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New Technology for Managing the Formosan Subterranean Termite

The Formosan subterranean termite, *Coptotermes formosanus* Shiraki, is Hawaii's most economically important insect pest, causing about $100 million in damage each year. Its biology, aggressiveness, and hidden, unpredictable invasiveness make this insect difficult to detect and control. This publication describes some techniques for managing this pest that have been developed recently as alternatives to pesticides. Alternatives are needed because the soil termiticides currently allowed do not last as long as the products used before 1988, which have been banned. Also, many people simply do not wish to use pesticides around the home and prefer non-chemical control methods. The alternative techniques include physical (particle) barriers, wire-mesh barriers, in-ground and aboveground baiting systems, removable building components, and construction materials resistant or unsusceptible to termite damage.

Increased urbanization in Hawaii has made research on controlling structural pests as economically and environmentally important as research on agricultural pests. The concept of integrated pest management that guides current pest-control efforts places an emphasis on avoiding pesticide use when possible. The condition of Hawaii's fragile ecosystems and particularly the islands' water resources are serious concerns to consider when evaluating pesticide uses and their subsequent environmental and health impacts. Research on low-toxicity termite control strategies has been done by CTAHR entomologists with the goal of minimizing pesticide use in Hawaii, especially in urban areas, and some of these methods have been commercialized.

Physical barriers: the basaltic termite barrier

Physical barriers are gaining popularity world-wide as methods of preventing attacks on structures by subterranean termites (also called ground termites). Research has shown that ground termites have difficulty penetrating layers of certain granular materials, depending on the material's physical size, smoothness, shape, weight, and hardness. Studies in Hawaii and elsewhere have found that for various termite species, suitable materials include crushed basalt, granite, or quartz, silica sand, and even glass shards. Research at CTAHR involving extensive laboratory and field tests found that crushed, screened basaltic gravel is suitable as a barrier to the Formosan subterranean termite. This material is marketed in Hawaii as the basaltic termite barrier (BTB) (Ameron Hawaii, Honolulu).

The Hawaii studies used irregularly shaped particles in sizes ranging from less than 1⁄10 inch to about 1⁄5 inch (0.2–4.8 mm). The laboratory technique used a glass tube with about 1½ inch of the test material sandwiched between layers of agar. Termites were put in one end of the tube and allowed to bore through the agar to the material. It was found that the termites were unable to penetrate basaltic particles sized from 7⁄100 to 9⁄100 inch (1.7–2.4 mm), even when they had access to the material for as much as five years. For practical applications, a layer of basalt at least 4 inches (10 cm) thick is recommended.

In 1989, BTB was accepted into the City and County of Honolulu Uniform Building Code as a more permanent alternative to chemical soil treatments in Hawaii. The barrier can be used as a fill before pouring a concrete slab foundation, be placed around the perimeter of an existing concrete slab, or can be placed beneath and around foundation retaining walls during new construction. It can also be used to fill voids in hollow-tile construction. Although the primary use of BTB is for new construction, other postconstruction uses are being developed.

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Particle barriers can be difficult to install in some situations or without proper training. Problems may occur where the soil is unstable or not fully compacted, when surfaces at the edges of the barrier are rough or irregular, or if there is no protection from mixing with the adjacent soil material. In general, installation by trained professionals is recommended. Installation details are available from Ameron Hawaii.

Physical barriers: metal mesh

A termite barrier consisting of a marine-grade 316 stainless steel mesh was recently developed and patented in Australia as Termi-Mesh™ (Termi-Mesh Australia Pty. Ltd.), and it is currently used in building construction there. This mesh has an aperture size of 0.66 x 0.45 mm, which is well below the 1.2 mm aperture size found to prevent passage of foraging Formosan subterranean termites in Hawaii. Tests showed that various Australian termite species, including *Coptotermes acinaciformis* (Froggatt), were unable to penetrate the mesh.

Experiments with the Termi-Mesh barrier on Oahu showed it to be effective as a barrier against the Formosan subterranean termite, provided that the mesh was properly installed and seamlessly bonded to other elements of the construction, such as concrete blocks, so that termites could not circumvent the barrier.

Pre- and postconstruction applications of the Termi-Mesh system are numerous. The product can be installed beneath concrete slabs, around plumbing and electrical conduits, to seal concrete cracks and cold joints, to prevent penetration through hollow-tile retaining walls, and as a “sock” or “boot” to protect wooden fence posts and utility poles.

The Termi-Mesh system was accepted into Hawaii’s Uniform Building Codes for all islands in 1995 as a stand-alone pretreatment for new construction. Since then, approximately 180 new-home installations have been done, and numerous postconstruction retrofits have been made to homes that were infested by Formosan subterranean termites. Termi-Mesh Hawaii (Honolulu) provides a substantial repair warranty should termites breach this physical barrier.

