USDA-Forest Service **RESEARCH WORK UNIT DESCRIPTION** Ref: FSM 4070	**1. Number** 4502 **3. Unit Location** Starkville, Mississippi	**2. Station** Southern Research Station

4. Research Work Unit Title

Wood Products Insect Research

5. Project Leader (Name and Address)

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6. Area of Research Applicability	**7. Estimated Duration**
National	5 Years

8. Mission

To define the role of termites in forest ecosystems, to improve protection of wood against damage, and to understand the impact of termites on forest health.

9. Justification and Problem Selection:

The United States is a world leading consumer of wood resources. However, increasing controversy about management of National Forests and diminishing wood resources worldwide makes it imperative that we protect wood in use. Extensive research and technology transfer are needed to improve wood protection. Termite control and repair of the extensive damage caused by subterranean termites cost U.S. taxpayers at least $1.5 billion annually. In addition, the Department of Defense spends several million dollars for termite control. Cost estimates for drywood termite control and repair of damage are not readily available, but expensive treatments such as fumigation in California, Hawaii, Florida, and the southern rim of the U.S. no doubt amount to many millions of dollars. Losses caused by wood-destroying beetles easily exceed $50 million annually for control, replacement of damaged wood, and litigation costs. Replacement of wood damaged by termites and wood-destroying beetles causes a serious drain on U.S. wood resources because thousands of acres of trees must be cut each year to meet this demand.

Subterranean termites are found throughout most of the U.S. and its territories. They are destructive, costly pests when infesting wooden structures, and cause damage to both wood and non-wood building components and contents. Control currently involves treatments to soil under and around building foundations with a persistent insecticide that is toxic and often repellent to termites. Among the termiticides, the chlorinated hydrocarbons provided decades of protection against termites. However, their use was curtailed by the Environmental Protection Agency in 1988 and these products will not be returned to the U.S. market. Recently labeled termiticides are effective for shorter periods than the chlorinated hydrocarbons, and retreatments may be needed every 5 to 10 years. Because retreatments are expensive and difficult to accomplish, owners of homes and other wooden buildings nationwide want termite control chemicals to remain effective for as long as possible.

Signature	Title	Date
Recommended: [illegible]	Assistant Director for Research	10/22/97
[illegible]	Assistant to Staff Director	11/14/97
[illegible]	Staff Director	11.14.97
Approved: Peter J. Roussopoulos	Station Director	11/25/97
Concurred: Barbara C. Weber	Deputy Chief for Research	12/31/97

9. Justification and Problem Selection (continued):

With concern increasing regarding the environmental and health impact of insecticides used in and around buildings, alternative control methods such as baiting techniques, preservative treatments to wood, biological control, and non-chemical and low-chemical physical barriers should continue to be investigated. Furthermore, extensive behavioral and ecological studies must be carried out that lead toward novel and proactive management systems. New information will be applied to current and emerging techniques for control of subterranean termites.

New and potentially effective termiticides, insect growth regulators (IGRs), bait compounds, physical barriers, and low-chemical barriers are continually being developed by chemical companies. Also, currently registered termiticides are being reformulated to increase efficacy. Thus, <u>there is a need for new and alternative compounds, materials, and treatment techniques for effective protection against damage caused by subterranean termites</u>. (Problem 1) Screening for the most effective insecticide and rate combinations and alternative techniques will provide relatively safer ways to protect wooden buildings, including homes, which are the largest single investment for most U.S. families. Based on previous test results, chances are greater than 90 percent that new termiticides, IGRs, bait compounds, and physical and low-chemical barriers will be found to protect buildings, thus conserving wood.

Termites are highly beneficial reducer-decomposers in their natural environment. They play an important role in temperate, subtropical, and tropical ecosystems, yet that role is poorly documented. Studies of decomposition in the forest and studies of termite interactions within a colony and among other biotic organism such as fungi are crucial for filling important knowledge gaps that exist both in understanding nutrient cycling in forests and in devising more effective control treatments. Chemicals were used effectively for so many years that some of this knowledge was not sought. Within subtropical and temperate climates in the U.S., Long Term Site Productivity experiments provide a framework for studying the role of termites in the forest.

In tropical environments such as on Midway Atoll, termites may play an even greater role in the ecosystem since biodiversity and biological activity are so intense. Our sites on Midway Island are used for testing materials against Formosan termites, but are difficult to maintain. Therefore, efforts will soon be underway to identify areas on Hawaii for tropical test sites. Likewise, efforts will soon be underway in Florida to move subtropical test sites from private land to National Forest land.

