Researchers Seek to control introduced

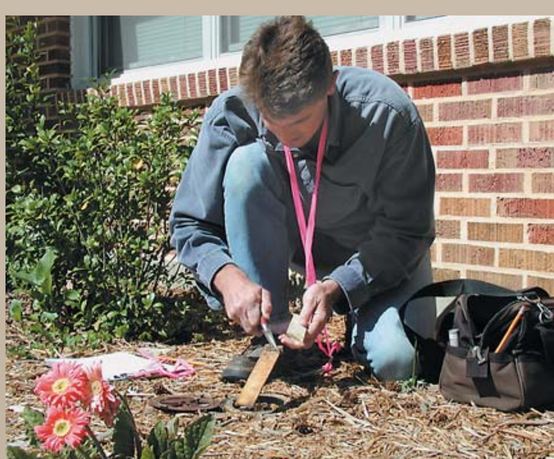
By Charmain Tan Courcelle

ANY military strategist would tell you that knowing your enemy is critical for success on the battlefield. MAFES scientists are applying this strategy to wage a war on a marauding pest.

The Formosan subterranean termite, *Coptotermes formosanus*, is a nonnative species of termite. Experts consider it to be one of the most aggressive and destructive species of termite in the world.

It's believed this pest first entered the southeastern United States on crated military supplies returning from the Pacific theater after World War II. Since then, Formosan subterranean termites have spread from their initial points of entry in New Orleans and Lake Charles, La.; Galveston and Houston, Texas; and Charleston, S.C., into nine Southeastern states. Formosan subterranean termites are also present in California and Hawaii, and it appears that this termite may be spreading beyond these borders, further through the country.

MAFES and other Mississippi State University scientists are working to determine the extent and severity of Formosan subterranean termite infestation in Mississippi and changes to the population over time, and to assess methods of termite management and control. These studies may uncover a chink in the termite's armor that could be used in the development of methods to control this pest.



Jennifer Carroll, CREC

Research technician David Lee checks an underground bait station for termites.

Neighborhood watch targets intruders

One method of termite control that is being evaluated is an area-wide management strategy. Cathy Hollomon, MAFES environmental scientist, is part of a team at the Coastal Research and Extension Center that is assessing this strategy in partnership with Operation Full Stop, the national campaign against Formosan subterranean termites led by the U.S. Department of Agriculture's Agricultural Research Service (ARS).

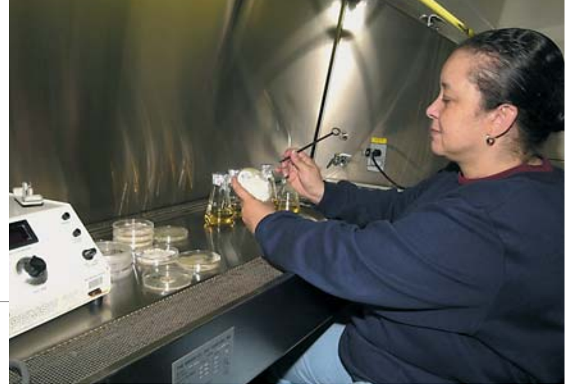
Unlike native subterranean termites, Formosan subterranean termites do not have to return to underground nests after foraging. If sufficient moisture is available, for example from leaking pipes, this species can build nests above ground in walls or live trees. Formosan subterranean termites are not restricted to dead trees and processed wood for food — any material containing wood fiber, or cellulose, is a potential food source for this species. And because of the large size of Formosan subterranean termite colonies, this pest consumes more wood than its native cousin.

To prevent further destruction and infestation by Formosan subterranean termites, project scientists have designed and are assessing an area-wide termite control approach. This strategy protects all structures within a given area or neighborhood by eliminating or reducing the size of the termite colony. Conventional barrier treatment methods only protect individual structures and don't reduce or eliminate a colony.

Formosan subterranean termites are social insects that forage over wide areas and develop more extensive colonies than native species. Because of this behavior, scientists say treating single buildings to manage Formosan subterranean termite activity is not an effective method of control. The colonies continue to grow and the termites find sustenance elsewhere, destroying buildings and infrastructure along the way.

