
DISCUSSION

What follows represents the minutes of the workshop on wood-destroying organisms held in Bend, Oregon, September 14, 1989. The theme of the workshop was the state-of-the art of control of wood destroying organisms and the needs for further research on wood-destroying organisms. The agenda for the session was organized by W. Wayne Wilcox and Michael I. Haverty.

FUTURE OF WOOD PRODUCTS PATHOLOGY

Wayne Wilcox outlined what he thinks are the priorities for education and research on wood products pathology:

- Education of the user (designers, builders, general public or building owners) to reduce the losses due to decay.
- Development of nondestructive techniques to evaluate wood decay in structures (also techniques for diagnosing infestations by active wood-destroying insects in structures).
- Development of new regimes for protecting wood from biodegradation in the absence of toxicants, i.e., biological control and modifications of wood chemistry.
- Evaluation of third-generation wood preservatives, and their effects on nontarget organisms. A variety of compounds or techniques will be used in specific applications. In the future it will be much more expensive to prevent wood decay.
- Increased knowledge of wood-destroying fungi—biological, taxonomic, phylogenetic—and of specialization of fungi in different environments.

Harold Burdsall discussed pathology research at the Forest Products Laboratory, Madison, Wisconsin.

- Institute for Microbial and Biochemical Technology. Investigations of biodeterioration or biodegradation as positive uses of wood-degrading organisms, lignin degradation, wood pulping, pretreatments to reduce the energy needed in pulping, fungi to break down toxic wastes, and fungi to clean up mill effluent.
- Biodeterioration of Wood. Basic biochemical mechanisms of decay, serological examinations, and mechanisms by which enzymes are delivered by fungi taken to wood tissues containing lignin for wood decomposition.
- Center for Forest Mycology Research. Taxonomy of fungi, *Armillaria* root rot, serological investigations of *Phlebia* for diagnosis of species, and other ways to distinguish species. This group is developing a chicken egg technique as an immunological test for identification of species or

strains. They inject fungal tissue into each breast and each leg of a chicken and repeat the process in 1 week. This results in an increase in diagnostic proteins in the eggs after approximately 3 to 4 weeks.

Elmer Schmidt discussed the most recent (1989) meeting of the International Research Group on Wood Preservation, Stockholm, Sweden. This organization is a forum for new ideas on wood preservation and wood-destroying organisms. The general areas are: (1) biological problems (fungi and insects), (2) testing methods (bioassays), (3) preservation of marine timber, and (4) wood preservation.

FUTURE OF WOOD PRODUCTS ENTOMOLOGY

Michael Haverty outlined what he thought were the key issues facing researchers in wood products entomology:

- Continued assessment of new soil termiticides with advances in their application for increased efficacy and longer effective life.
- Assessment of non-chemical, physical barriers for protection before construction begins.
- Better understanding of the taxonomy of the economically important termites in the United States, primarily *Reticulitermes* and *Coptotermes*.
- Acceleration of research on foraging behavior and related colony demography to increase our understanding of feeding behavior of termites.
- Increasing our understanding of the physiology and behaviors involved in feeding by subterranean termites: attractancy, repellency, and seasonal trends.
- Study of the biochemical mechanisms related to repellency to enhance protection of structures and counter the avoidance of toxic baits. Also continued study of the behavioral/biochemical basis of intra- and interspecific agonistic behavior in termites.
- Continued refinement of the bait/toxicant approach to subterranean termite control based on technological advances from areas above.
- Reassessment of mirex as the toxicant in termite baits.

Joe Mauldin discussed the use of borates as preventative treatments. Jeff Morrell (Oregon State University), Terry Amburgey (Mississippi State University), and Lonnie Williams (USDA Forest Service, Gulfport) are the primary investigators. Borates can be applied by diffusion into green (wet, moist) wood. High concentrations of borates on the wood surface diffuse into the center of the wood. Pressure treatment may be used after the wood is dry. There is also the possibility of injecting low concentrations of borates into live trees in hopes of protecting wood after harvest. These treatments are effective against termites, beetles, and many fungi. The treatment is tar-

geted for woods which will be protected from moisture, because borates can be leached from the wood. Effects on nontarget organisms are a concern if high concentrations of borates are misused. Borates are the major ingredients in household products such as Visine and 20-mule-team Borax detergent.

Joe Mauldin also discussed research projects by the scientists at the USDA Forest Service laboratory in Gulfport, Mississippi, directed at methods of protecting wood in use.

- Borates (see above).
- Wood extractives (natural preservatives in woods) are being investigated by Skip McDaniel. Chemicals are extracted, isolated, and their toxicity measured. Most of the toxic chemicals identified thus far are terpenes and alkaloids.
- Susan Jones is investigating baiting systems in Arizona for *Heterotermes* and in Mississippi and Florida for *Reticulitermes*. Some of the borate compounds appear to have promise in bait systems.
- Traditional termite control with soil toxicants is continuing to be developed by Brad Kard. In the laboratory he screens insecticides to find those with promise for long life in soil as termite barriers. He conducts his field studies at test sites all over the United States. Brad is also field-testing plastics with slow-release pesticide and crushed basalt as termite barriers.

Michael Haverty commented on an observation he (and Joe Mauldin and Nan-Yao Su) made in Southeast Asia. In the urban areas in Southeast Asia, the inhabitants have stopped building with wood; they use cement for the load-bearing parts of structures and use wood only in roof structures, window and door frames, or in ornamental situations where it could be easily replaced. Most of the structurally important wood used in Southeast Asia is either naturally durable or pressure treated.

