PEGGY GREB (K10575-1)

Operation Full Stop 2003

Stopping

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Formosan subterranean termites feeding on spruce (left) and birch wood blocks.

Part of a Formosan subterranean termite nest showing the extensive system of galleries the insects create. The nest was found in an apartment wall in the New Orleans French Quarter.

In New Orleans, it starts during the twilight hours in late April. Thousands of tiny, winged termites—alates—begin swarming lampposts. In some areas, the air becomes so thick with the flying pests that streetlights dim behind hovering brown clouds. As the alates mate and drop their wings, the street crackles underfoot.

New Orleans, Louisiana, can reasonably be called the termite capital of the continental United States. It has been overrun by *Coptotermes formosanus*, the Formosan subterranean termite. Experts believe that the stowaway species entered the country on ships sailing back from the Pacific after World War II. Since their arrival, these termites have multiplied exponentially in the moist, warm, southern Louisiana climate. They've also established themselves in 10 other states and cost U.S. consumers $1 billion every year in control costs and damages.

In 1998, the Agricultural Research Service, with several major cooperators, launched a national campaign to reduce the population of these voracious invaders and lower their cost to society. Now, the researchers are taking stock of the progress they've made and focusing on new endeavors.

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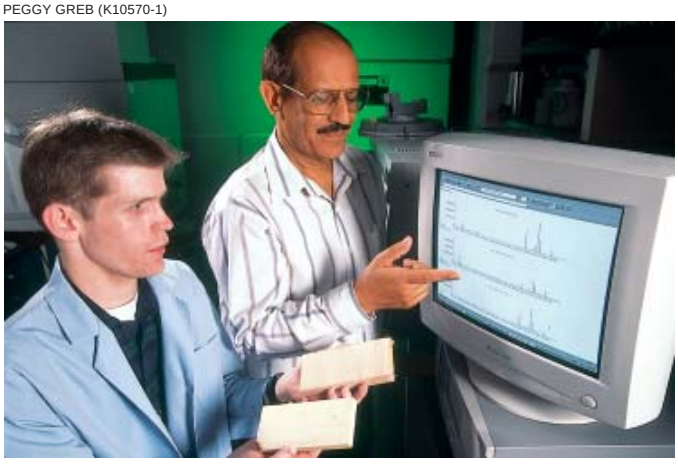

In studies to determine whether changes in diet trigger termite aggression, technician Christopher Florane (left) and entomologist Ashok Raina discuss gas chromatography-mass spectrometry profiles of termites fed different types of wood.

No Quarter for Termites in the Vieux Carré

New Orleans' historic French Quarter is the epicenter of the Formosan infestation—a worst-case scenario come to life. Many buildings in this part of

the Swarm

the city contain wood that dates back a century or more. And the city itself gets about 60 inches of precipitation annually. With an abundant food supply and a ready source of moisture, Formosan colonies have been able to increase and expand here over the years.

Exacerbating the problem? Construction practices and a defensive, protect-the-structure approach to termite control made traditional chemical treatment difficult. So near-perfect conditions for termite colonies, combined with limited effective pesticides, contributed to rapid population growth in the late 1980s.

By the mid-1990s, the U.S. Congress saw that without some type of intervention to contain the Formosan scourge, many properties within the world-famous Vieux Carré would be reduced to the lacy grillwork they're so famous for. Now, 5 years after Operation Full Stop began, the situation doesn't seem nearly as dire. It looks as though Formosan populations can be managed. The program's coordinators stress one of the most critical lessons they have learned from their research: the importance of having an offensive, areawide management approach.

"Areawide management is key," says Alan Lax, leader of ARS' Formosan Subterranean Termite Research Unit at the Southern Regional Research Center (SRRC) in New Orleans. "We've been able to reduce termite numbers in the French Quarter because we're treating entire blocks, not just individual homes or businesses."

Frank Guillot, ARS' Formosan termite program coordinator, concurs. "We've been keeping track of alate numbers inside and outside the treatment zone since 1998, the year we began the program. In 1998, about 70 percent as many alates were captured inside the treatment zone as were captured outside. By 2002, that number had been reduced to 42 percent." Visual inspection of easily accessible areas of structures in the French Quarter since the beginning of the program indicated no evidence of newly active termites or the damage they can cause. But advanced technologies—infrared, acoustic, and motion-detection devices—are now being used to search for termites or their damage in areas not readily accessible.