Currently, <u>inadequate knowledge of termite biology, ecology and behavior limits understanding of forest ecosystems and efficacy of protection techniques</u>. (Problem 2) An effective baiting technique would allow successful treatment of non-typical buildings such as those with subslab heating and air-conditioning duct work, which are difficult to treat with conventional termiticides. This technique would provide a supplement to conventional termiticide treatments to soil, or perhaps a sole option for building owners who want to minimize chemical use or need to control termites in locations where insecticide use is inappropriate. Ongoing research is promising, and Unit scientists believe that a 90 percent or greater chance exists that efficacy can be improved upon application of new information.

One of the most potentially damaging insects to wood is the Formosan termite, <u>Coptotermes</u> <u>formosanus</u> Shiraki. Infestations were first reported in the mid-1960's in Texas and Louisiana. Although this non-indigenous pest has been recognized for many years, it only recently gained the attention of supporters interested in funding efforts to combat its devastation. The Wood Products Insect Research unit has not studied the Formosan termite extensively because Louisiana State University historically has taken the lead role. Now, this pest has attained national status and must be dealt with quickly. The national role of the Wood Products Insect Research unit encompasses the Formosan termite situation which is worst in Atlantic Coast and Gulf Coast areas, and Honolulu, Hawaii.

Control operations are underway by city, State and private organizations, but no formal coordination exists as yet at the national level. With hopes of new funding targeted for research on the Formosan termite, the Wood Products Insect Research unit will increase efforts on developing management strategies and evaluating impact on forested land. Development of new information will enhance the use of current baiting techniques and testing of new barrier products as part of Problem 1. There is little understanding of the many factors that allow the Formosan termite to survive standard termiticide treatments (Problem 3).

10. Approach to Problem Solution:

Problem 1. There is a need for new and alternative compounds, materials, and treatment techniques for effective protection against damage caused by subterranean termites.

New insecticides are being formulated on a continuing basis, thus a laboratory screening program for identifying those most promising will be continued. This research will be primarily concerned with the evaluation of insecticides as treatments to soil for control of subterranean termites in the genus *Reticulitermes*. Field evaluation of the most promising new insecticides, including biologicals, will be initiated and long-term evaluations currently in place will be continued. Four nationwide screening sites allow for testing of *Reticulitermes* in subtropical and temperate climates and soil types in Florida, Mississippi and South Carolina; and for testing of *Heterotermes* in the desert climate and soil type in Arizona. The most effective termiticide application rates also will be determined. Efficacy data is required by the Environmental Protection Agency when industry seeks registration. Biological agents, and non- or low-chemical physical barriers will be investigated along with new products believed to provide protection against damage by subterranean termites.

Research using baits will provide information on termite foraging behavior in different geographic locations and climates. These baseline data will be used to develop suitable field test methods to evaluate the effectiveness of selected bait toxicants in suppressing or eliminating subterranean termite colonies. The goal is to control subterranean termites in urban settings using selected bait toxicants in acceptable delivery systems.

Accomplishments planned for the next 5 years:

1. Evaluate new materials and identify the most effective insecticides and application rates for the prevention and control of subterranean termites.

2. Determine the effectiveness of non-chemical and low-chemical physical barriers for prevention of damage by subterranean termites to buildings or wood products.

3. Evaluate promising insect pathogens for efficacy against termites.

4. Evaluate wood-chip-cement products, new panelling products, and other new materials for resistance to subterranean termites.

5. Evaluate depth and activity of newest and most widely used termiticides by soil analysis and corresponding laboratory bioassays of treated soil from core samples.

6. Continue to develop and improve bait toxicants and delivery systems for use in urban areas.

Environmental Considerations: Ongoing or proposed studies have little or no potential to significantly impact the human environment. Proposed research activities are limited in context and intensity. The environmental effects of specific actions will be considered during the development of study plans, as well as the existence of extraordinary circumstances related to any proposed action, and procedures for categorical exclusion will be followed in accordance with FSH 1909.15.

Problem 2. Inadequate knowledge of termite biology, ecology and behavior limits understanding of forest ecosystems and efficacy of protection techniques.

