Proceedings of the Tenth International Conference on Urban Pests
Rubén Bueno-Marí, Tomas Montalvo, and Wm. H Robinson (editors) 2022
CDM Creador de Motius S.L., Mare de Deu de Montserrat 53-59,
08930 Sant Adrià de Besòs, Barcelona, Spain

A 'SOLUTIONS APPROACH' FOR AREA-WIDE CONTROL OF SUBTERRANEAN TERMITES, *COPTOTERMES FORMOSANUS* AND *RETICULITERMES* SP. (BLATTODEA: RHINOTERMITIDAE)

[1]KYLE K. JORDAN, [2]CARRIE COTTONE, [1]MATTHEW SPEARS, [1]ROBERT HICKMAN, AND [2]CLAUDIA RIEGEL

[1]BASF Corporation, 26 Davis Dr, Durham, NC 27709 USA
[2]City of New Orleans Mosquito, Termite, and Rodent Control Board, 2100 Leon C Simon Dr, New Orleans, LA 70122 USA

Abstract The Exploreum Science Center and History Museum in Mobile, Alabama, USA, and UNESCO World Heritage Site Taliesin West – Frank Lloyd Wright's winter residence and architectural school in Scottsdale, Arizona, USA, are both complex structures that were experiencing substantial termite activity. A 'solutions approach' – use of multiple formulations/products – was used to protect each of these historic structures from termites. This approach is especially important for structures that have historical significance since termites need to be effectively controlled with as little disturbance or risk of damage as possible to the structures and surrounding areas. These treatments implemented combinations of termite baiting and liquid termiticides (high-pressure injection), and foam and resulted in elimination of termite activity in the structures with minimal disruption to the structures, grounds, and the personnel working in and visiting the sites.

Key Words Trelona, Novaluron, Termidor, Fipronil, Area-wide

INTRODUCTION

Subterranean termites are significant economic pests throughout most of the United States. While most homeowners readily seek solutions to their termite issues, many municipal-owned buildings forego treatment for long periods of time for a variety of reasons, including not having pest control staff and funds not typically being budgeted for termite control – particularly for introduced species.

The Gulf Coast Exploreum Science Center and History Museum in Mobile, Alabama, USA, is located well within the range of the Formosan termite, *Coptotermes formosanus* (Shiraki, 1909), a species introduced to the United States sometime after World War II (Su and Tamashiro, 1987). The collection of structures, which covers an entire city block and includes a historic fire station, lent itself to termite infestation – moisture issues due to leaks in roofs, irrigation along the foundation, and synthetic stucco siding, wood-to-ground contact, and infested trees in close proximity to the structure. Formosan termite activity had been addressed over the years with localized treatments of Termidor® Ant & Termite Foam (Termidor Foam) in walls and window frames, but the city sought a more comprehensive approach to implement an area-wide treatment strategy and hired a pest management company, who reached out to BASF – the manufacturer of a product they wanted to use. Because the New Orleans Rodent, Mosquito, and Termite Control Board (NOMTRCB) had extensive experience with area-wide termite control, members of the Board were brought in as consultants for the project. The pest control company, BASF, and NOMTRCB worked with the City of Mobile to formulate a plan to control termites in the structure and the area surrounding the museum in hopes that they City of Mobile could apply the concept to additional areas of infestation.

Taliesin West in Scottsdale, Arizona, USA, was an experimental lab for historic American architect Frank Lloyd Wright and his students, and Wright spent his winters there until his death in 1959. Although he was renowned for his innovative design and construction, these same assets became a liability when it came to termite control because of the complicated experimental construction techniques utilized throughout the structures. Taliesin West lies on 495 acres in the active range of the desert subterranean termite, *Heterotermes aureus* (Snyder), and all of the

primary structures in the complex had experienced termite activity for years. The Frank Lloyd Wright Foundation hired a local pest management company who reached out to BASF to devise a strategy for controlling the termites without disturbing Wright's structures or the landscaping around them.

The products chosen for these sites were selected not only for their proven efficacy but because they also lend themselves to non-invasive termite control. Installing bait stations creates minimal disturbance when compared to digging a trench around a structure. Placement of the bait stations is flexible and allows for targeting areas of termite activity or conducive conditions without being conspicuous. Termite baiting has also been shown to be an integral component of area-wide termite control in the French Quarter in New Orleans, Louisiana, USA (Guillot et al., 2010) and other areas with widespread termite activity (Getty et al., 2007). The High-Precision (HP) system for delivering liquid termiticides also eliminates the need for digging a physical trench. The termiticide is injected into the soil and uses the pressure created by the equipment and chemistry of the formulation to penetrate the soil rather than gravity and sheer volume of water. Applying termiticide using the HP unit therefore not only reduces disturbance, but it conserves water and greatly decreases the amount of time it takes to perform a liquid application – both important aspects when performing a termiticide application in the arid Southwestern US. Ready-to-use foams are not only convenient because they do not require mixing, but they can be applied into voids or nest material via small access holes, where they can then move three-dimensionally throughout the void.

