IRG/WP 00-10370

THE INTERNATIONAL RESEARCH GROUP ON WOOD PRESERVATION

Section 1.5 Biology (Insects)

Termite Attack on Susceptible Lumber Above Naturally Durable Support Posts

J. Kenneth Grace

Department of Entomology
University of Hawaii
3050 Maile Way, Room 310
Honolulu, Hawaii 96822
USA

Paper prepared for the 31st Annual Meeting
Kona, Hawaii
14-19 May 2000

IRG Secretariat
c/o KTH
SE 100 44 Stockholm
Sweden

Termite Attack on Susceptible Lumber Above Naturally Durable Support Posts

J. Kenneth Grace
Department of Entomology, University of Hawaii, 3050 Maile Way, Room 310
Honolulu, Hawaii 96822, USA

Abstract
A multi-year field study was designed to simulate the use of naturally durable sill plates (dodai) and floor support posts in Japanese housing construction and test whether Formosan subterranean termites (*Coptotermes formosanus*) would tunnel over or through these resistant timbers to attack susceptible Japanese red pine (*Pinus densiflora*) lumber placed above them. This test was intended to explicitly address the possibility that a durable timber placed upon a solid concrete footing might create a sufficient barrier to subterranean termites to protect the structure from attack, in the absence of any other termite control specifications such as soil insecticide treatment. Inspection after three years in the field revealed that termites had damaged a Kiso Hinoki (Japanese cypress, *Chamaecyparis obtusa*) sapwood (with heart center) post, and a Hiba Arbor-vitae (*Thujopsis dolabrata*) sapwood (with heart center) floor post, although they had not reached the red pine block above each post. However, termites had also fully penetrated a Kiso Hinoki (Japanese cypress, *Chamaecyparis obtusa*) heartwood post, and severally damaged the red pine block on top of it. None of the durable woods in this test were damaged to the point where they would pose any sort of structural hazard. However, they clearly do not represent a barrier to further termite foraging, and there is also variation in durability among different samples of these durable woods. Sole use of termite-resistant sill plates or floor posts (as commonly required in both Japanese and American construction), in the absence of any other termite control measures, cannot be relied upon to protect the structure from termite penetration and damage to the adjoining susceptible wood framing.

Keywords: *Coptotermes formosanus*, Formosan subterranean termite, hinoki, *Chamaecyparis obtusa*, *Thujopsis dolabrata*

Introduction

The Formosan subterranean termite, *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae) is an important pest in both southern Japan and Hawaii. Although *C. formosanus* has a limited distribution in Japan, that distribution is gradually expanding northward (Yamano 1987) and this termite has the ability to cause more rapid and extensive structural damage than the native Japanese termite *Reticulitermes speratus* (Kolbe). In Hawaii, *C. formosanus* was introduced to Honolulu in the late 1800s and is responsible for over US$ 100 million in costs of treatment and damage repairs each year throughout the state (Tamashiro et al. 1990).

Proper structural design and construction are important components in preventing termite attack. Termite-resistant building materials and physical barriers to prevent termite penetration have become even more important as a result of the loss of the long-lasting soil insecticides chlordane and aldrin, and increasing environmental concerns over possible ill effects from applications of large quantities of insecticides for termite control. These concerns and the desire for more permanent methods of termite control led to the development of the Basaltic Termite Barrier in Hawaii and the similar product Granitgard in Australia (Tamashiro et al. 1991). Both of these are crushed rock (gravel), screened to a specific size that prevents subterranean termite penetration. The gravel particles are too large for the insects to grip in their mandibles and move, but pack too tightly together for them to tunnel between the particles. A high-grade stainless steel mesh, Termi-Mesh, was also developed in Australia as a physical termite barrier, and has enjoyed commercial success in both Australia and Hawaii (Grace et al. 1996, Lenz & Runko 1994, Yates et al. 1997).