Understanding the role of termites and associated organisms is important to maintaining forest health. A moderate amount of literature exists on termite biology, but little research has been conducted on their behavioral ecology based on semiochemicals. Research also has not addressed the development of environmentally safe and economically feasible integrated management strategies that reduce pesticide pollution and safeguard structures. Although spatial analysis is known, little has been done on its use in interpreting observations and data on complex biological phenomena associated with subterranean social insects, nor in its use for practical reduced-risk IPM. Therefore, this research program must create and test biological, biorational and ecological hypotheses in the context of pest spatial behavior for the development and integration of precision targeting technologies (GPS, GIS, geostatistics) as practical solutions to the problems of urban insect management with less reliance on pesticides. Research efforts are in collaboration with USDA-ARS cooperators in Gainesville, FL, where success is being achieved with other social insects. Hopefully, this technology can be applied to termites to achieve success in developing standardized monitoring techniques. Proactive monitoring and managing of termites will ultimately reduce pesticide usage.

Much of industry is focusing on baiting techniques for termite control to be used in conjunction with traditional chemicals. Bait strategies rely on suppressing or eliminating a termite colony in a given area while using less toxicant than used in standard treatments to soil. As foraging termites feed on a treated cellulose bait and pass a slow-acting toxicant to other colony members, the termite infestation may be eliminated eventually. To improve pest management strategies of subterranean termites, including use of baits, new information on behavior, ecology, and monitoring of termites is crucial. Project efforts will emphasize applying new knowledge of biology and behavior to baiting strategies. The result should be more effective use of bait systems.

The response of termites to fungal decayed wood is thought to be important in decomposition of woody debris in the forest. Previous work indicated that one compound (cis,cis,trans-3,6,8-dodectrien-1-ol) isolated from Gloeophyllum trabeum infected wood was responsible for the trail following response in several species of termites. However, other compounds may be present in decayed wood that elicit responses in subterranean termites. Many years have elapsed since initial work in this area was conducted; followup is necessary to evaluate the viability of this approach. Efforts will be directed toward using new and existing information on attractants to improve control methods. The goal is to quickly screen promising compounds without spending considerable time and effort in identifying compounds.

Several isolates of G. trabeum will be cultured, and extractions will be done to isolate compounds responsible for termite responses. Preliminary identification of compounds responsible for certain responses will be accomplished using gas or liquid chromatography techniques, with confirmation of identification using other analytical methods. This work will be accomplished in cooperation with the Forest Products Laboratory at Mississippi State University. In addition to identifying the chemical components responsible for behavioral responses, contributions will be made to a database of wood decay fungi using the Microbial Identification System (MIDI). This system represents cutting edge technology for identifying fungi compared to the traditional identification procedures based on morphological characteristics.

Woody debris is critically important in forest ecosystems as habitat, in affecting soil transport and sediment storage, in energy nets and nutrient cycles. Little work has been done in the loblolly pine (Pinus taeda L.) forest type. Loblolly pine is an economically and ecologically important species in the southern U.S. Our understanding of the role of woody material decomposition in maintaining the long-term carbon and nutrient capital of the soil and thereby the ability to sustain production in these systems is minimal. Designed experiments in which site resources are manipulated and quantified are needed to understand the basis of sustainable productivity, predict long-term response, and manage to meet the needs of the human component of the ecosystem. The National Long-Term Site Productivity Study (LTSP) was begun to determine the impact of macroporosity reduction and organic matter removal on long-term productivity of our forest resource. The study has been installed over a wide range of forest and soil conditions, and the study offers a unique opportunity to study forest processes across a climatic gradient. SRS4502 will cooperate with SRS units in Pineville and RTP which are responsible for particular LTSP sites. The primary objective of this cooperative study is to quantify the role of subterranean termites and closely associated organisms in decomposition of loblolly pine logs and branches along a climatic gradient in the southern United States.

Termites also are prevalent in hardwood forests. A study of the role of termites in hardwoods may be initiated, as well as in wetlands (cypress), to better understand nutrient cycling in these systems. Hopefully, indicator species can be used to identify progression of decomposition and/or damage.

Accomplishments planned for the next five years:

1. Develop spatially-based monitoring systems making management of termites possible while reducing pesticide use.

2. Collect and identify isolates of G. trabeum to be tested. Setup database for identification and confirmation of these isolates by the microbial identification system.

3. Screen fungal decayed material for response by termites, and isolate and identify compound(s) responsible for response; determine minimal concentration of compound(s) needed to induce the response.

4. Characterize the association of termites with flora and fauna.

5. Through FS or Mississippi State University cooperators, characterize volatile organic compounds from rotting logs and relate to organisms present (fungal and arthropod). This effort depends on availability of resources to accomplish the work.

6. Determine the invasion rates of logs and branches by insects and fungi.

7. Ascertain the role of termites and associated arthopods in turnover of carbon and nutrients in forest ecosystems.

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Problem 3. There is little understanding of the many factors that allow the Formosan termite to survive standard termiticide treatments.

