

Field Comparison of Sand or Insecticide Barriers for Control of *Reticulitermes* spp. (Isoptera: Rhinotermitidae) Infestations in Homes in Northern California

by

Vernard R. Lewis¹, Michael I. Haverty², Douglas S. Carver³, and Calvin Fouche⁴

ABSTRACT

Eleven homes with active subterranean termite (*Reticulitermes* spp.) infestations had a sand barrier (51cm wide and 7.6cm deep; 1.6 to 2.5mm dia. particles) installed along the raised foundation inside the crawl space. Eight homes were conventionally treated with a commercially available liquid termiticide. All homes were monitored for 3 years. At 1 year after treatment, the number of barrier penetrations was similar: 3 for the sand treatment and 2 for the chemical treatment. Spot retreatments or corrections to the barrier were made for both sand and insecticide "failures." At 2 and 3 years after treatment, 3 homes in the sand treated group still showed signs of barrier penetration while the chemically treated homes had none. Wood-soil contacts, cracks in the foundation, difficulties in treatment installation, and uneven foundation surface contributed to barrier penetrations for sand- and chemically treated homes. Periodic monitoring and improved installation techniques could increase the long-term performance for either barrier treatment directed against *Reticulitermes* spp. infestations.

INTRODUCTION

In the United States control and damage repair costs due to subterranean termites exceed \$5 billion per year (Su & Scheffrahn 1990). In California, these costs exceeded \$300 million per year a decade ago (Brier, Dost, & Wilcox 1988). Chemical barriers have been the dominant means of protecting the multi-billion dollar national investment in wood-in-service for more than 50 years. Since the early 1940's when chlorinated hydrocarbons were shown to have biological activity against insects, chemical barriers have been the mainstay of the pest control

¹Division of Insect Biology, Department of Environmental Sciences, Policy and Management, 201 Wellman Hall, University of California, Berkeley, CA 94720.

²Pacific Southwest Research Station, Forest Service, USDA, P. O. Box 245, Berkeley, CA 94701.

³Live Oak Structural Inc., 801 Camelia St. Suite B, Berkeley, CA 94710.

⁴University of California Cooperative Extension San Joaquin County, 420 S Wilson Way, Stockton, CA 95205.

industry in combating subterranean termite infestations. In California, the risk homeowners face in having a termite infestation is substantial; 30% of all structural pest inspection reports (over 1.5 million conducted per year) reveal signs of active subterranean termites (Brier, Dost, & Wilcox 1988).

Not long ago, the commonly used soil termiticides (chlordane, aldrin, dieldrin, and heptachlor) were voluntarily withdrawn or banned by the U. S. Environmental Protection Agency because of the public's concern over their persistence and toxic effects in our environment (Anonymous 1989). New termiticides have been developed as replacements for these chlorinated hydrocarbons, but their performance has been much poorer; as much as 30% of the treatments failed within a year (Katz 1989). Also disturbing are reports that termite damage and control costs have tripled for some parts of the southeastern United States since the use of chlordane has been discontinued (Su & Scheffrahn 1990). The registered rates of the chlorinated hydrocarbon insecticides have remained efficacious in field tests for over 40 years (Kard *et al.* 1989), whereas the replacement insecticides are considered effective if they prevent damage by termites for only 5 years.

Persistent soil-drench termiticides continue to be developed and registered for control of subterranean termites. Eleven termiticides representing 6 active ingredients registered by the U.S. Environmental Protection Agency are currently marketed for use under and around wooden structures (Kard 1996a). Their use in some parts of the southeastern United States has been reported to exceed 390 kg/ha (La Fage 1986). This alarmingly high application rate is almost 200-fold greater than the 2.2 kg/ha rate reported for agriculture (Pimentel & Levitan 1986). In California, over 7.6 million liters (more than 76,000 kg of active ingredient) of termiticides were applied for termite control in the 6 San Francisco Bay Area counties from 1986 - 1990 (D. Carver, unpublished data). Literally all of these termiticides are placed under or adjacent to structures occupied by people at a time when public concern over toxic chemical usage is increasing. Recently a slow-acting bait has been approved and marketed for subterranean termite control around homes (Silvestri 1996). However, termite baiting is still undergoing development and is not in wide-scale use.