Dennis Ring, an entomologist with the Louisiana State University Agricultural Center (LSU AgCenter) and principal investigator of the French Quarter program, explains that instead of applying repellent chemical barriers around buildings, participants are having baits or nonrepellent liquid termiticides installed around their properties. They're "playing offense" against the termites instead of defense, and it's working.

Encouraged by the program's success, researchers expanded the original 15-block treatment zone in 2002. Ring says, "Public participation in the original area is nearly 100 percent. We've moved out one block in all directions, so now we're covering close to 30 blocks. We've already got 60 percent of the properties in the expanded area into the program, and people continue to join up."

Says Lax, "Before Operation Full Stop began, there was this pervasive myth that you shouldn't pay for commercial termite treatments because they don't work. In fact, only 15 to 20 percent of the properties in the French Quarter had undergone any type of termite prevention program.

"We've shown property owners that termite treatments can be effective under the right conditions. Our latest estimate is that even outside our treatment zones, where homeowners receive no help from the program, 40 percent of the properties have undergone some type of treatment."

High-Tech Detection

Having access to highly sensitive instruments that can pinpoint exactly

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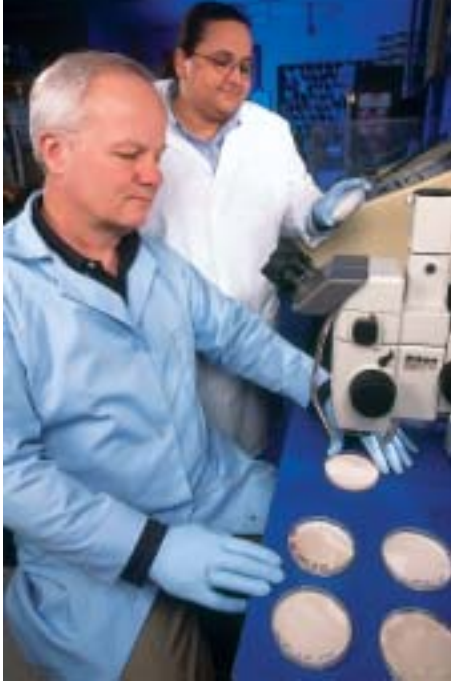
Formosan termites can infest railroad ties like this one. Termite Board entomologist Janet McAllister inspects a tie for termites and nests in New Orleans.



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Left: Cottony mold, *Paecilomyces fumosoroseus,* is proving very effective as a natural termite-control agent. ARS microbiologists Mark Jackson and Maureen Wright observe *Paecilomyces* cultures before exposing termites to the fungus.

Right: ARS technician Pete Levy (left) and LSU Agricultural Center cooperator Chris Morel inspect one of many in-ground stations placed throughout the New Orleans French Quarter to monitor the presence and activity of Formosan subterranean termites.

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where the termites are hiding is an important aspect of the offensive strategy. Jack Leonard of the New Orleans Mosquito and Termite Control Board (NOMTCB) has been using one such instrument in the field for several years. It's a thermal imager that can detect termites behind walls and in other hard-to-reach places. The late Bob Melia, who owned Real Time Thermal Imaging, helped develop the application. He died in 2001, but his family has continued running his business. Leonard uses the technology to evaluate different termite control projects sponsored by Operation Full Stop. Most recently, he checked schools in the Orleans Parish where control treatments took place.

"The thermal imager is a handheld device about the size of an 8-mm camcorder," explains Leonard. "It takes practice and experience in the field to read the black-and-white images, but we've had good success in detecting infestations. We hope to train more people to use it."

SRRC entomologist Weste Osbrink and Richard Mankin, an entomologist at ARS' Center for Medical, Agricultural, and Veterinary Entomology in Gainesville, Florida, have been focusing on a different type of technology to uncover termite infestations—acoustics. Osbrink is a termite expert, and Mankin is an expert at detecting insects by their sounds.

