Perkasie, PA 18944

Abstract The odorous house ant, *Tapinoma sessile* (Say), is a severe pest of structures. We have investigated whether the use of liquid bait formulations is an effective strategy for control of this peripatetic, tramp-ant species. Sixteen homes or business establishments, located in or near Cape May, NJ, were selected for the study. Fifteen of the structures were assigned to one of three treatments, five structures per treatment, and the remaining structure served as a control and was left untreated. Each property was initially scouted for ant trails, and we recorded the number of ants crossing a selected point along a trail in five minutes; a bait station was positioned nearby the trail. No structure received fewer than three stations, and none greater than seven. At the control site, trails were similarly located and counted, but no bait stations were put in place. At 1, 2, 4, 6, and 8 weeks ant numbers were counted along extant trails, and bait solutions were added to stations as needed. Results showed that two formulations containing 50 ppm imidacloprid (Pre-Empt® Liquid Ant Bait) reduced ant numbers by over 80% after 6 weeks, as did a formulation containing boric acid (Drax Liquidator®). Reductions were directly attributable to the baits, as ant numbers remained relatively stable at the control site throughout the study. Liquid formulations show considerable efficacy in the control of odorous house ants.

Key Words *Tapinoma sessile* baiting imidacloprid boric acid

INTRODUCTION

In recent years, ants have been garnering increasing attention as pests. This is largely attributable to growing concern about such invasive species as the red imported fire ant, *Solenopsis invicta* Buren, and Argentine ant, *Linepithema humile* (Mayr). These two species are common in southern United States (Tschinkel, 1998; Reierson et al., 2001). *Myrmica rubra* Buckley, a red stinging ant from Eurasia (Radchenko, 1995), and sometimes called the Down east fire ant, is common along the coast of Maine.

These pilgrim species are in many instances out-competing and displacing resident ants (Suarez et al., 1998; Holway, 1999), but native ants do persist as pests. For example, *Camponotus* spp. cause damage to structures throughout the United States (Cook, 2000a). The odorous house ant, *Tapinoma sessile* (Say), is one of the most bothersome household pest ants (Summerlin, 2000), and is abundant in northeastern states.

Making *T. sessile* interesting to scientists, but much less so to homeowners, has been the fact that it possesses many of the behavioral and social attributes of some of the most notorious invasive species. It exhibits polygyny (Smith, 1928), as do *L. humile* and *S. invicta* (Hölldobler and Wilson, 1977; Tschinkel, 1998), and this means that the odorous house ant has tremendous reproductive potential.

Supercolonial behavior is an attribute that the odorous house ant shares with some invasive species (Markin, 1968; Hölldobler and Wilson, 1977). Inspection of a site infested with *T. sessile* will usually lead to the discovery of several nests, all typically queenright (Smith, 1928), and probably exchanging workers and reproductives. Multiple-site nesting and the vagile nature makes

Proceedings of the 4th International Conference on Urban Pests.
Susan C. Jones, Jing Zhai, and Wm H. Robinson editors. (2002)

odorous house ants difficult to control. Colonies move on a regular basis (Smallwood and Culver, 1979; Smallwood, 1982), and the reasons underlying their frequent uprooting are not always clear. Stress may play a role, but mobility may be an intrinsic, specialized feature of the species and possibly the genus (Meudec, 1982; Cook, 2000b). In any event, locating all nests on a property can be difficult.

Attempts to control the odorous house ant have historically met with mixed results. Environmental modifications may help to mitigate an infestation (Meissner and Silverman, 2001), but an integrated approach may be the best strategy for this species. The results of liquid baits to control *T. sessile* are reported here.

MATERIALS and METHODS

Study Sites

The investigation was conducted in summer of 2001, and the first treatments were 9, 10 July. Sixteen homes and business establishments with known infestations of odorous house ants were selected for the study. All were situated within Cape May County, New Jersey and previous attempts to control the ants at any of these sites had resulted in only temporary relief at best.