The use of sand barriers for prevention of damage of the western subterranean termite was first proposed nearly 40 years ago (Ebeling & Pence 1957). However, until recently this work went largely unnoticed. These authors showed that workers of *Reticulitermes hesperus* Banks, were unable to penetrate a layer of either dry or moist sand consisting of particles ranging in size from 1.6 to 2.5 mm. The smaller

diameter particles are wedged in the interstitial spaces between larger particles forming a barrier. The larger diameter particles are also too large for termites to grasp with their mandibles and move aside. Smith & Rust (1990) have reaffirmed the tunneling response of *R. hesperus*. Similarly, Tamashiro *et al.* (1987) have shown that the Formosan subterranean termite, *Coptotermes formosanus* Shiraki cannot penetrate basaltic barriers in Hawaii, and French (1991) reported on the successful stoppage of *Coptotermes spp.* in Australia using granite barriers.

All of the above studies used laboratory assays in obtaining the results, with the intended use of these barriers being under new slab-on-grade construction. Simulated field studies evaluating the impenetrability of sand barriers by subterranean termites are currently underway in several states (Kard 1996b). Field applications using sand as a barrier have only recently been realized (Ebeling & Forbes 1988, Daar 1990). In the United States the sand barrier technique is marketed as a remedial treatment for structures with active termite infestations as well as a preventative treatment. To date, there are no research studies that evaluate the use of sand or other materials as barriers in preventing subterranean termite attack for existing structures or to terminate an attack on an existing structure.

MATERIALS AND METHODS

Candidate homes for the study were selected from the client lists maintained by Live Oak Structural Inc., Berkeley, California and Another Termite Company, Richmond, California. Nineteen homes were selected from the greater San Francisco Bay Area. To be included in the study, homes were required to have an accessible crawl space and at least one shelter tube (in the crawlspace) active with subterranean termites. The crawl space for the 13 homes provided by Live Oak Structural were inspected by D. Carver and V. Lewis. The remaining 6 homes provided by Another Termite Company were inspected by V. Lewis. Any signs of active subterranean termite infestations, live termites in inspected wood or shelter tubes, were labeled and photographed prior to treatments. Participation by homeowners in the study was voluntary. Treatments were not randomly assigned to homes; selection of the treatment strategy, sand barrier or termiticide barrier, was left totally up to the homeowner.

For homes in the sand barrier group, a 51cm wide band of 16 grit sand (1.6 to 2.5mm diameter particles) was installed along the interior foundation. An average of 2.7 metric tons of sand was installed under each house. The sand barrier was approximately 7.6cm deep adjacent

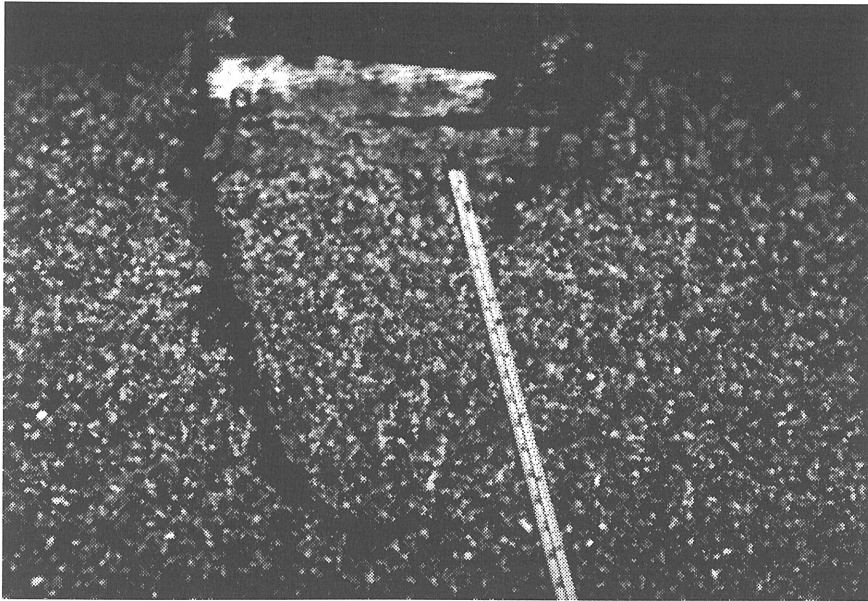


Fig. 1. Shelter tubes originating from an above soil satellite nest, Kensington, CA.

to the foundation, feathering out to less than a centimeter depth at the outer edge. Much of the sand was blown into the subarea of homes using a pressurized tank system developed by Walter Ebeling (Daar 1990).

For the termiticide-treated group, the exterior and interior foundations were trenched and treated with 1% permethrin (Torpedo®, Zeneca Professional Products, Wilmington, DE). The amount of permethrin solution used to treat homes varied from 378 to 587 liters. A low pressure motor driven sprayer was used to apply termiticide in a trench next to the foundation exterior according to manufactures' label instructions. Additionally, several homes in the sand barrier group also had their exterior foundation wall treated with 1% permethrin. However, no termiticide was used inside the crawlspace of any sand treated home.

