*Proceedings of the Sixth International Conference on Urban Pests*
*William H Robinson and Dániel Bajomi (editors), 2008*
*Printed by OOK-Press Kft., H-8200 Veszprém, Pápai út 37/a, Hungary*

# VIRTUAL BAITING TO CONTROL ANTS IN SENSITIVE URBAN ENVIRONMENTS

**MICHAEL K. RUST, DONG-HWAN CHOE, AND RICHARD S. VETTER**
Department of Entomology, University of California, Riverside, Riverside, CA, 92521-0314

Abstract Invasive ants present a serious threat to humans, wildlife and sensitive environmental habitats. The nature of these sensitive sites such as schools, nursing homes, parks, and zoos prevent the widespread application of insecticides to control ants and encourage alternative strategies. The presence of endangered seabirds and the site's proximity to the ocean prohibited conventional ant pest control strategies. A virtual bait station was developed and tested against Argentine ants, (Mayr), at a seabird nesting site along the California coast. The insides of PVC pipes were treated with 6.7 and 8.3 µg/cm$^2$ fipronil. The PVC pipes were capped and buried in the sand. Foragers crossed the treated barriers to consume sucrose water and were killed within 3-5 days after exposure. The delayed toxicity allowed ants to continue foraging on the sugar and interact with nestmates. There was a significant reduction in the number of ants at the site within 22 weeks.
Key Words Fipronil, Argentine ants, necrophoresis, horizontal transfer, California least tern

## INTRODUCTION

Ants are serious pests in sensitive urban environments such as hospitals, nursing homes, parks and recreation sites, schools, and endangered wildlife areas. Several species of ants such as Argentine ant, (Mayr); red imported fire ant, Buren; Pharaoh ant, (L.); and southern fire ant, McCook, present a serious problem to humans, domestic pets and wildlife. Control options are frequently limited because of potential exposures of insecticides or contamination to sensitive environmental areas. In these situations, baiting is the most environmental friendly approach to controlling pest ants.

Solid proteinaceous baits have been extremely effective against Pharoah ant (Oi et al., 1994, 1996) and southern fire ant (Hooper et al., 1998). Solid baits incorporating slow-acting toxicants such as hydramethylnon, IGRs, and indoxacarb into soybean or peanut oil have been extremely effective against many myrmicine ants such as red imported fire ant (Oi et al., 2006), Pharaoh ant (Oi et al., 2000), and harvester ants (Wagner, 1983). These types of bait are less effective against sweet feeding ants such as the Argentine ant and odorous house ant, (Say) (Wagner, 1983, Klotz et al., 2000). However, many species of dolichoderine and formicine ants do not readily recruit and forage on these types of baits, preferring sweet liquids instead. Consequently, formulating baits in aqueous sweet liquids presents a special problem because many of the slow-acting toxicants are not very soluble in water (Rust et al., 2004).

When Argentine ants were exposed to sand substrates treated with fipronil and returned to small laboratory colonies, fipronil was readily transferred to nestmates (Soeprono and Rust, 2004). Grooming and necrophoresis (removal of dead nestmates) were the primary modes of insecticide transfer. Many of the insecticides applied as a chemical barrier have recently been tested for their ability to be transferred from one ant to another. Fipronil and possibly high concentrations of thiamethoxam provided horizontal transfer and kill of workers.

To develop a strategy that exploits the recruiting behavior of ants, the effectiveness of slow-acting toxicants, and horizontal transfer, virtual bait stations were designed and tested against the Argentine ant. Foragers were permitted to cross surfaces treated with diluted insecticide en route to a sugar water feeding station. The workers picked up lethal doses of insecticide that exhibited delayed toxicity and were later transferred to nest mates by contact or necrophoresis. Consequently, it is possible to use insecticides and formulations that are not soluble in sugar water. We report the successful use of such a virtual baiting system to reduce Argentine ant populations at an endangered seabird nesting site.

## MATERIALS AND METHODS

### Ants

Argentine ants were collected from a citrus grove on the University of California, Riverside campus. Ant nests were excavated from the ground and transported to a laboratory chamber where they were extracted from the soil. Large laboratory colonies were maintained in plastic boxes (26.5 by 30 by 10 cm) with the inner sides coated with Teflon (fluoropolymer resin, type 30) to prevent ants from escaping. Each colony was provided with two or three artificial nests constructed from plaster-filled, petri dishes (9 cm diameter by 1.5 cm in depth) formed with a cylindrical area (5 cm diameter by 1 cm deep) in the center of the dish to serve as a nesting space (Soeprono and Rust, 2004). Colonies were provisioned with fresh water, 25% (wt/vol) sucrose water, and freshly killed western drywood termites, (Hagen), and American cockroaches, (L.).