Fifteen of the sixteen properties were randomly partitioned into three treatment groups. One set of five structures was treated with Drax Liquidator® (Waterbury Companies, Inc., Waterbury, CT) and the other two sets of five were baited with either of two formulations (A or B) of Pre-Empt® Liquid Ant Bait (Bayer Corporation, Kansas City, MO). The bait stations themselves were all of the type recommended for use with Drax. The active ingredient in Drax is orthoboric acid at a concentration of 1%. The active ingredient in Pre-Empt is the chlornicotinyl insecticide, imidacloprid; the concentration in both tested formulations was approximately 0.005%. The two Pre-Empt formulations differed only in their levels of antimicrobial agents.

The sixteenth property in the study served as a control site and was not baited. Ants were monitored at this location to ensure that any reductions in ant numbers at treated sites were not the result of fluctuations in populations owing to changes in season or weather.

Before properties were baited, a thorough inspection was carried out to identify all ant trails within each lot. Moreover, each trail was carefully traced to ascertain its independence from others. Once distinct trails had been identified, a central point on each was chosen, and the number of ants passing back and forth over that point was counted in five minutes. The data was logged and a single bait station was positioned adjacent to where the count had been taken. No property received fewer than three or more than 7 bait stations.

At weekly or fortnightly intervals thereafter, the number of ants sallying to and fro was counted on each trail for 5 minutes at the same position where the first count had been taken. After each count was made, bait stations were refilled with the appropriate formulations. At no point during the study was a bait station ever found to have been completely emptied between inspections.

Data Analysis

The Wilcoxon signed rank test, the Friedman test, and repeated measures analysis of variance (ANOVA) were used to determine whether ant numbers changed significantly over time. Statview 5.0 (SAS Institute Inc., Cary, NC) was used for all analyses, and an alpha of 0.05 was set as the decision criterion for rejecting null hypotheses. Standard error of the mean is given hereinafter as the measure of variability for all data.

Proceedings of the 4th International Conference on Urban Pests.
Susan C. Jones, Jing Zhai, and Wm H. Robinson editors. (2002)

RESULTS

Sixteen properties were included in the present study, and none had fewer than three distinct ant trails. Seventy-eight trails were identified across all sites, and the average number of ants passing a selected point on each trail in five minutes was 215.7 ± 21.1; the range was 21 to 875.

The average number of trailing ants in each of the three treatment groups was nearly identical at the onset of the study: 219.0 ± 36.1 in five minutes at sites receiving formulation A of Pre-Empt, 216.3 ± 37.6 at sites receiving formulation B, and 223.8 ± 42.2 at sites receiving Drax (Figure 1). Ant foraging declined noticeably within seven days and significantly by 14 days in all treatments (Wilcoxon signed rank test: Pre-Empt A, $P = 0.0022$; Pre-Empt B, $P = 0.033$; Drax, $P < 0.0001$), and this trend continued over the next several weeks. After 6 weeks, the number of ants on trails had decreased by over 80% in all groups.

Repeated measures ANOVA showed that changes in ant number over time were not influenced by the property on which ants were situated; changes in the number of ants on one property did not differ from those on any other property receiving the same treatment (Pre-Empt A: $F_{4,17} = 1.312$, $P = 0.31$; Pre-Empt B: $F_{4,18} = 2.135$, $P = 0.12$; Drax: $F_{4,21} = 2.752$, $P = 0.055$). This result provided justification for eliminating from subsequent statistical analyses a blocking factor representing the fifteen different properties. A repeated measures ANOVA, addressing the effect of