"We worked together to create a device that detects termites through the sounds they make as they're feeding on wood," says Osbrink. Although such devices are not yet in widespread use, they have great potential to help scientists and pest control operators manage the termite problem.

Additional research is being conducted by cooperators at the National Center for Physical Acoustics in Oxford, Mississippi, to develop technology and systems to detect termites or their structural damage.

Termite-ators: They'll Be Back?

Researchers involved in Operation Full Stop's Armstrong Park project have helped prove how important areawide management and constant vigilance are. Nan-Yao Su, an entomology professor at the University of Florida, and Matt Messenger, an entomologist with NOMTCB, lead the project.

New Orleans' Louis Armstrong Park covers about 31 acres and sits next to the north side of the French Quarter. Su and Messenger, with their cooperators, have been studying the foraging behavior of the park's 4 to 6 native subterranean termite colonies and 14 to 18 Formosan subterranean termite colonies. In one study, they determined how quickly other termites would reinvade an area after a single colony had been eliminated. Their work showed that if untreated, both Formosan and native colonies will begin to occupy vacated territory within days. Complete reoccupation by Formosan colonies may take as little as 6 months.

The scientists have just begun a new project. Su explains, "We're trying to eliminate all the termites in Armstrong Park so that we can see where new colonies will take hold. This will help us better understand the ecological succession of termite infestations. It will also help us focus on where future problems may occur in an areawide management approach."

Prime Target: Termites' Tastebuds

One of the most effective ways of getting rid of a termite colony is with a toxic bait matrix—a combination of materials that the pests like to eat and a slow-acting toxic agent that ultimately kills them. SRRC entomologists Juan Morales-Ramos and Guadalupe Rojas are experts on termite nutritional preferences, and they have created several matrix formulations.

Rojas says, "In the lab, we have hundreds of petri dishes filled with termites, and we use the termites like sensory panelists. We feed them different nutrient

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Left: Underground monitoring stations are installed in New Orleans' Louis Armstrong Park. Aaron Mullins, an entomologist with the New Orleans Mosquito and Termite Control Board, checks for termite activity in the monitors.

Right: In spring, alate traps are placed on lampposts throughout the French Quarter to monitor mating Formosan subterranean termites. Chris Morel (left) and student worker David Cox inspect an alate trap.

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mixtures to find out what they like to eat best."

In October 2002, Rojas and Morales-Ramos completed a 2-year, areawide, bait matrix study in residential Mississippi neighborhoods in Poplarville, Picayune, and Biloxi, at Keesler Air Force Base. The research was done with entomologist David Nimocks, president of Ensystex of Fayetteville, North Carolina. The scientists have a cooperative research and development agreement with Ensystex, and ARS has granted an exclusive license to the company to manufacture the bait matrix. Other collaborators included scientists from Mississippi State University's Coastal Research and Extension Center, including David Veal, head of the center; researchers Christine Coker and Patricia Knight; and research associates Margaret Lockwood and Larry Etheridge.

Mississippi has a growing Formosan termite problem, although populations there aren't nearly as dense as they are in New Orleans. Using an ARS bait matrix containing chlorfluazuron, ARS and Ensystex researchers were able to reduce native and Formosan termite activity by 95 percent in one test area in Picayune. In a related study, they found that one of their bait matrices, which incorporates diflubenzuron, was also effective against red imported fire ants. These pests must be controlled in and around bait sites because their presence repels the termites. And fire ants are another major urban pest. Having filed a patent application on the ant bait matrix, the scientists are currently working with Ligia Hernandez, product development manager for Waterbury Co., Inc., Independence, Louisiana, which has applied for a license for its manufacture.

Rojas says that they have started new experiments in cooperation with MSU, Ensystex, Waterbury, and James M. Spiers and Formosan termite personnel at ARS' Small Fruits Research Unit in Poplarville. The goal is to focus even more attention on integrated methods to best control both termites and ants.

Termites vs. Essential Oils and Mold

By studying different plant extracts, entomologist Gregg Henderson at the LSU AgCenter has found compounds that are effective against termites and other insects, including red fire ants, mosquitoes, ticks, and cockroaches. One such compound, nootkatone, is derived from essential oils in vetiver grass.

