Distribution and Management of Termites in Hawaii

by

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ABSTRACT

Eight termite species are currently considered to be established in the Hawaiian islands, although four of these are fairly recent introductions with limited distributions. The Formosan subterranean termite, *Coptotermes formosanus* Shiraki (Isoptera: Rhinotermitidae) is the most economically serious pest in Hawaii. Methods applied to prevent and control termite infestations include physical and chemical barriers, use of preservative treated wood (and naturally-resistant woods to a limited extent), soil insecticide applications, and baiting systems. In addition to refinements to existing technology, research efforts are focused on improving our understanding of termite biology and behavior in Hawaii, and development of novel biologically-based approaches to termite management.

TERMITE DISTRIBUTION

Termites are estimated to cost the residents of Hawaii approximately US$100 million each year. The Formosan subterranean termite, *Coptotermes formosanus*, is the most serious pest. This termite has been present in Hawaii for over 100 years, and is found on all of the major islands (Tamashiro *et al.* 1987b, Woodrow *et al.* 1999) . A second subterranean termite, *Coptotermes vastator*, was collected from a single structural infestation in Honolulu in 1963 (Bess 1970), and was not collected again in Hawaii until 1999 (Woodrow *et al.* 2001). However, in the past two years, we have found *C. vastator* in six different locations on the southwest coast of the island of Oahu (Honolulu). These recent collections indicate that *C. vastator* is established in Hawaii, but currently has a limited distribution (Woodrow *et al.* 2001). The discovery of *C. vastator* in Hawaii is significant, since it is the most serious termite pest in Guam and the Philippines (Su & Scheffrahn 1998, Wang & Grace 1999). Research is in progress to help us understand whether interactions with the Formosan subterranean termite may limit the ability of *C. vastator* to spread in Hawaii.

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The drywood termites *Cryptotermes brevis*, *Incisitermes immigrans*, and *Neotermes connexus* are also long-term residents of Hawaii (Woodrow *et al.* 1999). *Cryptotermes brevis* is most commonly found in buildings, although *I. immigrans* also occasionally infests structural lumber. In the past few years, the introduced structural pest *Cryptotermes cynocephalis* has also been collected on the island of Oahu, although only in a very limited area and from dead vegetation rather than structural timbers. *Incisitermes minor*, which is the most important drywood termite pest in California, was also recently found infesting two buildings in different parts of Oahu (Woodrow & Grace, unpublished data). Both buildings have since been fumigated, but not before alate flights occurred, so *I. minor* is probably established in at least a very limited area of Hawaii. Lastly, the rotten wood termite *Zootermopsis angusticollis* was recently found to be well-established at a high elevation on the island of Maui (Woodrow & Grace, unpublished data). *Zootermopsis angusticollis* is also found in California and Oregon and usually occurs in logs and other dead wood on the ground. It only attacks structural lumber when that lumber is wet and decayed.

TERMITE CONTROL

The majority of termite control efforts in Hawaii are aimed at the Formosan subterranean termite, and include the use of gravel and stainless steel physical barriers, soil insecticides, baits, and wood preservatives. A screened particle barrier, the Basaltic Termite Barrier, was invented in Hawaii by Emeritus Professor Minoru Tamashiro of the University of Hawaii (Tamashiro *et al.* 1987b, Yates *et al.* 2000). This product consists of crushed basaltic rock, screened to a particle size that termites are unable to move with their mandibles. The rock is too hard for the termites to crush, and packs together too tightly for them to find spaces through which to move. Thus, it forms a non-chemical barrier to termite tunneling. This barrier is used in all State Government construction in Hawaii, and is also used by a number of architects in residential construction. A second physical barrier invented in Australia and consisting of a stainless steel screen, TermiMesh, is also commonly used in new construction in Hawaii to prevent termite penetration (Grace *et al.* 1996b). Soil insecticides are also applied to the soil to prevent termite attack, although the popular insecticide chlordane has not been used in Hawaii since 1986 (Grace *et al.* 1993). Field tests by the University of Hawaii over the past 20 years have indicated that the pyrethroid insecticide permethrin is particularly long-lasting as a soil insecticide under the tropical conditions found in Hawaii (Tamashiro *et al.* 1990, Grace *et al.* 1993, Grace 1996). Other pyrethroid insecticides are also currently used, and in recent years the less repellent insecticides imidacloprid and fipronil have also been introduced.

Hawaii is unique among the United States in requiring that all of the structural lumber used in new building construction must be pressure treated with a wood preservative to prevent termite attack. Chromated copper arsenate (CCA) and disodium octaborate tetrahydrate (DOT) are commonly-used preservatives, with DOT currently the most widely used one in Hawaii (Grace & Yates 1999). Field tests over the past 4 years in Hawaii have demonstrated that termites will do only superficial damage to the surface of borate-treated lumber under conditions where untreated lumber is rapidly and completely destroyed (Grace *et al.* 2000, 2001). Both laboratory and field tests are also being performed with many other wood preservatives to determine the concentrations necessary to prevent damage by the Formosan subterranean termite (Grace 1998). Naturally-resistant woods are also used to a limited extent in construction in Hawaii (Grace & Yamamoto 1994, Grace & Yates 1999), and may have more potential for future uses (Grace *et al.* 1998, Morris *et al.* 1999).

Hawaii and Florida were the first two states in which hexaflumuron baits (Sentricon System, Dow AgroSciences) were used commercially for subterranean termite control. These baits have proven to be quite effective in Hawaii (Grace *et al.* 1996a, Yates *et al.* 1999, Yates & Grace 2000), and have been used to protect historic structures such as the Iolani Palace in Honolulu. In field tests over the past 8 years, we have observed that new termite colonies do eventually invade areas where baits have been used, but careful monitoring of the bait stations and subsequent application of hexaflumuron has been found to be effective in detecting and suppressing these new invasions before any structural damage could occur (Grace & Su 2001). Baits have clearly found a place in subterranean termite control, and research is continuing with other bait materials (Grace *et al.* 2000).

NEW RESEARCH DIRECTIONS

As discussed elsewhere in this proceedings (Husseneder *et al.* 2002), current research efforts at the University of Hawaii are examining the molecular genetics of *C. formosanus* populations and colonies. These results will increase our understanding of termite spread and distribution, interactions among colonies, and social organization of individual colonies (Wang & Grace 2000; Husseneder & Grace 2001a, 2001b). The ability to discriminate among *C. formosanus* colonies on the basis of their DNA profiles will be of great help in bait efficacy evaluations and in studying reinvasion of baited areas by new termite colonies. Current research on *C. formosanus* tunneling patterns and food location should also prove helpful in improving the application of baits for subterranean termite control (Campora & Grace 2001).

Biological control has been used successfully in Hawaii against agricultural insect pests, but not against termites. Both insect-pathogenic fungi and nematodes have been studied quite a bit in the laboratory (Grace 1995, Jones *et al.* 1996), but have not yet been used effectively in the field (Grace 1997, Culliney & Grace 2000). Currently, we are studying possible applications of bacteria to biological control (Grace & Ewart 1996), and are hopeful that an improved understanding of the microbial ecology of the diverse bacterial community found within the termite intestinal track may lead to more promising breakthroughs in microbial termite control.

Termites have been a problem in Hawaii for over 100 years, and introduction and establishment of new species in the islands has clearly increased over the past several years. As reviewed here, newly developed methods of termite control are helping to address these problems, and steady improvements in research technology (particularly in molecular biology) offer promise for the future. Research efforts at the University of Hawaii are focused upon understanding and manipulation of termite biology and behavior to develop effective and environmentally-acceptable methods of termite management.

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