# Field Attraction of Termites to a Carbon Dioxide-Generating Bait in Australia (Isoptera)

by

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## ABSTRACT

Termite bait stations with or without a $CO_2$-generating bait (Focus Termite Attractant, produced by Brotica, Inc., Fort Collins, Colorado, and distributed by Ensystex Australasia) were tested at tree and house locations in Australia. The termite species *Coptotermes acinaciformis* (Froggatt) (Isoptera: Rhinotermitidae), *Schedorhinotermes intermedius* (Brauer) (Isoptera: Rhinotermitidae), *Microcerotermes turneri* (Froggatt) (Isoptera: Termitidae), and *Nasutitermes exitiosus* (Hill) (Isoptera: Termitidae) discovered more monitoring stations when the $CO_2$-generating bait was present, and also discovered the monitoring stations more quickly when the $CO_2$-generating bait was present.

## INTRODUCTION

The economic impact of termites may exceed $11 billion each year in the United States (Su 2002) and $40 billion worldwide (Wiseman & Eggleton 1994). The majority of damage to homes and other structures is caused by subterranean termite species in the family Rhinotermitidae (Su 1990).

Baiting strategies for termite control have recently gained popularity due to the withdrawal of chlordane, chlorpyrifos and other termiticides from the market (Kard 1999, Su & Scheffrahn 2000). Current efforts are focused on improving specific aspects of these systems, including the addition of attractants and/or bait enhancers (Pawson & Gold 1996, Lewis *et al*. 1998, Potter *et al*. 2001, Lax & Osbrink 2003). In a baiting system, the pesticide is typically introduced into a station only after termites are detected in that

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station, and depending on the species, weeks may pass before termites locate a station and begin to feed (Lewis et al. 1998, Potter et al. 2001).

Baiting has been promoted as a more desirable method of termite management. It is generally considered to more environmentally sound as baiting uses very small amounts of insect specific toxicants that are administered in stations that are targeted at the economically important termite species only (i.e., it replaces the broad-scale application of liquid chemicals used to poison the soil around a building). For baiting to work successfully, termites must find the bait stations so that the matrix with toxicant can be added for termite consumption and transfer it back to the nest. These requirements are important, and a successful baiting program can take up to nine months (e.g. 3-9 months Su, 1994; 7 months Tsunoda *et al*., 1998; 3-7+ months Su & Scheffrahn, 2000), which is much slower than by other methods.

Carbon dioxide ($CO_2$) has been reported as an attractant for the termite species *Reticulitermes flavipes* (Kollar) (Isoptera: Rhinotermitidae), *R. virginicus* (Banks) (Isoptera: Rhinotermitidae), and *R. tibialis* (Banks) (Isoptera: Rhinotermitidae) in the United States (Bernklau et al. 2005). The most attractive concentration of $CO_2$ is 5 mmol/mol for *R. tibialis* and 10 mmol/mol for *R. flavipes* and *R. virginicus*. An attractant such as $CO_2$ has the potential to improve the effectiveness of termite baiting systems by reducing the time interval between station placement and introduction of the pesticide.

Focus Termite Attractant (produced by Brotica, Inc., Fort Collins, Colorado, and distributed by Ensystex Australasia) is a granular formulation that reacts in soil to generate $CO_2$ in the optimum concentration range for termite attraction (Bernklau *et al*. 2005). Focus Termite Attractant is a non-toxic formulation composed of natural materials, and it contains no pesticidal components. We tested Focus Termite Attractant in combination with Exterra Quarterra Termite Stations (Ensystex Australasia) to determine the ability of the attractant to enhance the efficacy of bait stations by creating a larger 'footprint' for termite discovery. Specifically, we were interested in three ecological effects, (i) the time required for station discovery, (ii) the number of stations discovered, and (iii) the rate at which stations were abandoned by termites.

## MATERIALS AND METHODS

Trial sites were established in the vicinity of known termite activity and/or colonies of the species *Coptotermes acinaciformis* (Froggatt) (Isoptera: Rhinotermitidae), *Schedorhinotermes intermedius* (Brauer) (Isoptera: Rhinotermitidae), *Microcerotermes turneri* (Froggatt) (Isoptera: Termitidae) in Queensland, Australia, and *Nasutitermes exitiosus* (Hill) (Isoptera: Termitidae) in New South Wales, Australia. Exterra Quarterra Termite Stations (Ensystex Australasia) were placed equidistant around the termite colonies in holes 10 cm diameter by 20 cm deep, prepared using a Jarrett auger. Due to the dry conditions encountered, the soil around each hole was moistened with 100 ml water. For the $CO_2$-baited stations, Focus Termite Attractant granules (5 g) were added to each hole prior to station placement. A minimum distance of three meters was maintained between any control station and any Focus-treated station to minimise the chance of the $CO_2$ gradient from a Focus-treated station impacting the results at a control station. Stations were inspected weekly for the presence of termites. Each station contained six *Eucalyptus delegatensis* R. T. Baker timber interceptors for feeding by the termites.