Cracks in concrete slab foundations permit subterranean termites to enter the building from the soil. Lenz et al. (1997) reported that the Australian termite *Coptotermes acinaciformis* could penetrate cracks as small as 1.5 mm in width, and Ewart et al. (1991) found that mature workers of *C. formosanus* could penetrate circular holes as small as 1.4 mm in diameter. Thus, in order to function as a physical barrier to termites, a concrete slab must be uncracked and not subject to degradation by the termites, and any planned cracks (cold joints) or plumbing penetrations through the slab must be protected by additional physical or insecticidal barrier treatments.

A point of some contention in subterranean termite control, particularly among government officials and those concerned about insecticide overuse, is the value of naturally-durable or chemically-treated sill plates and floor posts (resting on a solid concrete foundation) alone in protecting the structure from termite penetration. In both Japanese and American housing construction, use of durable and termite-resistant bottom sill plates (mud sills, or dodai) and support posts is generally required by law, but the wood framing above these lowest structural members is generally not required to be either decay or termite-resistant. In societies that are increasingly concerned about health and environmental issues, speculation inevitably arises over whether termites may actually be deterred from foraging any further into the structure when they encounter a termite-resistant sill plate or floor post; and whether additional termite control methods, such as soil treatment, may therefore be redundant and unnecessary sources of environmental pollution.

The present 4-year study was initiated by the Japan Termite Control Association in collaboration with researchers at the University of the Ryukyus, Kyoto University, and the University of Hawaii. This study was designed to simulate Japanese housing construction and determine whether *C. formosanus* was capable of tunneling up a concrete foundation wall or post footing of the standard heights used in Japanese construction, and then over or through a sill plate (dodai) or floor post of resistant lumber to reach the non-resistant lumber above.

Materials and Methods

In 1995, field experiments were designed and initiated in Hawaii, all using the Formosan subterranean termite, *Coptotermes formosanus* Shiraki. The field studies were carried out in Honolulu at the Pearl City Urban Garden Center, a teaching and research facility of the College of Tropical Agriculture, University of Hawaii. Using mark-release-recapture methods (Grace 1992, Grace et al. 1995), the field site was determined to support a very active colony exceeding one million termites. This field study was designed to test the ability of Formosan subterranean termites to tunnel up a concrete foundation wall or concrete post support, and over or through a sill plate (dodai) or floor post consisting of insect and decay-resistant wood in order to attack susceptible Japanese red pine (*Pinus densiflora*) lumber. The concrete foundation walls, concrete post supports, sill plates and floor posts were of the dimensions commonly used in Japanese residential construction.

Four "house" test units were constructed at the Pearl City field site, each 96 x 96 cm in size, with a solid poured concrete perimeter foundation wall 12 cm thick and 45 cm in height, embedded 5 cm in the soil (for an above-grade height of 40 cm. On top of this concrete perimeter foundation wall, we placed 12 small sill plates of experimental "resistant" lumber, each 105 x 105 x 200 mm. On top of each sill plate, a 105 x 105 x 200 mm piece of Japanese red pine was placed.

On the soil within each "house", we placed six concrete post supports, each embedded 5 cm in the soil, and rising 5 cm above the soil surface. Brackets on each concrete post support held a 105 mm long 50 x 50 cm floor post. On top of each floor post, a 105 x 105 x 105 mm piece of red pine was placed. Finally, each of the four test units was covered by a slanted opaque fiberglass roof, supported by side walls of untreated plywood, as with the similarly-sized units constructed to test termite penetration of concrete.

