Potential Biological Control Agents for the Red Imported Fire Ant

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The red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae), arrived in the United States, with few parasites or pathogens that attack this pest in its native home of South America (Wojcik 1998). Lack of natural enemies is believed to be one factor that has allowed the red imported fire ant to spread and dominate the landscape Porter 1998). Fire ant densities are five times greater in the U.S. than in South America, where this pest is attacked by many different natural enemies. Biological control, the use of natural enemies to suppress pest populations, offers an opportunity to re-establish these natural enemies with the introduced pest(s) or augment these natural enemies in the U.S. and reduce the impact of the red imported fire ant. Biological control is one area funded for expanded research under the Texas Fire Ant Research and Management Plan (see Brochure, “”Red Imported Fire Ant Highlights 1997-2003).

How Is Biological Control Accomplished?

Biological control can be pursued through the introduction and establishment of new natural enemies or by mass-rearing and periodically releasing new or existing natural enemies. The first approach is termed **importation biological control**.

The first step is to search for promising natural enemies in the ant’s native home. Only natural enemies that attack the red imported fire ant, and not ants native to the U.S., are considered for importation and release. This is important because native ant species compete with imported fire ants for food. Native ants also attack and kill young fire ant queens as the queens begin to establish colonies in new territories.

The importation of exotic natural enemies must be approved by the U.S. Department of Agriculture-Animal and Plant Health Inspection Service. Once approved for importation and release in the U.S., the natural enemy is reared in large numbers and released at multiple locations during several years. The goal of importation biological control is to establish permanent and effective populations of the natural enemy. Establishment of the natural enemy at effective levels eliminates the need for further mass-rearing and release, which is expensive.

Some imported natural enemies may be effective but fail to establish permanent populations. Other natural enemies may be already present in the U.S. but occur in numbers too small to provide effective control. In these cases, it may be possible to mass-rear the enemy and periodically release it to increase the level of biological control. This activity is termed **augmentation biological control**.

This approach requires rearing procedures that maintain the genetic characteristics necessary for the natural enemy to be effective when released in the field. Some natural enemies, especially pathogens, may be formulated and applied much like an insecticide.

How Does Biological Control Work?

Pathogens, predators, and parasites can impact fire ant populations directly by killing ants or indirectly by making them less competitive with native ants. Native fire ants compete with red imported fire ants for food. Also, native ants feed on fire ant queens and can eliminate colonies while they are still small. Currently, most of our native ant species cannot compete effectively with fire ants and are soon overwhelmed. If imported natural enemies reduce the fire ant’s ability to forage for food, reproduce, or disperse, then native ant species may gain a competitive edge and suppress fire ant densities.

A combination of several natural enemies will likely be necessary to shift the balance in favor of native ants. Establishing new enemies and developing methods for augmenting natural enemies of the red imported fire ant require long-

term commitments to research and development. Even then, natural enemies alone are not expected to control fire ants. Rather, biological control will be one part of an **integrated pest management** program that will likely include selective insecticides, cultural practices, and other control methods (see Brochure, "Areawide suppression of fire ants", USDA-ARS).

Natural Enemies of the Red Imported Fire Ant

The following is a list of pathogens, predators and parasites under study for potential use as biological control agents. Most are in the early stages of research. A few species have been released in limited numbers under controlled conditions. None are yet available for general distribution.

Thelohania. *Thelohania solenopsae* is a microscopic protozoan that infects immature and adult fire ants. Diseased ants, including queens, have shorter life spans, and over a period of several months to a year, the colony declines. The pathogen is apparently transmitted by diseased ants moving between multiple-queen colonies. *Thelohania* attacks only the exotic red and the black imported fire ant and does not attack other ant species native to the U.S.

In Argentina, about 20 percent of the red imported fire ant colonies are infected. Surveys in the U.S. did not detect this disease organism until 1997, when it was discovered in Florida. Since then, *Thelohania* has also been found in Texas and Mississippi. Research is under way to discover ways to increase the impact of this pathogen and culture it in the laboratory and the field (Williams et al. 1999).

Beauveria. *Beauveria bassiana* is a common fungus that attacks many species of insects. A strain of *Beauveria* that attacks the imported fire ant was reported from Brazil in 1987. This fungus produces microscopic spores that attach to the ant's body, germinate, and grow inside the ant. The fungus feeds on the internal organs of the ant. The ant soon dies, and its body is filled with a fungal growth. The fungus sometimes grows outside the dead ant, covering it with a white, fuzzy growth. Studies have shown that *Beauveria* applied to the soil is much less effective than if the spores are applied directly to the ants. The application of *Beauveria* to fire ant baits is being investigated (Bextine & Thorvilson 2002).