Termite baiting systems

Baits are an attractive method for control of insect pests that are cryptic (hidden or secretive) and social, such as ground termites. Bait systems use only a small amount of insecticide, and it needs to contact only a relatively small proportion of the foraging population, who then proceed to distribute the toxicant to other colony members. Certified pest-control operators in Hawaii currently offer baiting systems marketed as Exterra™, FirstLine™, and Sentricon™. The Sentricon systems were the first to be made available, and because they are the only ones that have been thoroughly evaluated by CTAHR entomologists, they are described here. The two basic types of bait stations in current use are in-ground and aboveground.

In-ground stations. The Sentricon™ Termite Colony Elimination System manufactured and distributed by Dow AgroSciences LLC (Indianapolis, IN) has been in commercial use since 1995. It uses monitoring stations, plastic cylinders about 8 inches long and 1¾ inches in diameter, with side ports to permit termite entry, placed in holes augured into the soil. Each cylinder has a tamper-resistant cap and contains two small, removable pieces of wood for monitoring. The stations are placed around the building at intervals less than 15–20 feet apart, as well as elsewhere on the property where ground termites might be expected to occur.

When termites are found in a monitoring station, the wood in the station is replaced with Recruit II™, consisting of a plastic cylinder with small holes in the sides containing cellulose impregnated with 0.5% hexaflumuron, a chitin synthesis inhibitor.

Even after adding bait to cylinders at a site, monitoring of termite activity at unbaited cylinders around the potential termite foraging area is essential. This documents bait efficacy without confounding factors, such as avoidance of bait, or deterrence due to mortality at the cylinder. The primary practical goal of bait applications is suppression or removal of the termite population to a level where termite activity can no longer be detected in baited and unbaited monitoring stations, both in the structure to be protected and elsewhere in the immediate vicinity of the structure.

Beginning in fall 1993, field studies were conducted with a prototype Sentricon system around three representative structures in Hawaii, each of which had a history of subterranean termite infestation and recurring problems. They were a four-unit condominium building on Kauai, a single-family home on Oahu, and a large commercial building on Oahu. All of these buildings had concrete-slab foundations and had previously been treated with soil insecticides around the exterior perimeter and through the slab at various locations. Basaltic termite barrier gravel (Ameron Hawaii) had also been installed in a trench around the condominium building. However, construction defects such as stucco extending into the ground, concrete and asphalt walkways abutting the buildings, and (in the case of the residential structure) rocky hillside soil conditions had contributed to continuing termite problems. Using the method of mark, release, and recapture, the termite foraging populations at the sites were estimated at 0.33 million (Kauai), 0.94 million (Oahu home), and 5.35 million (Oahu building). Application of hexaflumuron baits eliminated all termite activity at these sites. Continued monitoring is very important, though. Several years later, termites were again found to be reinvading two of these locations, but using baits again elimated the infestation.

Aboveground stations. The in-ground Sentricon baiting system is marketed as a preventive method for subterranean termites and a remedial control tool for existing infestations in structures. One limitation of the latter approach is the length of time it could take to mitigate an ongoing infestation in a building within a reasonable amount of time while termites locate the bait stations. Some pest-control professionals have provided estimates of this time ranging from one month to more than a year.

The aboveground Sentricon baiting system developed by Dow AgroSciences has been under study by CTAHR entomologists since December 1995 in field trials using two buildings with ongoing Formosan subterranean termite infestations: a 12-floor high-rise residential condominium building, and a large single-story United States Department of Agriculture (USDA) fruit fly rearing facility.

Inspection of the high-rise complex identified an aerial infestation (no connection to the ground) affecting the roof and two units on the 12th floor. Using mark-release-recapture methods, the termite foraging population was estimated at 469,000. After application of 0.1% and 0.5% hexaflumuron in two plastic bait stations attached to the roofing membrane, the infestation was eliminated in 76 days, as evidenced by lack of termite activity in monitoring stations containing untreated wood wafers as a food source and when the roofing membrane was replaced approximately two months later.

Ground infestations affected several locations at the USDA facility. Bait stations containing 0.1% and 0.5% hexaflumuron were attached to walls in the infested rooms of the building, and modified in-ground Sentricon stations were installed around a detached infested storage container. Infestations in two of the building's rooms were eliminated in 72 days, but termites remained active in monitoring stations located in another room, and around the storage container and the building perimeter, indicating that multiple subterranean termite colonies were infesting the site. Application of baits to stations around the storage container eliminated termites in all of these locations.