Recently, Henderson and his collaborators have been evaluating how well compounds such as nootkatone work to protect wood from Formosan termites. Results have been promising. Henderson says the compounds seem to affect termites' neurotransmitters and stop their movements. If further experiments prove successful, these essential oils could replace chemicals such as copper, chromium, and arsenic currently used to treat lumber against insect attack.

At ARS' Natural Products Research Unit in Oxford, Mississippi, chemists are extracting natural compounds from other sources, seeking new active ingredients that could act as termiticides or form the structural basis for developing such ingredients.

SRRC microbiologist Maureen Wright has been having good success with a natural termite control agent. It's derived from a cottony mold called *Paecilomyces fumosoroseus*. Wright heard about its biological control abilities from Mark Jackson, a microbiologist with ARS' National Center for Agricultural Utilization Research, in Peoria, Illinois.

Jackson had developed an efficient and relatively inexpensive way to produce large amounts of the fungus to control whiteflies, aphids, and other agricultural pests. Wright tested samples of the mold against Formosan termites and came away with impressive results: It killed 100 percent of the termites in less than a week.

Wright has demonstrated that termites exposed to the mold transfer it to other

members of their colony. She's also shown that it can be effective in various settings. Retired SRRC chemist Bill Connick helped develop several application formulations. A termite-infested tree, for instance, might require a different application method than a wooden structure. ARS is currently negotiating with a company that wishes to license the technology.

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Termites living in railroad ties could reinfest treated areas of New Orleans. NOMTCB termite inspectors Gustavo Ramirez (foreground) and John Stennett remove monitoring devices to count termites and score wood consumption.

What Makes Termites Tick

Besides developing new methods of termite control, Operation Full Stop scientists have also been learning more about the Formosan termite's basic biology. Entomologist Ashok Raina leads a group within the main termite research unit at SRRC. His group observed and recorded, for the first time, mating in the Formosan termite. They also discovered a contact sex pheromone in the female's tergal gland—the first time such a pheromone has been identified for any termite species.

Recently, Christopher Florane, a University of New Orleans graduate student who has been working with Raina's group, discovered new information about why termite colonies attack each other. He found that the basis of aggression was the type of wood eaten by the termites. Only when two termite colonies feed on two different types of trees do they become aggressive toward each other. Florane's abstract and presentation about his finding won a President's Prize at the Entomological Society of America's national meeting in Fort Lauderdale, Florida, in November 2002. He is currently working with Raina to determine exactly how changes in diet trigger aggression.

Termite Research Chugs Along

Also in 2002 . . . NOMTCB entomologist Janet McAllister began a new study—in cooperation with Dow AgroSciences—that may eventually help the New Orleans termite control zone grow still larger. She and her collaborators are trying to find the best way to treat railroad ties that could be serving as huge Formosan termite reservoirs.

McAllister explains, "There are two railroad lines running next to the French Quarter and the Mississippi River that fall outside the current Operation Full Stop treatment zone. The railroad ties are treated with creosote, but where the ties have cracked, termites have invaded untreated pockets of wood inside."

The termites that live in the wooden ties might eventually move right back into the areas where other Formosan termite populations have been reduced. McAllister and her team are focusing on a little less than a mile of track and have already counted eight separate colonies in the study area. They plan to test different types of baits and toxins, placing them at varying intervals along the tracks to see which configuration works best. She expects the project to last several years.

Edgar G. King, Jr., ARS' Mid South Area director, who's been with Operation Full Stop from the beginning, says, "I am pleased with all the cooperation we've received from our partners in the program. Their contributions have been critical to successes in the Vieux Carré, Armstrong Park, and south Mississippi. Fundamental research on the termite's biology and ecology, development of new technologies like the bait matrices and detection devices, and discovery of new chemical and biological control agents will all help ensure sustained control of this destructive pest. Our goal now is to implement these measures throughout larger areas and eliminate the Formosan subterranean termite as a pest of dwellings in these treated areas."—By **Amy Spillman,** formerly with ARS.

This research is part of Arthropod Pests of Animals and Humans, an ARS National Program (#104) described on the World Wide Web at www.nps.ars.usda.gov.

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