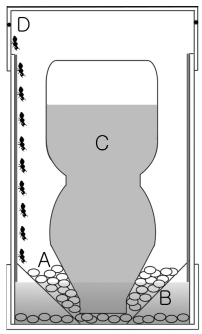
### Seabird

The California least tern (CLT),  (Mearns), is a federally and state endangered ground-nesting, migratory near shore seabird. The CLT nesting colony at White Beach along the coast north of Oceanside, CA, covers approximately 2.02 hectares divided into 55 grids, each grid being approximately 900 m$^2$ (25 m x 30 m). Argentine ants are the primary ant species on the White Beach CLT nesting site.

### Bait Stations

The virtual bait stations (Figure 1) were modified from a design by Cooper and Daane (2007). The stations were buried in the soil to avoid direct sunlight and keep the station cool. Four equally spaced horizontal holes (6.3 mm diameter) were drilled along the top of the PVC pipe and cap to permit ants access to the sugar water.

**Figure 1**. Side view of the virtual bait station. A. Gravel at the bottom covering the inverted cone. B. Plastic inverted cone to hold the sugar water container (C) and gravel. D openings for ants to enter the station.




To determine the amount of fipronil to apply to a 30-cm long strip of PVC pipe, ants were forced to forage across a strip of treated PVC to obtain sugar water. An ant colony was deprived of food for at least 3 days. During this period only water was provided. A strip of PVC pipe (2.5 cm by 30 cm, 75 cm$^2$) was cut from a section of PVC pipe. The inner surface of the strip was treated with an aqueous preparation of fipronil (Termidor 2SC, BASF Corp., Research Triangle Park, NC) at a rate equivalent to 3.3, 5, 6.7, 8.3, and 10µg/cm$^2$. Twenty drops of Tween 80 was added to the 100ml fipronil preparations to ensure good coverage on the plastic surface. The strips were allowed to dry. A small polystyrene weigh dish (4.5 cm dia) was attached at the end of a PVC strip, and 25% sugar water was provided in it. When one ant was released at the other end of the strip, it had to transverse the treated PVC surface to obtain the sugar water. To ensure ant's straight passage on the treated surface to reach the sugar water dish, 5ul of acetone preparation (10 µg of pheromone / ml) of synthetic trail pheromone cis-9-hexadecenal was applied on the PVC surface in a straight line using disposable glass pipets. After the ant consumed the sugar water, it returned to its original release point over the treated surface of PVC. The average of total exposure time going to and returning from the sugar water was 48.8 ± 18.2 sec (mean ± SD, n = 60). This procedure was repeated ten times for each of the treatment. The ants for each treatment were captured on their return and placed together in a container provided with water. The number of dead ants was counted daily.

To determine the level of Argentine ant foraging activity, the consumption of 50% sucrose solution was used at White Beach. Approximately, 48 ml of a 50% sucrose solution was placed in 50-ml polypropylene conical tubes (Falcon #352070, Becton Dickinson Labware, Franklin Lakes, NJ). The tube was wedged diagonally in the sand so that liquid would not spill from the tube. Each tube was covered with a yellow wooden shelter to prevent sand from blowing into the tubes. The tubes were left out in the field for 24 hours. Initially, two tubes were placed in each grid along the centerline, about 20 m apart. The amount of sucrose liquid consumed was adjusted by subtracting evaporation loss. Control vials (evaporation checks) were buried in a container that prevented ants from gaining access to them. The amount of water that evaporated from the control vials was determined. The number of ant visits was calculated by first correcting for evaporation loss and then dividing the amount an Argentine ant can consume (0.0003 g) per visit (Reierson et al., 1998). Fifty-two sucrose vials were placed each date at White Beach on 4/18/2007, 5/30/2007, 6/26/2007, 7/25/2007, 8/29/2007, and 9/25/2007.