Interest in developing aboveground bait systems stemmed from the need to reduce or eliminate traditional pesticide spot treatments within residential structures, as well as the possibility that the aboveground system would be a complement to or substitute for in-ground bait stations. Moreover, applying the bait to existing infestations rather than waiting for termites to locate in-ground stations offers an expedient means of eliminating infestations within structures. The aboveground system has been commercially available in Hawaii since early 1997.

Removable baseboards

Termite inspections of double-wall constructed buildings (containing finished interior walls) have long troubled the pest-control industry, sometimes resulting in litigation when termites are not detected either during an ongoing preventive pest-control inspection contract or when a home is inspected before its resale.

A removable baseboard product was recently developed by a Hawaii company (P.I.M. Development, Inc., Kaneohe, Hawaii). It provides a nondestructive means to inspect sill plates, wall studs, and plumbing penetrations that are ordinarily concealed within double-wall voids. The prototype consisted of a spring-steel clip and spacer block to attach a 3¼-inch, medium-density fiberboard to the bottom edge of inner gypsum walls of double-wall constructed homes. During construction, gypsum wallboard is secured to wall studs leaving 3 inches of space above the finished floor. The clipped baseboard is attached to the bottom edge of the gypsum wall. For existing homes, the gypsum wall has to be cut 3 inches above the finished floor to install the system as a retrofit. The prototype was not simple to install because its fitting and installation required special carpentry tools and skills and was labor intensive. Continued product development led to the current all-polymer Snap On Baseboards™ with baseboards extruded from solid polyvinyl chloride and clips inject-molded with acetyl plastic that snap into grooves molded in the back of the baseboard. A snap-in corner system was also developed to eliminate the need to miter baseboards to fit corners. Interest in the system is growing in Hawaii and the mainland USA, where it is available from the manufacturer and hardware stores.

Resistant building materials

The use of steel framing in residential building construction has increased in Hawaii in the past several years. However, the higher cost of steel and the need for specialized installation procedures still limit its use. From an environmental standpoint, the energy costs associated with steel production and the production of preservative-treated wood products are also of concern.

Naturally durable woods are a good alternative for many construction uses. For example, Western red cedar (*Thuja plicata*), Alaska cedar (*Chamaecyparis nootkatensis*), redwood (*Sequoia sempervirens*), and teak (*Tectona grandis*) have moderate to high resistance to Formosan subterranean termite attack. Although wood from the neem tree, *Azadirachta indica*, is not sufficiently resistant to termites to be useful in construction, both the wood and bark are less preferred by termites compared to other tree species, suggesting that neem might be useful for landscape plantings.

A recent survey of indigenous and introduced Hawaiian tree species found that sugi (*Cryptomeria japonica*), kou (*Cordia subcordata*), kamani (*Calophyllum inophyllum*), milo (*Thespesia populnea*), and tallowwood (*Eucalyptus microcorys*) were quite resistant to Formosan subterranean termite feeding. The current availability and wood characteristics of these species suggest that sugi, tallowwood, and milo may have the greatest potential of the termite-resistant species in Hawaii for expanded cultivation, harvest, and development and marketing of wood products.

Conclusion

"Urban entomology" is a new science that focuses on needs of homeowners in rural as well as urban communities. One role of the urban entomologist is to aid acceptance of new technologies for control of insect pests by educating homeowners, residential developers, architects, the construction industry, and pest control operators. Not all of these parties have the same ideas and motives about new pest-control or pest-avoiding technologies, which can add to construction costs. Developers can be sales-oriented. Architects may follow aesthetic criteria in their designs that result in conditions conducive for urban pests. Some pest-control practitioners may believe that non-chemical pest control methods are an economic threat to their livelihood. Finally, homeowners may perceive traditional chemical applications as more cost-effective in a short-term period.

Proper construction techniques, such as isolating wood from the soil, and the use of physical barriers to exclude subterranean termites, are practical approaches to preventing termite attack on structures. All too frequently, construction details that are conducive to termite infiltration or to moisture accumulation and fungal decay are incorporated into new buildings under the guise of economy or aesthetics. Certainly, adoption of vigilant construction methods and the use of inert physical barriers such as properly sized gravel to prevent termite penetration into the structure promises more permanent termite control than is possible with insecticide applications to the soil alone. The new technologies can be safer to use and potentially less harmful to the environment than relying only on pesticides. New solutions to the problem of preventing and controlling infestations by urban pests can be less costly in the long term.

A list of references from the technical literature describing research on termites and termite control methods can be obtained from the author by writing to the Department of Entomology, 3050 Maile Way, Honolulu, HI 96822.