Houses in the study had all existing termite shelter tubes removed prior to treatment. Homes were treated as they were received. All homes were re-inspected for new shelter tubes 4-times in 1991, 3-times in 1992, and once each in 1993 and 1994. Inspections were conducted during the spring (March or April), except 1991 when inspections were conducted in summer and fall (August through November). As penetrations were found, they were corrected with either sand or termiticide

Table 1. Percentage of homes with barrier penetration from *Reticulitermes* spp. at 3 month, 1 year, 2 years, and 3 years after treatment with a sand or chemical barrier.

Sand ^a				Chemical ^b			
3 mo	1 yr	2 yr	3 yr	3 mo	1yr	2 yr	3 yr
18%	36%	27%	27%	13%	25%	0%	0%

^a For the 11 homes in the sand barrier group, a 51 cm wide band of 16 grit sand (1.6 mm to 2.5 mm diameter particles) was installed along the interior foundation wall. The sand barrier was approximately 7.6 cm deep adjacent to the foundation wall, feathering out to less than 1 cm depth at the outer edge.

^b For the 8 homes in the chemically treated group, the exterior and interior foundation walls were trenched and treated with 1% permethrin.

depending on the original treatment. Those wanting termiticide treatments had their inspection fee reimbursed \$125 by the project. Homeowners who opted for the sand barrier were reimbursed \$400. There were 11 homes in the sand barrier group and 8 homes in the chemically treated group. Because treatments were not randomly assigned, no statistical comparisons were made. Results were summarized for demonstration purposes only.

RESULTS AND DISCUSSION

In the first 3 months of the study, chemical and sand treatments had similar percentages of homes with barrier penetrations by new shelter tubes (Table 1). There was 1 home penetrated for the termiticide group and 2 for the sand barrier group. At 1 year the number of homes with barrier penetrations was 3 for the sand- and 2 for the termiticide-treated homes, respectively. However, at 2 and 3 years into the treatment period, the sand barrier group still had 3 homes with barrier penetration while the chemical group had none. All barrier penetrations were found in the crawlspace. Although inspected for, no shelter tubes were found on the exterior walls for any home in the study.

For the sand barrier group, some of the shelter tubes appeared to originate from satellite nests; that portion of colony cut off from soil contact (Fig. 1). Other penetrations originated from subterranean galleries exploiting shallow points of coverage in the sand or rough spots along the foundation wall (Figs. 2 and 3). Improved methods of sand installation, increasing sand thickness, removing all wood-soil contacts, and capping the foundation wall to reduce rough surfaces for shelter tube attachment could improve barrier performance.