The floor posts and sill plates in these test structures consisted of two potentially resistant wood species, and three nonresistant wood species. The resistant woods were classified as either heartwood lumber ("H") or sapwood lumber with a heart center ("S"), and were also classified by their prefecture of origin. Only one of the nonresistant woods (Japanese cedar) was classified as either "H" or "S," and the origin of these three woods was not specified. The experimental resistant woods were: (1) Japanese cypress, *Chamaecyparis obtusa*, classified as either "H" or "S," and originating from Nagano Prefecture (Kiso Hinoki, labeled as "a"), Nara Prefecture (Yoshino Hinoki, labeled as "b"), or Miyazaki Prefecture (no specific brand name, labeled as "c"); and (2) Hiba Arbor-vitae, *Thujopsis dolabrata*, classified as either "H" or "S," and originating from Aomori Prefecture (no specific brand name). The susceptible, or control, wood species were: (1) Japanese cedar, *Cryptomeria japonica*, classified as either "H" or "S;" (2) Douglas-fir, *Pseudotsuga menziesii*; and (3) western hemlock, *Tsuga heterophylla*. In each case, the susceptible or "bait" wood placed on top of the floor post or sill plate was Japanese red pine, *Pinus densiflora*. Each of the 12 experimental woods was included as one sill plate in each of the four test units (total of four sill plate replicates of each wood species), and was replicated twice in the floor post study.

Results and Discussion

Over the course of the past three years, the field site was examined periodically for evidence of termite tunneling activity and attack on the wood samples. Although termites were, and continue to be, extremely active at the field site, as evidenced by regular examination of termite traps (Tamashiro et al. 1973) placed on either side of the test structures, the process of leveling the soil, pouring concrete, and building the test structures clearly inhibited termite attack on those structures during the first year of the study. Within the first six months, termites constructed a shelter tube 15 cm high in the inside corner of one of the concrete foundations, but appeared to abandon it at that point. On the other hand, the exterior plywood walls around the test units were immediately attacked by the termites and heavily damaged, necessitating regular repairs.

In order to encourage greater termite activity within the test structures, the fiberglass roofing was removed approximately one year after initiation of the test, and replaced with plywood covers to darken the interior. At this time, we also placed cut pieces of Douglas-fir lumber on the soil within the test units as "bait" wood to encourage termite activity. These efforts were successful to the extent that termites rapidly attacked the wood placed on the soil.

After 1.5 years, termites were noted to have tunneled up the sides of two of the post supports and into the base of these two wooden floor posts. One of these posts was susceptible Douglas-fir, but the other post was Kiso Hinoki lumber with heart center ("S"), or Japanese cypress from Nagano Prefecture. At this point, it did not appear that the termites had yet reached the red pine blocks on top of the posts.

Three years after initiation of the study, a thorough inspection was performed of the sill plates and floor posts. At this point it was noted that the red pine block on top of the Kiso Hinoki ("S") floor post had not been damaged (although the post itself was damaged), but the red pine on top of the Douglas-fir floor post was significantly damaged. In addition to these two floor posts, termite penetration was also noted in two of the Hiba Arbor-vitae floor posts, one being heart center lumber ("H"), and the other sapwood lumber with heart center ("S"). Although termites had not yet reached the red pine block on top of the sapwood lumber with heart center ("S"), they had reached and significantly damaged the red pine block secured to the top of the heartwood ("H") Hiba Arbor-vitae post. Since this 3-year inspection, termite activity appears to have again dropped off within the test units, although activity is still extremely high within the aggregation traps placed on either side of the test units. To date, conditions noted at three years remain the same and no additional damages have occurred during the past year.

The vast majority of the durable timbers in the test have shown no signs of termite attack, and the small number of damaged posts were certainly not damaged to the point where they would pose any sort of structural hazard. However, this provides evidence of variation in durability among different lumber samples of these naturally durable woods, and demonstrates that use of a durable floor post does not represent a barrier to further termite foraging over and above that post. Thus, use of termite-resistant sill plates or floor posts alone (as commonly required in both Japanese and American construction), in the absence of any other termite control measures, cannot be relied upon to protect the structure from termite penetration and damage to the adjoining susceptible wood framing.

Conclusions

1. Construction activities such as leveling the soil grade and pouring concrete may temporarily suppress termite activity in the immediate area of construction for several months.

2. This study demonstrates that it is possible for termites to tunnel over concrete post supports and damage Japanese cypress and Hiba Arbor-vitae floor posts, demonstrating that some degree of variation in termite resistance exists among lumber cut from naturally durable species.