In most termite treatments, only a liquid termiticide or a termite bait is used around a structure (not both), as each is approved in almost every state as a 'stand-alone' treatment that itself provides structural protection. The goal of these two projects was to use a 'solutions approach' that combines multiple product options into a single plan that provides efficacy and structural protection but also minimizes impact on the structure, grounds, and personnel.

MATERIALS AND METHODS

Infested structures were inspected by local pest control companies and treatment plans were developed in conjunction with personnel from BASF, the pest control companies, the local research cooperator (NOMTRCB or Paul Baker, faculty emeritus at University of Arizona), and representatives from the historic sites (City of Mobile and the Frank Lloyd Wright Foundation). Termidor® and Trelona® product options for the treatments included the liquid termiticide Termidor® High-Precision termiticide II (Termidor HP II), 'ready-to-use' foam product Termidor Foam, and the in-ground termite bait Trelona® Compressed Termite Bait (Trelona) installed in ATBS Advance® Termite Bait Stations. Based on the inspection and the characteristics of the buildings, specific products were chosen to be effective in controlling the termites while causing as little disturbance as possible to the structures and surrounding areas.

Gulf Coast Exploreum. Based on inspections of the structures and the surrounding areas, a total of 248 ATBS Stations were installed in May 2017 around the structures according to the label (Figure 1). A mix of regular stations and concrete core stations were installed, depending on whether soil was accessible or the ground was paved. All stations initially contained the commercial Termite Monitoring Base made of wood and the Termite Inspection Cartridge, containing cellulose with no active ingredient. After three monthly inspections to establish a baseline of activity, the contents of all stations were replaced with two Trelona Bait cartridges, containing 0.5% novaluron. The bait stations and structures were inspected quarterly for the next year by the pest management company and NOMTRCB. Interior activity was noted with the intention of treating with Termidor Foam once the baiting period began. Voucher specimens were collected throughout the duration of the study for genetic analysis.

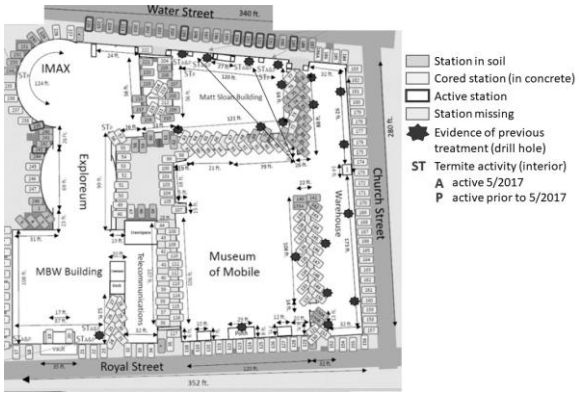

Figure 1. Diagram of the Gulf Coast Exploreum site (Mobile, Alabama, USA) indicating locations of termite bait stations and termite activity.

Taliesin West. Treatment of the Taliesin West complex was performed in three phases (Figure 2). Phase I included the bookstore & maintenance shed areas, Phase II included the studio/school and Wright residence, and Phase III

included the office and theaters. One structure adjacent to the Phase II treatment area was treated prior to the study (2013-2018) by the pest management company using sporadic spot treatments of Termidor® High-Efficiency termiticide (0.125% fipronil). Treatments for each phase included combinations of Termidor HP II (0.125% fipronil), Termidor Foam (0.005% fipronil), and Trelona Bait (0.5% novaluron). Evaluation of the treatments was based on elimination of termite activity in the structures.

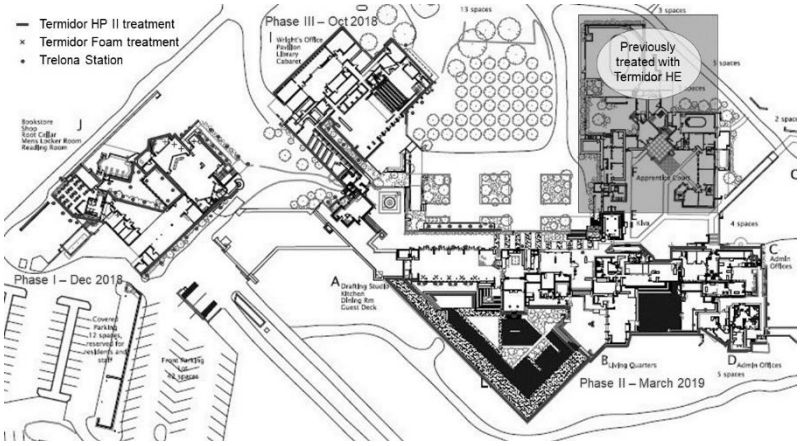

Figure 2. Treatment diagram for Taliesin West, showing Termidor HP II, Trelona, and Termidor Foam treatment sites.