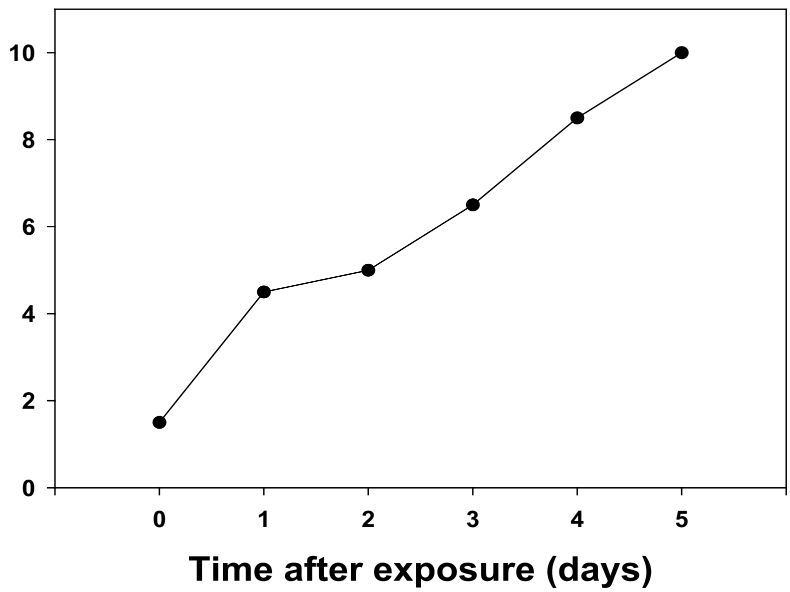
**Data Analysis**

The number of ant visits for both the treated and untreated grids was analyzed with a Kruskal-Wallis test (Statistix, 2005).

## RESULTS

When foragers crossed the PVC bridge treated with fipronil, deposits of 5, 6.7, 8.3, 10 μg/cm$^2$ provided 100% kill within 5 days. The efficacy of 5 μg/cm$^2$ deposit decreased after 1 week, killing only 40% of the ants within 4 days. Exposure to 10 μg/cm$^2$ provided faster kill, providing 100% mortality within 2 days. Exposure to 6.7 and 8.3 μg/cm$^2$ resulted in delayed toxicity between days 2 and 4 (Figure 1).

The initial numbers of ants in the untreated grids were significantly higher than in the grids that were treated with the virtual bait stations (Table 1). The number of ants visits to the monitors remained unchanged for 22 weeks in the untreated control. In the grids with the virtual bait traps, the number of ants significantly decreased at week 22. The number of ants in the baited section remained unchanged and considerably lower than the untreated grids. Thousands of ants were found dead in the virtual bait stations at each inspection throughout the summer.




. Delayed toxicity after exposure to deposits of fipronil on PVC pipe. Mortality data from 6.7 and 8.3 μg/cm$^2$ deposits were averaged.

**Table 1.** Efficacy of virtual bait stations against Argentine ants at White Beach.

| Treatment | Pretreatment avg. no. ant visits/vial | Avg. No. Ant Visits/Vial at week[a] 4 | 8 | 12 | 18 | 22 |
|---|---|---|---|---|---|---|
| Fipronil 10µg/cm$^2$ | 22,964 ab | 24,250 a | 17,578 ab | 25,231 a | 35,856 a | 8,719 b |
| Untreated | 53,424 | 57,857 | 41,832 | 47,590 | 59,757 | 42,452 |

[a] Averages followed by the same letter within a row are not significant different P= 0.05 (Kruskal Wallis test). Ant visits in the untreated series were not significantly different.

## DISCUSSION

The control of Argentine ants remains a serious problem without any specific strategy being consistently effective (Rust et al., 2003). Barrier applications and spot sprays with fipronil provide excellent control around structures for up to 12 weeks (Klotz et al. 2008). However, the use of sprays in sensitive areas is typically discouraged. The use of baits is frequently recommended as an alternative approach to controlling ants (Klotz et al., 1997). Unfortunately, many of the commercial baits sold for Argentine ant control are not very attractive or palatable (Rust et al., 2003).

The CLT nests on sandy patches along protected coastal areas of southern California from April until mid-September. Consequently, the use of insecticides to control ants in this extremely fragile environment is strictly monitored. Argentine ants are the primary ant species on the White Beach CLT nesting site. White Beach is atypical for Argentine ant in that the soft sand of the beach does not provide adequate support for the ants to build nests and tunnels. Nearly all of the ants nest in or adjacent to wood debris that occurs on the site. The debris is a combination of driftwood washed onto the site or cane and brush washed down the canyon during winter rains. In addition, the soil near the creek is moist and compact enough to allow ants to construct nests. The beach sand east of the creek gives way to soil, which is also supporting ant colonies. Large colonies of Argentine ants inhabit most of the tern site.