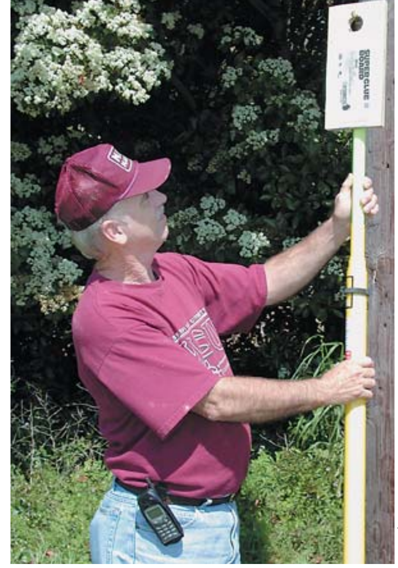
"With an area-wide approach to termite control, the entire colony is affected, not just individual termites. So, this approach should eliminate or at least reduce the threat of further infestation," Hollomon said.

In earlier studies, Hollomon and colleagues investigated the extent of the Formosan subterranean termite pest



Marco Nicovich

Research assistant Lynn Prewitt inoculates an agar plate with a candidate termite biological control agent.



Jennifer Carroll, CREC

Visiting research scientist Larry Etheridge prepares a sticky trap for the alate monitoring studies.

problem in Mississippi. Using sticky trap monitoring stations to survey for alates — the winged, reproductive form of termites — the team confirmed the presence of Formosan subterranean termites in Mississippi. Ongoing annual surveys are providing a measure of the spread and severity of Formosan subterranean termites in the state.

"Based on our survey for the presence of alates, we also determined the locations for the area-wide management studies," Hollomon said.

The scientists established 12 study sites within neighborhoods at the Keesler Air Force Base in Biloxi and began monthly monitoring for Formosan subterranean termites in September 2000. Each study site has underground bait stations placed in a grid pattern around centers of high alate capture. Since March 2001, monitoring stations with positive hits for Formosan subterranean termites have been baited. The bait used is made up of a matrix developed by ARS scientists, and laced with diflubenzuron, a toxin that disrupts formation of the termite's outer shell. Hollomon said foraging worker termites, which provide food for the colony, bring the toxin back to the nest and contaminate other members of the colony.

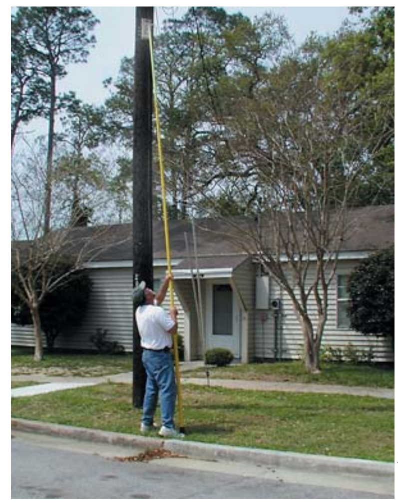
"The toxin eventually kills termites that have visited the baited monitoring stations and consequently others in the colony, including the queen," she said.

"So far, our preliminary data look promising, but we need to continue with these area-wide studies to see how effective the method is."

In the meantime, alate monitoring studies to track the occurrence and spread of Formosan subterranean termites in Mississippi continue each spring. As a result of this work, Hollomon and coworkers have also confirmed the spread of Formosan subterranean termites into forested areas.

"This is the first time we have seen spread from urban areas into naturally forested areas," said Jennifer Carroll, MAFES research associate. "We're excited about this finding because these colonies provide us with a 'field lab' to study the behavior of Formosan subterranean termites in natural environments, away from man-made structures."

Scientists involved in the project hope their studies in the "field lab" and with the area-wide management systems will lead to effective baiting techniques and methods to detect termite activity and to eliminate Formosan subterranean termite populations.



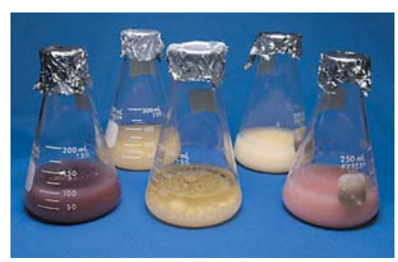
Jennifer Carroll, CREC

Technician Jimmy Spigener sets up a sticky trap monitoring station.

Planned reunion brings termites and natural enemies together

Because the Formosan subterranean termite is not native to the U.S., it has no natural predator in this country. MSU forest products scientist Susan Diehl is working with ARS scientists to identify organisms from the termite's original home that might be used as biological control agents.

In its native land, enemies like the fungi *Metarhizium anisopliae* and *Beauveria bassiana* keep the Formosan subterranean termite in check. Diehl is screening fungi isolated from soil and termite samples collected in China by her ARS collaborators for these and other natural foes.