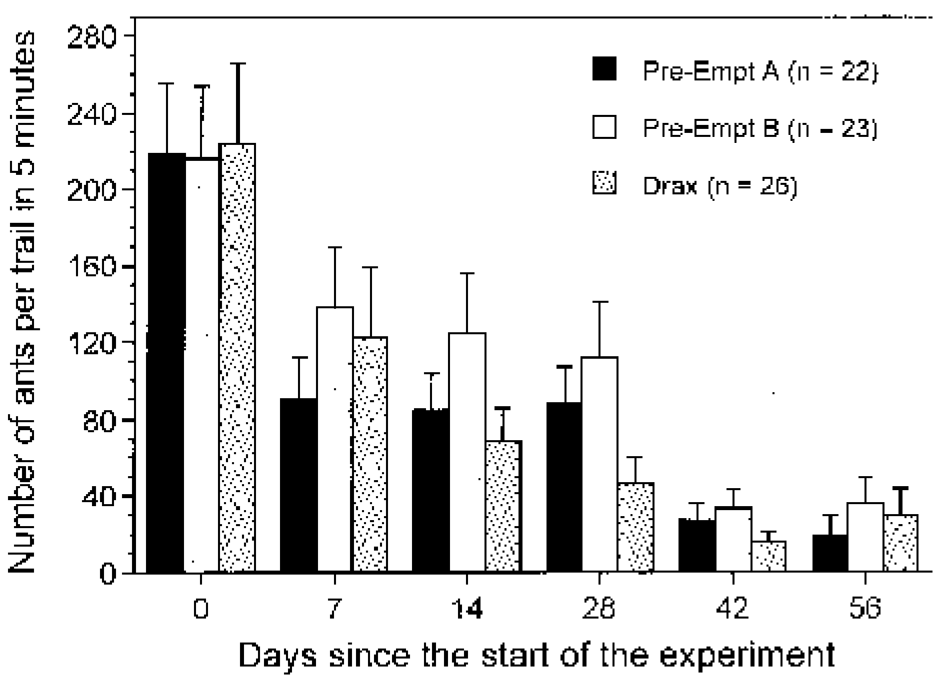

Figure 1. Changes over time in the number of odorous house ants foraging on properties treated with three different bait formulations. All distinct trails were identified at 15 different sites, and the number of ants crossing a set point along each trail was counted in five minutes. Then, five of the properties were baited with formulation A of Pre-Empt, five with formulation B, and the remainder with Drax. The ants were re-counted at weekly or bi-weekly intervals, and the mean number of ants in all trails, within a treatment on a given day, is shown above. Error bars represent standard error of the mean.

Proceedings of the 4th International Conference on Urban Pests.
Susan C. Jones, Jing Zhai, and Wm H. Robinson editors. (2002)

the three bait formulations, did not show a significant difference in ant numbers among the three treatment groups ($F_{2,68} = 0.764$, $P = 0.47$). This result suggested that all formulations had a similar impact on ant populations.

Throughout the study ants were also monitored at a control site receiving no bait stations. Although the number of ants per trail did fluctuate at this site around the original average of 173.3 ± 43.3 ants per five minutes ($n = 7$; Figure 2), a Friedman test failed to show a significant difference in ant foraging through time ($\chi^2 = 4.754$, $df = 5$, $P = 0.45$). This finding supported the hypothesis that decreases in ant number at treated sites were directly attributable to the baits.

DISCUSSION

In spite of its status as a major structural pest, the odorous house ant has been the subject of little research. Smith (1928) reported the natural history of this species, and stated that the largest odorous house ant colony he had seen consisted of about 10,000 individuals, with the average colony ranging in size from two to five thousand. Given our present results, showing in many cases hundreds of workers passing a single point along a trail in just five minutes, it seems reasonable to presume odorous house ant colonies can attain a much larger size than previously reported by Smith. Smith's results should not, however, be disregarded. The generally mild conditions along the New Jersey shore may be more favorable to colony growth than those experienced by ants in Illinois, where Smith did his research.