### *Coptotermes acinaciformis*

Three colonies of *C. acinaciformis* were located in trees in a residential park in Deception Bay, Queensland. Four control and four Focus Termite Attractant stations were placed on either side of each colony. Stations were placed in a line running east to west with one meter between each series of four stations on either side, and four meters separating the line of control stations from the line of Focus Termite Attractant stations. At two trees the control stations were placed to the north of the colony and at one tree they were placed to the south of the colony.

### *Schedorhinotermes intermedius*

A domestic residence in a leafy suburb in Upper Caboolture, Queensland, was selected due to the known long-standing presence of *S. intermedius* in the garden. Evidence of *Schedorhinotermes* activity was noted in the garden though no termites could be located. Stations were placed at three meter intervals around the home. Sides were selected randomly, two sides with Focus Termite Attractant stations and two with control stations. Nine stations for each treatment were placed.

### *Microcerotermes turneri*

An inspection also revealed the presence of *Microcerotermes turneri* in a timber gate post at the front of the same property in Upper Caboolture, Queensland. Four stations were placed, two on the nature strip and two in the front garden, equidistant at 1.5 meters from the post infested with *Microcerotermes*, with three meters between the control and Focus Termite Attractant stations.

### *Nasutitermes exitiosus*

A mound of *N. exitiosus* was located in a garden bed at a domestic residence in Maitland, New South Wales. Six Focus Termite Attractant stations and six control stations were placed on either side of the mound.

## Statistical Analysis

T-tests were used to analyze differences in termite presence among stations that contained or lacked $CO_2$ baits (SAS 2000).

## RESULTS

Exterra Quarterra Termite Stations containing Focus Termite Attractant were located more often and also more quickly than control stations for the four termite species that were tested (Table 1, Table 2, Table 3, Table 4).

### *Coptotermes acinaciformis*

Termites were found significantly more often in Focus-baited stations than in control stations (Table 1, $P<0.05$, t-test). Termites located 10 of the 13 Focus-baited stations, but only located 3 of the 13 control stations (Table 1). Over the course of the 9 week study, termites were found in Focus-baited stations on 68 occasions, but termites were found in control stations on only 12 occasions (Table 1). Two of the Focus-baited stations were found by termites within the first week after installation, but none of the control stations were located by termites until 4 weeks after installation. On average, of the stations located by termites, Focus-baited stations were found after 3.20 $\pm$SE 0.57 weeks, but control stations were found only after 6.00 $\pm$SE 1.15 weeks. None of the stations were abandoned by termites once the termites were first observed in them.

### *Schedorhinotermes intermedius*

Table 1. Termite bait stations containing *Coptotermes acinaciformis*.

| Stations | Site | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO2 bait | Tree 1 | - | - | X | X | X | X | X | X | X |
| CO2 bait | Tree 1 | - | - | - | X | X | X | X | X | X |
| CO2 bait | Tree 1 | X | X | X | X | X | X | X | X | X |
| CO2 bait | Tree 1 | - | - | X | X | X | X | X | X | X |
| CO2 bait | Tree 2 | - | - | X | X | X | X | X | X | X |
| CO2 bait | Tree 2 | - | X | X | X | X | X | X | X | X |
| CO2 bait | Tree 2 | - | - | - | - | - | - | - | - | - |
| CO2 bait | Tree 2 | - | - | - | - | X | X | X | X | X |
| CO2 bait | Tree 3 | - | - | - | - | - | - | - | - | - |
| CO2 bait | Tree 3 | - | - | X | X | X | X | X | X | X |
| CO2 bait | Tree 3 | - | - | - | - | - | - | X | X | X |
| CO2 bait | Tree 3 | X | X | X | X | X | X | X | X | X |
| CO2 bait | Tree 4 | - | - | - | - | - | - | - | - | - |
| Control | Tree 1 | - | - | - | - | - | - | - | X | X |
| Control | Tree 1 | - | - | - | - | - | - | - | - | - |
| Control | Tree 1 | - | - | - | - | - | - | - | - | - |
| Control | Tree 1 | - | - | - | X | X | X | X | X | X |
| Control | Tree 2 | - | - | - | - | - | - | - | - | - |
| Control | Tree 2 | - | - | - | - | - | X | X | X | X |
| Control | Tree 2 | - | - | - | - | - | - | - | - | - |
| Control | Tree 2 | - | - | - | - | - | - | - | - | - |
| Control | Tree 3 | - | - | - | - | - | - | - | - | - |
| Control | Tree 3 | - | - | - | - | - | - | - | - | - |
| Control | Tree 3 | - | - | - | - | - | - | - | - | - |
| Control | Tree 3 | - | - | - | - | - | - | - | - | - |
| Control | Tree 4 | - | - | - | - | - | - | - | - | - |

A Focus-baited station was the only station found to contain termites in this test, and none of the 9 control stations were located by termites (Table 2). The Focus-baited station was located in Week 2 after the stations were installed. In Week 8 after the experiment began, this station was found to have been flooded by a broken pipe, and subsequent data was not available. The station had not been abandoned as of the last reliable observation in Week 7.