Many of the urban pest species belonging to the subfamily Dolichoderinae forage on extraforal necataries and tend hemipteran insects that produce honeydew. Argentine ants will forage on sucrose water the entire year (Rust et al., 2000). Consequently, stations filled with sugar water will attract ants even when the seasons and reproductive cycles of the ant colony change. The virtual bait station exploits this strong feeding preference for sugars and carbohydrates. Formulating insecticides into aqueous sucrose solutions present a major challenge, especially those insecticides with low water solubility.

By the end of the summer, the virtual bait stations had significantly reduced the number of ants foraging in the treated grids. The bait stations were returned to the laboratory and strips of the PVC treated with fipronil were tested for insecticidal activity. The strips provided 40 to 90% kill of foragers with 5 days. The PVC container had protected the treated surfaces from exposure to sunlight, moisture and heat preventing the rapid breakdown of the fipronil deposits. Soil surfaces treated with fipronil may be sensitive to photolysis, especially at temperatures of > 32˚C (Connelly 2001). In addition, the virtual bait stations prevented non-target organism from contacting treated surfaces.

Alternative control strategies of controlling ants may be accomplished by exploiting their social behavior in such a manner as to minimize environmental contamination. Foraging and necrophoresis can be exploited to return lethal active ingredients into the nest. This strategy may also be effective for other social and semi-social insects such as termites and yellowjackets.

## ACKNOWLEDGMENTS

This research has in part been supported by funding from U.S. Navy.

## REFERENCES CITED

**Cooper, M.L. and Daane, K.M. 2007.** Argentine ant management: liquid bait program for vineyards. http;//www.ucce.ucdavis.edu/files/filelibrary/1650/35710.pdf.

**Hooper, L.M., Rust, M.K., and Reierson, D.A. 1998.** Using bait to suppress the southern fire on an ecologically sensitive site (Hymenoptera: Formicidae). Sociobiology 31: 283-289.

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

**Klotz, J., Greenberg, L., and Venn, G. 2000.** Evaluation of two hydramethylnon granular baits for control of Argentine ant (Hymenoptera: Formicidae). Sociobiology 36:201-207.

**Klotz, J.H., Rust, M.K., Field, H.C., Greenberg, L., and Kupfer, K. 2008.** Controlling Argentine ants in residential settings (Hymenoptera: Formicidae). Sociobiology 51: 1-10.

**Oi, D.H. and Oi, F.M. 2006.** Speed of efficacy and delayed toxicity characteristics of fast-acting fire ant (Hymenoptera: Formicidae) baits. J. Econ. Entomol. 99: 1739-1748.

**Oi, D.H., Vail, K.M., Williams, D.F., and Bieman, D.N. 1994.** Indoor and outdoor foraging locations of Pharaoh ants (Hymenoptera: Formicidae) and control strategies using bait stations. Florida Entomol. 77: 85-91.

**Reierson, D.A., Rust, M.K., and Hampton-Beesley, J. 1998**. Monitoring with sugar to determine the efficacy of treatments to control Argentine ants, Linepithema humile (Mayr), pp. 78-82. In Proceedings of the National Conference on Urban Entomology 1998, San Diego, CA.

**Rust, M.K., Reierson, D.A., and Klotz, J.H. 2003.** Pest management of Argentine ants. J. Entomol. Sci. 38: 159-169.

**Rust, M.K., Reierson, D.A., and Klotz, J.H. 2004.** Delayed toxicity as a critical factor in the efficacy of aqueous baits for controlling Argentine ants (Hymenoptera: Formiciade). J. Econ. Entomol. 97: 1017-1024.

**Rust, M.K., Reierson, D.A., Paine, E., and Blum, L.J. 2000.** Seasonal activity and bait preferences of the Argentine ant (Hymenoptera: Formicidae). J. Agric. Urban Entomol. 17: 201-212.

**Soeprono, A.M. and Rust, M.K. 2004.** Effect of horizontal transfer of barrier insecticides to control Argentine ants (Hymenoptera: Formiciade). J. Econ. Entomol. 97: 1675-1681.

**Statistix 2005.** Statistix user manual version 8. Analytical Software, Tallahassee, FL.

**Wagner, R.E. 1983.** Effects of Amdro fire ant insecticide mound treatments on southern California ants, 1982. Insect. and Acaricide Tests 8: 257.