The criteria for barrier penetration warrants further discussion. For

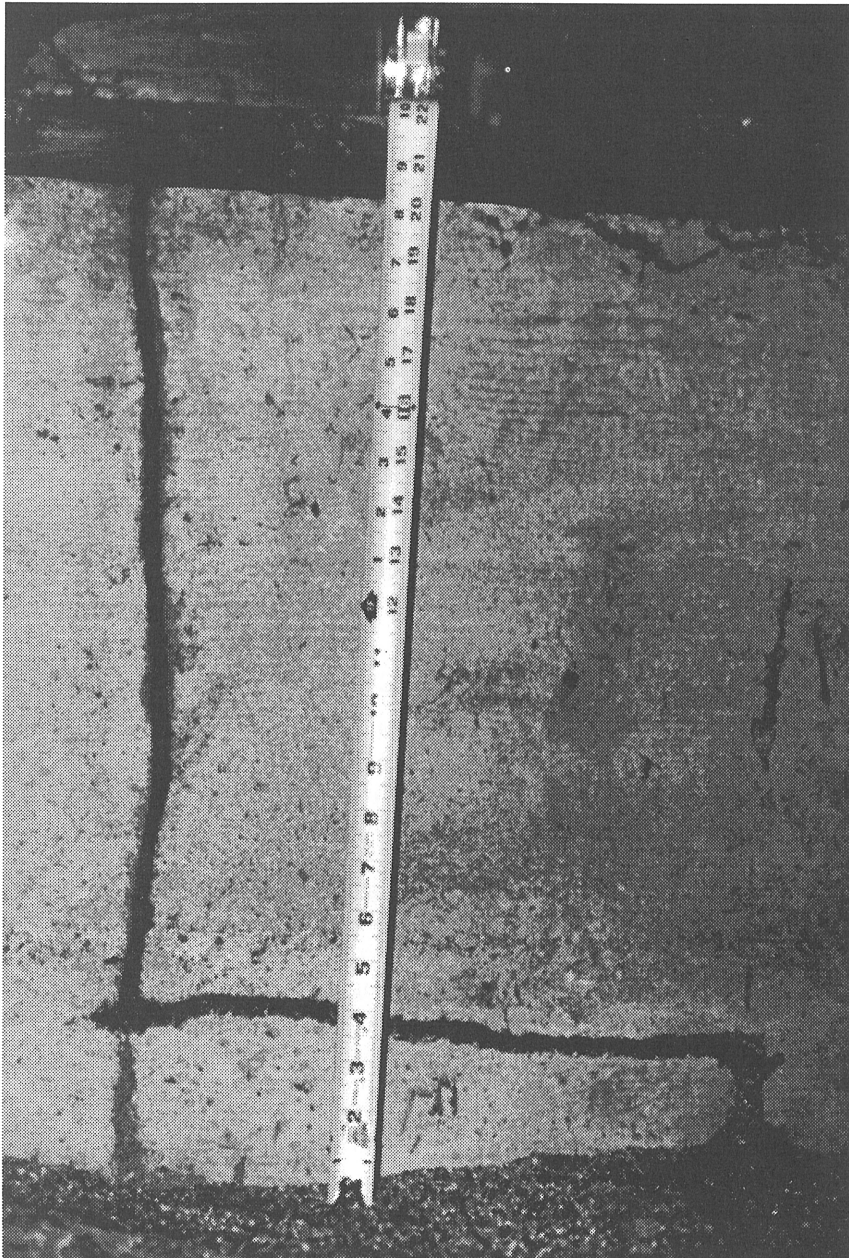


Fig. 2. Shelter tube penetration through shallow point of coverage by sand barrier, Novato, CA.

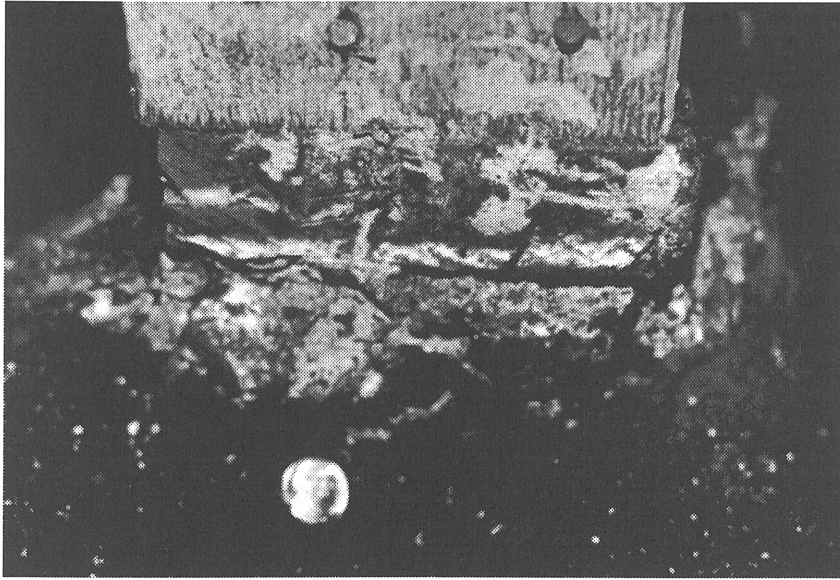


Fig. 3. Shelter tube penetrating sand barrier along rough surface face of foundation wall, El Cerrito, CA. Coin in the foreground is a dime (U.S. \$0.10 coin) for size comparison.

the sand barrier group, homes appeared to have more termite pressure and activity prior to treatment than the termiticide treated group (V. Lewis, unpublished observation). Several of the homes also had satellite nests for a number of months. Published studies on *Reticulitermes* spp. foraging behavior suggest that populations may vary from hundreds of thousands to millions (Esenther 1980, Su *et al.* 1993, Grace *et al.* 1989, Haagsma & Rust 1995, and Thorne *et al.* 1996). At one of our sites in Novato, CA, with several sand barrier failures, we have found numerous *Reticulitermes* spp. colonies adjacent to and underneath the structure with a population pressure in excess of 500,000 foragers (Haverty and Lewis, unpublished observation). This certainly appears to have led to the penetration of the sand barrier in this one situation. From the results presented in our field demonstrations, it is evident sand barriers can initially stop attack on homes by subterranean termites. However, periodic monitoring and attention to construction details before treatment will improve the long-term performance for any barrier treatment directed against subterranean termites.

ACKNOWLEDGMENT

The authors wish to thank Jerry Horton of Another Termite Com-

pany, Richmond, CA for providing homes for the study and all participating homeowners in the study. Funding was provided by the State-wide IPM Project, University of California, Davis, CA.