Marco Nicovich

These liquid cultures could contain natural fungal enemies of the Formosan subterranean termite.

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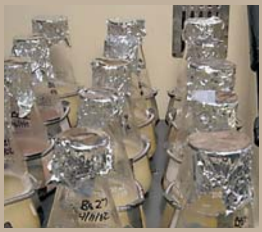
Researchers Seek to Control Introduced Pest (continued)



Diehl's team at MSU is isolating individual microbial species from each ARS sample. Her group will then determine the best culture, or growth, conditions that will allow accurate identification of candidate biological control agents based on their composition and concentration of fatty acids, a molecular component of cells.

Diehl said the task of identifying helpful fungal species rapidly is made difficult because there is limited information about fungi that can cause disease in termites and other insects, so-called entomopathogenic fungi.

"Most identification databases are for medically important fungal species," she said. "We hope to improve the current fungal pathogen databases, which should increase our ability to pull out fungi that seem promising as termite biocontrol agents."

Improvements to the databases will also provide an analytical tool to identify fungal isolates or strains that may be hazardous, she added.

The screening process is the first step in a long battery of tests that any potential biocontrol agent needs to pass before it can be adopted for use. Once Diehl's team has provided ARS scientists with a list of potential agents and their identifying characteristics, her collaborators will need to determine whether their biology and host range make them safe for use in the United States — nonthreatening to humans, animals, native plants and beneficial insects.

"After these extensive tests, the final challenge will be whether we can introduce a termite pathogen that can survive conditions in New Orleans or anywhere else that it's introduced, that can be incorporated as part of a bait system and that will be effective in killing Formosan subterranean termites," Diehl concluded.

Editor's Note: Cathy Hollomon has relocated outside the U.S. The Formosan subterranean termite project at the Coastal Research and Extension Center is being continued by Carroll, MAFES scientists Linda Andrews and Christine Coker, and other research personnel at the station.

Study Searches for fungus, disease, yield *Connection*

By Charmain Tan Courcelle

Experiment Station researchers are determining whether fungi are responsible for some of the seedling diseases and low grain yields seen in Mississippi.

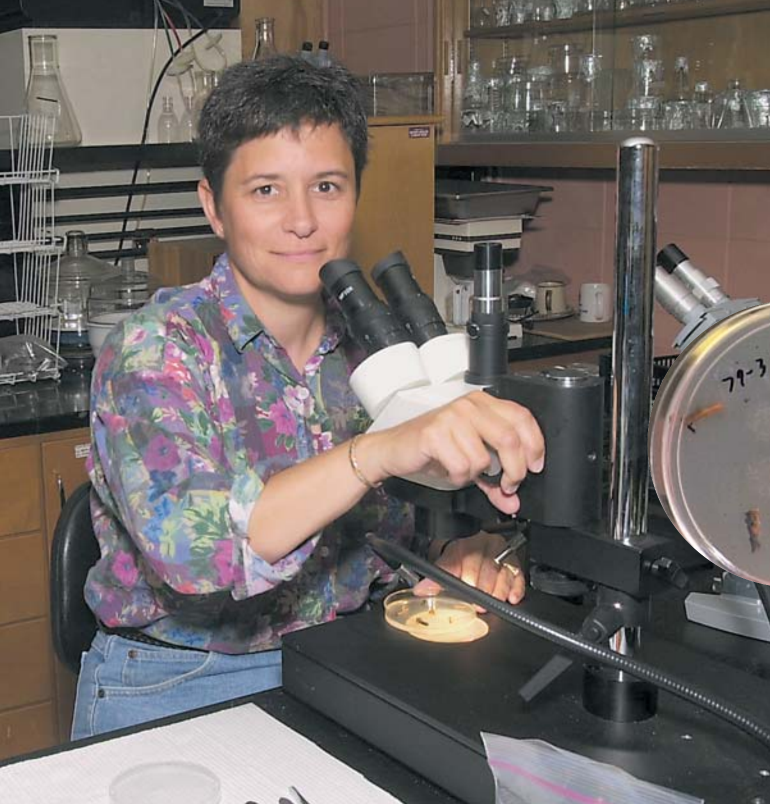
Larry Trevathan, MAFES plant pathologist, is identifying fungal species common to corn production systems in Mississippi and looking for a link between fungal occurrence in the roots of this crop and subsequent seedling disease.