Current work on the Formosan termite is limited to screening studies of stainless steel mesh and basaltic sand, two non-chemical physical barriers (see Problem 1). Formosan termite studies have been located on Midway Island, but the Navy has turned over the island to the Department of Interior. Bioremediation was planned for in the past year by Navy personnel, and certain tests were protected or moved to different locations. The Navy wishes to assist the Forest Service in locating long-term sites in Hawaii due to logistics of travel and plot maintenance on Midway. Mainland sites on the Gulf Coast and/or in Louisiana could be made available upon initiation of new studies involving the Formosan termite. Work depends on funding through USDA-ARS. However, immediate involvement could occur upon redirection of some of the current screening effort.

Accomplishments planned for the next 5 years:

1. Designate research sites in Hawaii and the Gulf Coast for potential work with the Formosan termite.

2. Develop cooperative efforts with the newly evolving network of scientists involved in the Formosan termite. Studies would involve biology, ecology and behavior.

3. Assess damage to forested lands by the Formosan termite upon collaboration of the National Forest and/or LSU.

Environmental Considerations: Ongoing or proposed studies have little or no potential to significantly impact the human environment. Proposed research activities are limited in context and intensity. The environmental effects of specific actions will be considered during the development of study plans, as well as the existence of extraordinary circumstances related to any proposed action, and procedures for categorical exclusion will be followed in accordance with FSH 1909.15.

11. **Cooperations:** Screening and research studies involve cooperation with representatives of the pest control industry, universities, regulatory agencies, Southern Research Station, and Region 8.

Problem 1: Screening study cooperators represent a long list of pest control-related organizations. EPA and State regulatory officials are keenly interested in the conduct of nationwide tests. Michael Haverty (FS) is a potential cooperator on bait studies in Arizona. Cooperators abroad include scientists and companies with new products to be tested. Testing sites are located on private land, National Forests, Dept. of Defense land, Dept. of Interior land, and University of Arizona land. University cooperation includes Univ. of Hawaii, Univ. of Florida, Mississippi State Univ., and Univ. of Arizona. The study on depth and activity of termiticides is with James Jarratt et al., Mississippi State University.

Problem 2: Semiochemical and monitoring work will be accomplished in cooperation with USDA, ARS scientists at Univ. of Florida (Richard Brenner, Weste Osbrink, James

Tumlinson, et al.) and with the Dept. of Defense. Michael Haverty is a potential cooperator on biology and behavior studies of termites. Fungal isolation work will be conducted at Mississippi State Univ. (Terry Amburgey, Darrel Nicholas, Lynn Prewitt, and Susan Diehl). Volatile organic compounds likely will be done with Lynn Prewitt and Leonard Ingram at Mississippi State, and/or Richard Hemingway, FS, Pineville, LA. Potential cooperators for natural attractants are Stephen Duke and Mario Tellez, ARS, Oxford, Mississippi. The rotting log research in pine involves use of LTSP sites of Marilyn Buford in NC, and Allan Tiarks in LA; sites in MS and TX also will be used. Kier Klepzig and Jane Hayes will be major cooperators in insect and fungus interactions at LTSP sites. Work in hardwoods would be in cooperation with John Stanturf (FS). New collaboration at Auburn Univ. (Faith Oi) and Alabama A&M (Rufina Navasero Ward) may be initiated on the relationship among ants and termites, and at Mississippi State on nutrient cycling and soil relationships to termites (Alex Friend, Stephen Schoenholtz).

Problem 3: Formosan termite research would be accomplished with the National Forests, Dept. of Defense, New Orleans Mosquito Board, and university cooperators, primarily Ken Grace, Nan-Yao Su, Philip Koehler, and Gregg Henderson.

12. Staffing:

	Year				
Scientist	1997	1998	1999	2000	2001
Years	1	2	3	4	5
Problem 1	1.2	1.1	1.0	0.9	0.9
Problem 2	0.8	2.6	2.6	2.6	2.6
Problem 3	0.0	0.3	0.4	0.5	0.5
TOTAL	2.0	4.0	4.0	4.0	4.0

Budget calculations based on $225,000 per SY.
Figures in table are x $1,000.

	Year				
	1997	1998	1999	2000	2001
Budget	1	2	3	4	5
Problem 1	270	247.5	225	202.5	202.5
Problem 2	180	585	585	585	585
Problem 3	0	67.5	90	112.5	112.5
TOTAL	450	900	900	900	900