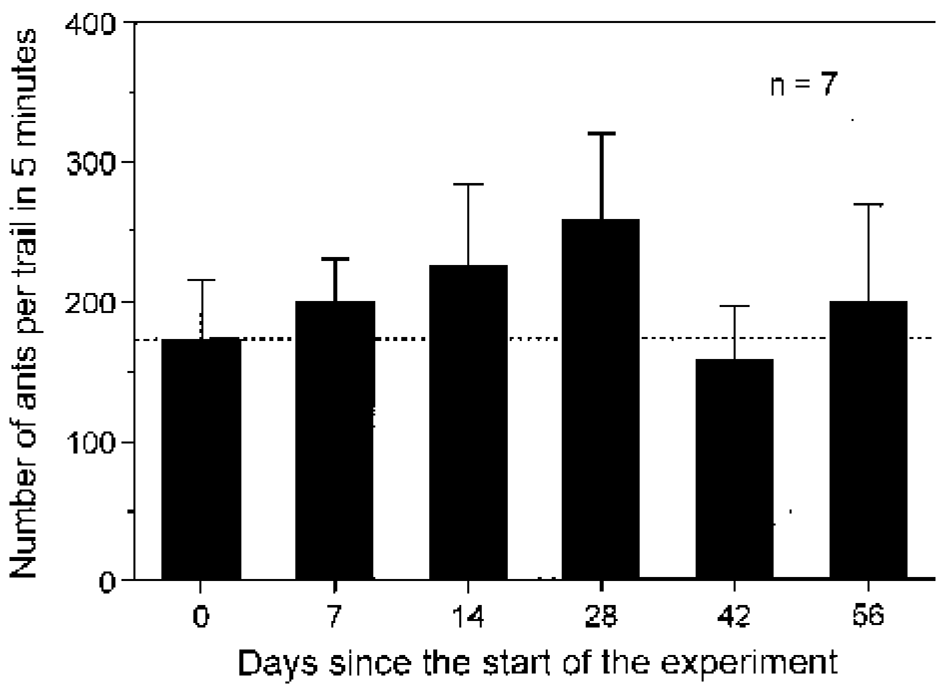

Figure 2. Changes over time in the number of odorous house ants foraging on a property not treated with bait. Seven distinct trails were identified on the property, and the number of ants foraging along each was counted at weekly or bi-weekly intervals. Bars indicate the mean number of ants on the seven trails. The dashed line is for purposes of comparison, allowing the mean on day 0 to be compared with that on all other days. The error bars represent standard error of the mean.

In the past decade, baits containing a variety of active ingredients have been tested against ants and shown to have great potential (Klotz et al., 1997a, 1997b, 1998), but little work has been carried out on whether baits are effective for the control of odorous house ants. We show that liquid formulations containing either imidacloprid or boric acid can greatly reduce foraging of odorous house ants around structures. We have reason to suspect absolute numbers of ants were reduced as well, because existing trails diminished in activity. Population suppression seems to have been achieved.

Laboratory trials have shown imidacloprid lethal to the black carpenter ant, *Camponotus pennsylvanicus* (DeGeer) (Klotz and Reid, 1993). Imidacloprid is effective at low (50 ppm) levels in bait, to bring about a reduction in odorous house ant populations. Workers that have consumed such small amounts of the insecticide may not die immediately and may have the opportunity to convey the insecticide back to the nest, whereupon they might transfer it to others, perhaps even to reproductives.

Evaporation of water from liquid baits might concentrate their active ingredients, and make them repellent. This concern is not solely academic, at least in the case of boric acid, since the typical level of this material incorporated into baits, 1%, is known to be slightly repellent to at least one ant: *S. invicta* (Klotz et al., 1997c). Argentine ants are perhaps slightly more tolerant of boric acid, but they exhibit depressed feeding on sucrose solutions containing just 2% of it (Klotz et al., 2000). Drax was effective in this study, as ants consumed this bait throughout the trial. Problems related to evaporation were mitigated by supplementing the baits stations with new solutions at intervals exceeding no more than 2 weeks. Further research is needed to determine whether this should be a standard practice. Liquid baits containing even very low levels of insecticide, at least in the case of imidacloprid, seem an excellent option for the control of odorous house ants.

ACKNOWLEDGMENTS

This work was, in part, supported by generous gifts from Bayer Corporation and Merrill and Mildred Davis. Moreover, we thank Annie Steed and Miles Saunders, as well as employees of Western Pest Services, Rick McKeown, Todd Parziale, and Phil Ziolkowski, for their contributions to the project.

REFERENCES

Cook, J.L. 2000a. Carpenter ants. In: Gold, R.E. and Jones, S.C., eds. Handbook of Household and Structural Insect Pests, Lanham, MD: Entomological Society of America, pp. 108-110.