REFERENCES

- Anonymous. 1989. The termiticide label controversy. *Pest Control Technology* 17(3): 70, 71, 72, 76, 77, & 78.
- Brier, A. N., W. A. Dost, & W. W. Wilcox. 1988. Characteristics of decay and insect attack in California homes. *Calif. Agric.* 42(5): 21-22.
- Daar, S. 1990. IPM for termites: a new direction in structural pest control services. *IPM Practitioner* 12(11): 1-5.
- Ebeling, W., & C. F. Forbes. 1988. Sand barriers for subterranean termite control. *IPM Practitioner* 10(5): 23-28.
- Ebeling, W., & R. J. Pence. 1957. Relation of particle size to the penetration of subterranean termites through barriers of sand or cinders. *J. Econ. Entomol.* 50: 690-692.
- Esenther, G. R. 1980. Estimating the size of subterranean termite colonies by a release-recapture technique. Inter. Res. Group on Wood Preservation Doc. No. IRG/WP/112. 4pp.
- French, J. R. J. 1991. Baiting techniques in the control of *Coptotermes* species within existing buildings in Australia, pp. 46-50. In M. I. Haverty and W. Wayne Wilcox (tech. coords.), *Proceedings of the Symposium on Current Research on Wood-Destroying Organisms and Future Prospects for Protecting Wood in Use*, September 13, 1989, Bend, Oregon. USDA Forest Service Gen. Tech. Report. PSW-128.
- Grace, J. K., A. Abdallay, & K. R. Farr. 1989. Eastern subterranean termite (Isoptera: Rhinotermitidae) foraging territories and populations in Toronto. *Can. Entomol.* 121: 551-556.
- Haagsma, K. A., & M. K. Rust. 1995. Colony size estimates, foraging trends, and physiological characteristics of the Western subterranean termite (Isoptera: Rhinotermitidae). *Environ. Entomol.* 24(6): 1520-1528.
- Kard, B. M. 1996a. Termiticide field tests: 1996 Gulfport update. *Pest Control* 64(2): 45, 46, 48, and 92.
- Kard, B. M. 1996b. High-grade stainless-steel mesh and sand-barrier field tests for control of subterranean termites. Abstract from the Proceedings of The National Conference on Urban Entomology, February 18 - 20, 1996, Arlington, Texas.
- Kard, B. M., J. K. Mauldin, & S. C. Jones. 1989. Evaluation of soil termiticides for control of subterranean termites (Isoptera). *Sociobiology* 15(3): 285-297.
- Katz, H. 1989. What is the "Jugular Strategy"? *Pest Management* 88(2): 14-15.
- LaFage, J. P. 1986. Subterranean termites: A personal perspective. pp. 45-57, In P. Zungoli [ed.], *Proc. Nat. Conf. Urban Entomol.*, Univ. Maryland, College Park, MD.
- Pimentel, D., & L. Levitan. 1986. Pesticides: amounts applied and amounts reaching pests. *BioScience* 36(2): 86-91.

- Silvestri, S. 1996. Innovative termite bait technology saves building and business. *Pest Control* 64(2): 64, 65, and 68.
- Smith, J. L., & M. K. Rust. 1990. Tunneling response and mortality of the western subterranean termite (Isoptera: Rhinotermitidae) to soil treated with termiticides. *J. Econ. Entomol.* 83: 1395-1401.
- Su, N-Y. & R. H. Scheffrahn. 1990a. Economically important termites in the United States and their control. *Sociobiology* 17: 77-94.
- Su, N-Y., P. M. Ban, & R. H. Scheffrahn. 1993. Foraging populations and territories of the eastern subterranean termite (Isoptera: Rhinotermitidae) in southeastern Florida. *Environ. Entomol.* 22: 1113-1117.
- Tamashiro, M., J. R. Yates, & R. H. Ebesu. 1987. The Formosan subterranean termite in Hawaii: problems and control, pp. 15-22. *In* M. Tamashiro and N.-Y. Su [eds.], *Biology and control of the Formosan subterranean termite. Proceedings for the International Symposium on the Formosan Subterranean Termite, 67th Meeting of the Pacific Branch Entomological Society of America, Research Extension Series 083, University of Hawaii, Honolulu, HI.*
- Thorne, B. L., E. Russek-Cohen, B. T. Forschler, N.L. Breisch, & J. F. A. Traniello. 1996. Evaluation of mark-release-recapture methods for estimating forager population size of subterranean termite (Isoptera: Rhinotermitidae) colonies. *Environmental Entomology* (in press).