### *Microcerotermes turneri*

A Focus-baited station was the only station found to contain termites in this test, and neither of the 2 control stations were located by termites (Table 3). The Focus-baited station was located in Week 1 after the stations were installed.

### *Nasutitermes exitiosus*

Table 2. Termite bait stations containing *Schedorhinotermes intermedius*.

| Stations | Site | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO2 bait | House | - | - | - | - | - | - | - | - | - |
| CO2 bait | House | - | - | - | - | - | - | - | - | - |
| CO2 bait | House | - | - | - | - | - | - | - | - | - |
| CO2 bait | House | - | - | - | - | - | - | - | - | - |
| CO2 bait | House | - | - | - | - | - | - | - | - | - |
| CO2 bait | House | - | - | - | - | - | - | - | - | - |
| CO2 bait | House | - | X | X | X | X | X | X | N/A[a] | N/A[a] |
| CO2 bait | House | - | - | - | - | - | - | - | - | - |
| CO2 bait | House | - | - | - | - | - | - | - | - | - |
| Control | House | - | - | - | - | - | - | - | - | - |
| Control | House | - | - | - | - | - | - | - | - | - |
| Control | House | - | - | - | - | - | - | - | - | - |
| Control | House | - | - | - | - | - | - | - | - | - |
| Control | House | - | - | - | - | - | - | - | - | - |
| Control | House | - | - | - | - | - | - | - | - | - |
| Control | House | - | - | - | - | - | - | - | - | - |
| Control | House | - | - | - | - | - | - | - | - | - |
| Control | House | - | - | - | - | - | - | - | - | - |

[a] In Week 8 after the experiment began, this station was found to have been flooded by a broken pipe.

A heavy infestation of termites was recorded in one of the Focus Termite Attractant stations 16 days after installation (Table 4). A light infestation of termites was recorded in one of the control stations on the same date. Further inspections each week thereafter revealed that the termites remained in the Focus Termite Attractant station, but the termites vacated the control station the week after they were detected and did not return. After six inspections, the trial was terminated to allow elimination of the termite colony and safeguard the property.

Table 3. Termite bait stations containing *Microcerotermes turneri*.

| Stations | Site | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO2 bait | House | - | - | - | - | - | - | - | - | - |
| CO2 bait | House | X | X | X | X | X | X | X | X | X |
| Control | House | - | - | - | - | - | - | - | - | - |
| Control | House | - | - | - | - | - | - | - | - | - |

Table 4. Termite bait stations containing *Nasutitermes exitiosus*.

| Stations | Site | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 |
|---|---|---|---|---|---|---|---|
| CO2 bait | Mound | - | X | X | X | X | X |
| CO2 bait | Mound | - | - | - | - | - | - |
| CO2 bait | Mound | - | - | - | - | - | - |
| CO2 bait | Mound | - | - | - | - | - | - |
| CO2 bait | Mound | - | - | - | - | - | - |
| CO2 bait | Mound | - | - | - | - | - | - |
| Control | Mound | - | - | - | - | - | - |
| Control | Mound | - | - | - | - | - | - |
| Control | Mound | - | - | - | - | - | - |
| Control | Mound | - | - | - | - | - | - |
| Control | Mound | - | - | - | - | - | - |
| Control | Mound | - | X | - | - | - | - |

## DISCUSSION

We conclude that the $CO_2$ gradient from each Focus-baited station effectively created a larger 'footprint', and that the termites then followed the $CO_2$ gradient to the station. For the four termite species tested, the presence of Focus Termite Attractant in Exterra Quarterra Termite Stations increased the number of stations that were found by termites. Termites did not abandon any of the bait stations once they located them, whether baited with Focus Termite Attractant or not, except for one of the control bait stations that was abandoned by *Nasutitermes exitiosus* after a single week of occupancy (Table 4).

The presence of Focus Termite Attractant also decreased the time required for termites to discover the stations. This point is of particular interest in the development of baiting system technologies, because it has been observed that weeks may pass before termites locate a bait station and begin to feed (Lewis et al. 1998, Potter et al. 2001). In the present study, two of the termite species located Focus-baited stations within the first week after installation (*C. acinaciformis* and *Microcerotermes turneri*), and the other two termite species located the Focus-baited stations within the second week after installation (*N. exitiosus* and *Schedorhinotermes intermedius*). In contrast, control stations were never observed to contain termites for two of the species tested (*Schedorhinotermes intermedius*. and *Microcerotermes turneri*), and required a minimum of 2-4 weeks for the two termite species that did find them (*C.*

*acinaciformis* and *N. exitiosus*).

The use of Focus Termite Attractant in association with Exterra Quarterra Termite Stations will provide added benefits to pest managers using the Exterra Termite Interception & Baiting System by detecting the presence of termites within the vicinity of a property sooner. Early interception in a Station further reduces the risk of termites entering a structure and enables earlier placement of Requiem Termite Bait. Previous data has shown termites are more likely to discover the Exterra Quarterra Stations compared to other commercial Stations due to the larger size and use of a more favored timber source for the interceptors. Focus Termite Attractant will further enhance the benefits of the Quarterra Stations.

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