Cook, J.L. 2000b. Ghost ant. In: Gold, R.E. and Jones, S.C., eds. Handbook of Household and Structural Insect Pests, Lanham, MD: Entomological Society of America, pp. 51-52.

Hölldobler, B. and Wilson, E.O. 1977. The number of queens: an important trait in ant evolution. Naturwissenschaften 64: 8-15.

Holway, D.A. 1999. Competitive mechanisms underlying the displacement of native ants by the invasive Argentine ant. Ecology 80: 238-251.

Klotz, J.H., Greenberg, L., Amrhein, C., and Rust, M.K. 2000. Toxicity and repellency of borate-sucrose water baits to Argentine ants (Hymenoptera: Formicidae). J. Econ. Entomol. 93: 1256-1258.

Klotz, J.H., Greenberg. L., Shorey, H.H., and Williams, D.F. (1997a) Alternative control strategies for ants around homes. J. Agric. Entomol. 14: 249-257.

Klotz, J., Greenberg, L., and Venn, E.C. 1998. Liquid boric acid bait for control of the Argentine ant (Hymenoptera: Formicidae). J. Econ. Entomol. 91: 910-914.

Klotz, J.H. and Reid, B.L. 1993. Oral toxicity of chlordane, hydramethylnon, and imidacloprid to free-foraging workers of *Camponotus pennsylvanicus* (Hymenoptera: Formicidae). J. Econ. Entomol. 86: 1730-1737.

Klotz, J.H., Vail, K.M., and Williams, D.F. 1997b. Liquid boric acid for control of structural infestations of Pharaoh ants (Hymenoptera: Formicidae). J. Econ. Entomol. 90: 523-526.

Klotz, J.H., Vail, K.M., and Williams, D.F. 1997c. Toxicity of a boric acid-sucrose water bait to *Solenopsis invicta*. J. Econ. Entomol. 90: 488-491.

Lenoir, A. 1979. Feeding behaviour in young societies of the ant *Tapinoma erraticum* L.: trophallaxis and polyethism. Insectes Soc. 26: 19-37.

Markin, G.P. 1968. Nest relationship of the Argentine ant, *Iridomyrmex humilis* (Hymenoptera: Formicidae). J. Kans. Entomol. Soc. 41: 511-516.

Meissner, H.E. and Silverman, J. 2001. Effects of aromatic cedar mulch on the Argentine ant and the odorous house ant (Hymenoptera: Formicidae). J. Econ. Entomol. 94: 1526-1531.

Meudec, M. 1982. Some aspects of individual behaviour during nest moving in the ant *Tapinoma erraticum*. Behav. Processes 7: 377-382.

Radchenko, A.G. 1995. A survey of species of the *Myrmica* groups of *rubra*, *rugosa*, *arnoldii*, *luteola*, and *schencki* (Hymenoptera: Formicidae) from Central and Eastern Palearctic. Entomol. Rev. 74: 122-132.

Reierson, D., Rust, M., and Klotz, J. 2001. There’s safety in numbers. Pest Control 69(3): 50-52.

Smallwood, J. 1982. Nest relocation in ants. Insectes Soc. 29: 138-147.

Smallwood, J. and Culver, D.C. 1979. Colony movements of some North American ants. J. Anim. Ecol. 48: 373-382.

Smith, M.R. 1928. The biology of *Tapinoma sessile* Say, an important house-infesting ant. Ann. Entomol. Soc. Am. 21: 307-329.

Suarez, A.V., Bolger, D.T., and Case, T.J. 1998. Effects of fragmentation and invasion on native ant communities in coastal southern California. Ecology 79: 2041-2056.

Summerlin, B. 2000. Odorous house ant. In: Gold, R.E. and Jones, S.C., eds. Handbook of Household and Structural Insect Pests, Lanham, MD: Entomological Society of America, p. 53.

Tschinkel, W.R. 1998. The reproductive biology of fire ant societies. Bioscience 48: 593-605.