Phase I involved Termidor HP II injections around a portion of the exterior perimeter and courtyard, totaling approximately 230 linear meters. Termite baits (37 stations total) were installed around the foundation and in areas of suspected or known termite activity and where moisture collected. Four areas of activity inside and outside the structure were treated using Termidor Foam, including ceiling beams in the bookstore and gift shop and rafters outside the locker room. Phase I occurred in December 2018.

Phase II treatments included extensive treatments (approximately 268 linear meters) using Termidor HP II. A total of 37 bait stations targeted additional areas that were not ideal for HP injections. Seven interior locations were treated with Termidor Foam. These treatments were performed in March 2019.

Phase III treatments occurred in October 2019 and consisted of approximately 152 linear meters of Termidor HP II treatment. Nine termite bait stations were installed in areas of termite activity.

Treated areas of Phase I were inspected at 90 days and again at six months by Dr Paul Baker. Bait stations were inspected at one year. Structures from Phase II were inspected where termite activity was present prior to treatment six months later. Phase III structures will be officially inspected in March 2020 at the six-month interval. All structures have been monitored by the facilities managers, particularly locations of previous swarms and other termite activity.

RESULTS AND DISCUSSION

Gulf Coast Exploreum. Based on genetic analysis, one colony of Formosan subterranean termites and one colony of *Reticulitermes* sp. were present at the site (Figure 3). After bait was introduced into the stations, both species steadily declined in presence until they were not detected in any stations one year from the initial install date (Table 1). The Formosan colony fed at ten different stations, while the Eastern subterranean colony fed at a single station. Only 0.1 cartridge (12 g of material) was consumed by the *Reticulitermes* colony, while approximately 1.1 cartridges' worth (136 g) was consumed by the Formosan colony. The relatively small amount of consumption accompanied by the disappearance of activity is a testament to the efficacy of novaluron and its ability to transfer and cause mortality (Lewis, 2008). No additional activity was ever detected inside the structure either, indicating that while Termidor Foam had been used in prior interior treatments with some success, the ongoing activity inside the structure was ultimately connected to the activity outside and was ultimately eliminated after the termites fed on the bait.

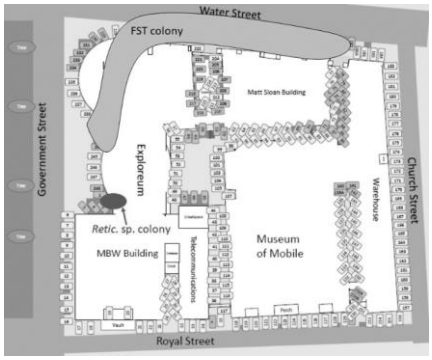

Figure 3. Location of the two termite colonies associated with the Gulf Coast Exploreum site (Mobile, Alabama, USA). FST = Formosan Subterranean Termite, Retic. sp. = *Reticulitermes* sp.

Table 1. Occurrence of Formosan Subterranean Termites (FST) and Reticulitermes sp. and consumption of Trelona® Compressed Termite Bait in termite bait stations during the monitoring and baiting phases of the Mobile, AL baiting project.

	Date	Number of Active Stations	Average Consumption (% bait cartridge)
Monitoring Phase (no active ingredient)	June 2017	FST – 0	0%
		Retic – 1	10%
	July 2017	FST – 4	6.3%
		Retic – 1	10%
	August 2017	FST – 10	30%
		Retic – 1	10%
Baiting Phase (0.5% novaluron)	November 2017	FST – 3	45%
		Retic – 0	10%
	February 2018	FST – 1	10%
		Retic – 0	0%
	May 2018	FST – 0	5%
		Retic – 0	0%

Taliesin West. No termite activity was detected in any structures treated in Phase I at 90 days post-treatment. At the 1-year inspection (Phase I treatment), termite activity was detected in one termite bait station. This activity corresponds to where live termites were seen inside the structure (where a Termidor Foam treatment took place). No other activity was detected during this inspection or subsequent inspections in any of the structures treated during any of the three phases, even where facility workers had regularly seen shelter tubes.

CONCLUSIONS

While Termidor HE and HP II liquid treatments and Trelona bait treatments are known to successfully protect structures by themselves, having the flexibility to use multiple methods of control as a 'solutions approach' allows pest management professionals the opportunity to reduce disturbance to structures and the surrounding areas while still successfully controlling termites. At both sites, termites were successfully eliminated from a large area with minimal disruption to the associated structures and landscapes. It is also important to note that there was very little disruption to the function of the sites. The greatest time required was by far the installation of concrete core bait stations around the Exploreum, which required renting specialized equipment to penetrate the sidewalks and pavement. Because Trelona only requires an inspection once a year, the treatments are basically non-invasive to the staff and visitors.

ACKNOWLEDGEMENTS

The authors would like to thank the City of Mobile and the Frank Lloyd Wright Foundation for the opportunity to 'think outside the box' when it came to protecting these important structures and BASF P&SS Marketing, who generously provided all of the products used in these treatments free of cost.

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