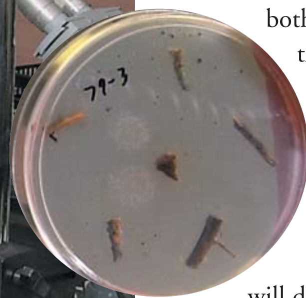
Plant-infecting fungi are found commonly in agricultural soil where they use crop residue as a source of nutrition during the winter and between crops. These fungi can also be found in untreated seed. While fungicides have been somewhat effective as control agents, their success depends on timely and accurate diagnosis of a fungal disease — a task made difficult by the similarity of symptoms for different diseases.

"We initially wanted to identify fungal pathogens that are most active under the corn production systems found in the state," Trevathan said. "A second goal was to find fungal species that might be useful in the future as agents of biological control."

One challenge facing researchers is that fungus-infected plants do not always show outward signs of disease.

"In most cases, you find visually discernible symptoms of a fungal infection," Trevathan said. "But sometimes you don't see symptoms at all, and you're left with the question, 'is this variety growing and producing yields to its full potential or is it infected with





Jim Lytle

Research associate Maria Tomaso-Peterson uses a light microscope to identify fungal species based on their physical characteristics.

a fungal species that is not causing symptoms but is affecting plant productivity?'"

In a three-year study, Trevathan looked at the effect of tillage systems (no-till and conventional), soil types (silty clay and silt loam soils) and planting date on the population and variety of fungal species found in corn. He also collected corn seedlings at three, 10, 17 and 28 days after planting to determine which fungal species are important disease agents at different times in the seedling stage of the plant life cycle and the effect infecting fungi have on subsequent grain yield.

"We found *Fusarium* species consistently in Mississippi soils and most frequently in silty clay. This is important because members of the Fusarium genus are some of the most serious seedling disease pathogens in the state," Trevathan said. "*Trichoderma* species were another well-represented class of fungi."

Results from this study showed a correlation between the incidence of fungal root infection and seedling disease severity. Trevathan also saw the highest incidence of seedling disease in tilled plots planted on the latest corn-planting date in silty clay soil.

He did not find a connection between root infection and yield or between disease severity and yield. Instead, corn grain yields appeared to be most affected by the type of tillage system used. No-till systems produced consistently higher grain yields on the silty clay and silt loam soils.

The researcher said his most significant finding, however, was the presence of fungi that have both disease-causing and nonpathogenic members in his samples.

"That means there's the potential to characterize both fungal pathogens and control agents out of the same population," he said.

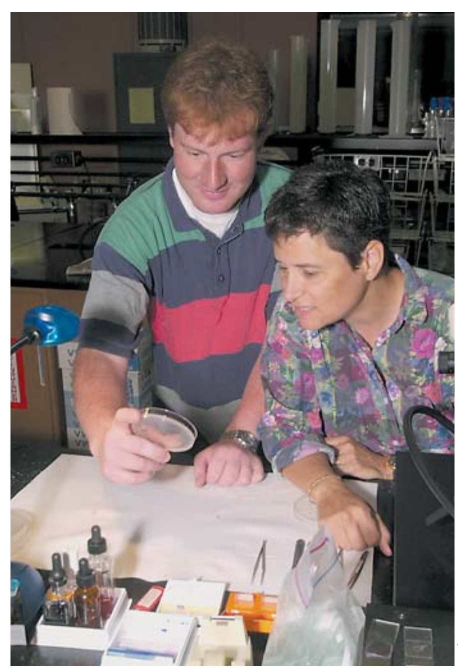
Nonpathogenic species of fungi could be used to competitively exclude or displace disease-causing members from crops, Trevathan said. They could also "prime" a plant's antifungal defenses.

For the next phase of his studies, Trevathan will determine whether the presence of seedling disease fungal pathogens influences the development of stalk rot, a disease of mature corn that reduces yields and can result in plant death. He said work in other states suggests some fungal species that cause seedling disease have roles in stalk rot, but such a connection has not been investigated in Mississippi corn production systems.

Another question that Trevathan would like to answer is related to the role of environmental stress on plant pathogen infection. Moisture is the number-one limiting factor to corn production in Mississippi. One management strategy that has been adopted to address this problem is early planting, he said.

"But if you plant early, there is more stress on the plant from the cool to cold, moist to wet soil conditions. We want to know whether this stress provides an advantage to plant pathogens that would be removed if planting is accomplished at a later date."

Trevathan said he believes the results from this and future studies will help producers develop improved pest management practices for fungi and give them confidence to make adjustments in production practices.



Jim Lytle

Graduate research assistant Lucas Pitre and Tomaso-Peterson examine a plate containing fungi isolated from corn seedlings.