Joe Mauldin was asked for his assessment of the future of soil pesticides. Mauldin emphasized that the USDA laboratory in Gulfport, Mississippi, will continue to conduct research on alternatives to currently registered soil insecticides. In the near future, control of subterranean termites will mostly be accomplished with soil insecticides. Additional areas of subterranean termite control include biological control: fungi, bacteria and nematodes work well in the laboratory, but in the field these agents have not been shown to be effective. Termites apparently have a defense, or way to fend off these treatments, which renders them ineffective in the field. Dogs are also now being used in termite control. The dogs' ability to detect termites in a structure has not been tested, but those marketing these animals as termite detection "devices" claim the dogs are effective at locating termite infestations.

Vernard Lewis inquired about closer scrutiny and a possible ban of fumigants in California. Apparently state regulatory officials are clamping down on use in structures and in wood yards. Ken Grace mentioned that there is a movement to register methyl bromide for fumigation in structures in Canada. Nan-Yao Su reported that Dow Chemical Co. requested tests of sulfuryl fluoride to satisfy the U.S. Environmental Protection

Agency. The goal of this research is to quantify the release of this fumigant from treated structures to support reregistration.

John French, Joe Mauldin, Nan-Yao Su, and Ken Grace discussed the future of bait/toxicants for subterranean termite control. Nan-Yao reviewed the basic concept. Over the past 40 years, the public has been relying on widespread use of huge quantities of pesticides in the soil to control subterranean termites. With bait toxicants, termites bring the toxicant back to colony and disperse it to colony mates, thereby causing the death of the entire colony. Until recently it has been difficult to determine whether termites simply move away or are killed by the bait. Nan-Yao feels it is crucial to monitor activity of foraging populations of field colonies by the mark-release-recapture technique before we apply test toxins. Chemicals under examination currently are: (1) borates, (2) A-9248 (Abbott Laboratories), and (3) sulfluramid (Griffin Corp). A-9248 reduced a *C. formosanus* colony from 3.6 million to 75,000 termites. Sulfluramid has toxicity, effective lethal time and acceptability to termites comparable to mirex. Sulfluramid is registered for use in baits for cockroaches and fire ants. Nan-Yao wants to emphasize that we are recommending use of bait toxicants to suppress termite populations in urban areas, not in forests.

Michael Haverty discussed his work and that of Susan Jones and Nan-Yao Su on the disruption of caste structure and demography of colonies. Insect growth regulators induce molting of workers or pseudergates to superfluous soldiers and intercastes. The goal of this control strategy is to cause the termite population to crash because of an excess of dependent castes. This strategy works in the laboratory but, so far, has not been demonstrated in the field. *Coptotermes* can tolerate as much as 50 to 60 percent of the population in the soldier caste.

Ken Grace has begun work to quantify *Reticulitermes flavipes* populations in southern Canada. He has determined that the colonies are as large as 3 million with extensive foraging territories. He will soon be moving to the University of Hawaii to study means of controlling the Formosan subterranean termite. He looks forward to a 12-month, warm field season!

John French discussed his work in Australia with mirex in baits. Mirex bait-blocks kill a mound of *Coptotermes lacteus* in 6 to 10 days. The system appears to be equally effective in buildings. He further emphasized that a bait/toxicant system must be foolproof to be used effectively by pest control technicians. The advantage of these systems is that they would use small amounts of pesticides, localized placements of pesticides, and the unused remnants can be withdrawn and disposed of after control has been achieved. It is sometimes necessary to practice "drastic carpentry" to place termite baits in the foraging path of the termites. Mirex-agar-sawdust baits kill *Coptotermes acinaciformis* in Sydney but not in Melbourne. There is obviously a behavioral or species difference. Another approach still used in Australia is to puff a toxic powder into termite galleries or wherever the termites aggregate. This strategy relies on the grooming behavior of termites to disperse the toxicant throughout the colony. The use of arsenic trioxide is still allowed in Australia. Inclusion compounds in peanut-shaped molecules

can be used to dust termites. When ingested during grooming the chemical becomes active and kills the termites.

Finally, Michael Haverty made his pitch for chemotaxonomic research on termites. It was the consensus of the group that one of the areas of concern is the Pacific Rim. *Coptotermes* species are probably the most economically important termites

in this area. We need to study this group extensively. Another ecologically important genus of termites is *Nasutitermes*. Our understanding of deforestation will be greatly enhanced by knowledge of the wood-destroying (or wood-recycling) and herbivorous termite species.



The Forest Service, U.S. Department of Agriculture, is responsible for Federal leadership in forestry. It carries out this role through four main activities:

- Protection and management of resources on 191 million acres of National Forest System lands
- Cooperation with State and local governments, forest industries, and private landowners to help protect and manage non-Federal forest and associated range and watershed lands
- Participation with other agencies in human resource and community assistance programs to improve living conditions in rural areas
- Research on all aspects of forestry, rangeland management, and forest resources utilization.

The Pacific Southwest Research Station

- Represents the research branch of the Forest Service in California, Hawaii, American Samoa and the western Pacific.
-

Persons of any race, color, national origin, sex, age, religion, or with any handicapping conditions are welcome to use and enjoy all facilities, programs, and services of the U.S. Department of Agriculture. Discrimination in any form is strictly against agency policy, and should be reported to the Secretary of Agriculture, Washington, DC 20250.