3. This study demonstrates that it is possible for termites to tunnel through a Hiba Arbor-vitae floor post and attack Japanese red pine lumber above the post.

4. Use of naturally durable posts or sill plates alone, in the absence of other termite control measures, cannot be relied upon to prevent further termite foraging and attack on susceptible building materials above the durable wood members.

Acknowledgments

Funding for this study was provided by the Japan Termite Control Association. Results discussed here were presented at the 40th Annual Convention of the JTCA in Tokyo, November 1998 (Grace 1999). The study was designed in collaboration with Professor M. Takahashi (Wood Research Institute, Kyoto University), Professor S. Yaga (University of the Ryukyus), and Mr. S. Tomokiyo (JTCA). Assistance in implementing the study in Hawaii was provided by Dr. J. R. Yates, Dr. J. Wang, Dr. R .J. Woodrow, Mr. R. Oshiro, and Ms. C. Tome.

Literature Cited

Ewart, D.M., M. Tamashiro, J.K. Grace and R.H. Ebesu. 1991. Minimum foraging aperture and particle barriers for excluding the Formosan subterranean termite. Unpublished poster presentation, Annual Meeting of the Entomological Society of America, Reno, Nevada, USA.

Grace, J.K. 1992. Termite distribution, colony size, and potential for damage. Pp. 67-76 *in* Proceedings of the National Conference on Urban Entomology (W.H. Robinson, ed.), College Park, Maryland, 23-26 February 1992.

Grace, J.K. 1999. Termite penetration of construction elements. Shiroari 115: 18-23 (in Japanese).

Grace, J.K., J.R. Yates, and C.H.M. Tome. 1995. Modification of a commercial bait station to collect large numbers of subterranean termites (Isoptera: Rhinotermitidae). Sociobiology 26: 259-268.

Grace, J.K., J.R. Yates III, C.H.M. Tome and R.J. Oshiro. 1996. Termite-resistant construction: use of a stainless steel mesh to exclude *Coptotermes formosanus* (Isoptera: Rhinotermitidae). Sociobiology 28: 365-372.

Lenz, M. and S. Runko. 1994. Protection of buildings, other structures and materials in ground contact from attack by subterranean termites (Isoptera) with a physical barrier - a fine mesh of high grade stainless steel. Sociobiology 24: 1-16.

Lenz, M. B. Schafer, S. Runko and L. Glossop. 1997. The concrete slab as part of a termite barrier system: response of Australian subterranean termites to cracks of different width in concrete. Sociobiology 30: 103-118.

Mori, H. 1987. The Formosan subterranean termite in Japan: its distribution, damage, and current and potential control measures. Pp. 23-26 in Biology and Control of the Formosan Subterranean Termite (M. Tamashiro and N.-Y. Su, editors). College of Tropical Agriculture and Human Resources, University of Hawaii. Research Extension Series 083.

Tamashiro, M., J.R. Yates, R.T. Yamamoto, and R.H. Ebesu. 1990. The integrated management of the Formosan subterranean termite in Hawaii. Pp. 77-84 in Pest Control into the 90s: Problems and Challenges (P.K.S. Lam and D.K. O'Toole, editors). Applied Science Dept., City Polytechnic of Hong Kong.

Tamashiro, M., J.R. Yates, R.T. Yamamoto and R. H. Ebesu. 1991. Tunnelling behavior of the Formosan subterranean termite and basalt barriers. Sociobiology 19: 163-170.

Yamano, K. 1987. Physical control of the Formosan subterranean termite, *Coptotermes formosanus* Shiraki. Pp. 43-47 in Biology and Control of the Formosan Subterranean Termite (M. Tamashiro and N.-Y. Su, editors). College of Tropical Agriculture and Human Resources, University of Hawaii. Research Extension Series 083.

Yates, J.R. III, J.K. Grace and M. Tamashiro. 1997. The Formosan subterranean termite: a review of new management methods in Hawaii. Proceedings of 1997 FAOPMA Convention (J. Chan, ed.). Hong Kong Pest Control Association. Pp. 59-68.