Phorid flies. Phorid flies (*Pseudacteon* species) are small flies that parasitize fire ants. The adult flies are about 1/16 inch long and fly rapidly. They hover above disturbed mounds or along foraging trails waiting for an opportunity to swoop down and deposit an egg on a fire ant worker. Once on the ant, the egg quickly hatches into a tiny maggot, which bores into the fire ant. The maggot feeds inside the ant for about three weeks before the parasitized ant dies. During the final stage of attack, the maggot consumes all of the head's contents and transforms to the pupa stage. The ant's head then falls from its body as enzymes produced by the parasite dissolve the connecting tissue. The adult fly emerges from the ant's head about three weeks later.

Typically, phorid flies parasitize only 1 percent to 3 percent of the native fire ants, and this alone has little impact on fire ant numbers. The flies' effect on ant behavior is more important. Fire ant workers quickly recognize when phorid flies are present and either attempt to escape underground or assume a defensive posture. The presence of only three to four flies is sufficient to disrupt ant activity.

As a result, ants attacked by phorid flies spend less time searching for food. Other ant species, not attacked by the phorid flies, benefit by the greater food resource available to them. Thus, the decline in food collection and increased competition from native ants has a much greater negative impact on a fire ant colony than does death of a small percentage of worker ants actually parasitized. It is expected that red imported fire ants in the U.S. will respond similarly to introduced phorid flies as do the red imported ants in South America.

The phorid flies native to the U.S. attack only the native fire ant species, *Solenopsis geminata.* There are about 15 species of *Pseudacteon* in Brazil and Argentina that attack the red imported fire ant and several of these species are being evaluated for rearing and release in the U.S. It is expected that those phorid species that attack ants foraging for food will be more effective than those fly species that attack ants only at disturbed mounds. Mass rearing techniques are being developed, and one exotic species was released by the USDA-ARS in Florida in 1997. Researchers at the University of Texas also have released an exotic species in Texas, *Pseudacteon tricuspis* Borgmeier (Porter & Alonso 1999). Studies are under way to determine if the released species

survive. Additional releases are planned as flies become available.

Parasitic ant. *Solenopsis daguerri* is an unusual ant species that takes control of the fire ant colony by parasitizing the fire ant queen or queens. The parasitic ant enters the fire ant colony and is not killed because it produces the same pheromone (chemical signals) that fire ants use to recognize their fellow nest mates. The parasitic ant seeks out a fire ant queen, crawls on top of her, and grasps her tightly with its legs and jaws. A fire ant queen can become "yoked" by two or three parasitic ants. Each parasite produces queen pheromones that allow it to masquerade as a fire ant queen. Thus deceived, the worker fire ants proceed to feed the parasite and tend the eggs it produces. The fire ant queen, left untended by the workers, gradually stops laying eggs and starves to death. Fire ant workers rear the parasitic ant eggs and soon the fire ant colony becomes a colony of parasitic ants. Emerging parasitic ants, which are all queens (no worker ants are needed) leave the colony in search of new fire ant colonies to parasitize. In South America, the parasitic ant is present in about 1 percent to 4 percent of the fire ant colonies. The parasitic ant is currently in quarantine in the U.S. Researchers are developing methods to rear sufficient numbers of the parasite for eventual release in the U.S.

Strepsiptera. Strepsiptera are minute insects that parasitize other insects. One species, *Caenocholax fenyesi*, attacks the red imported fire ant in the U.S. Like other Strepsiptera, *C. fenyesi* has a complex and unusual life cycle. The female parasitizes a species of bush cricket, *Hapithus agitator*. Once the immature parasite has consumed the cricket, she develops into the adult stage. However, the adult female never leaves the dead cricket. Rather, she produces thousands of eggs that hatch into larvae called triungulins. The tiny, flattened triungulins leave the female and search for new hosts. While female triungulins must find another bush cricket, male triungulins develop in fire ant adults. Once a male triungulin attaches to a passing fire ant, it burrows into the ant to feed and develop. Parasitized fire ants typically climb to a high perch where they soon die. The adult male Strepsiptera then emerges from the dead fire ant. Only about 1 percent to 2 percent of the fire ants in a colony are parasitized by *C. fenyesi* in Texas.

Orasema. Species of *Orasema* (Eucharididae) are tiny wasps that parasitize immature fire ants. Female *Orasema* wasps lay large numbers of eggs on plant leaves and buds. The eggs hatch into tiny flattened larvae called planidia. The planidia lie in wait and attach to passing ants. Once in the ant colony, the planidia leave the worker ant and attach to ant larvae. When the ant larva pupates, the planidia consumes the ant pupa. Typically, only a small percent of the fire ants are killed by *Orasema*. Several species of *Orasema* parasitize the imported fire ant in South America, and several other species of *Orasema* occur in the U.S. Research is under way to learn more about these ant parasites and to develop mass-rearing techniques.

Nematodes and mites. Certain nematodes (*Steinernema carpocapsae* and *Heterorhabditis* species) also attack and parasitize red imported fire ants, and other insects (see FAPFS012). Ants in treated colonies often leave the nesting site or mound and move to a new location (Drees et al. 1992). However, field evaluations of commercially available species/strains of these parasites currently being marketed for fire ant control have not yet been conducted to demonstrate their effectiveness.

The straw itch mite, *Pymotes tritici*, is a native external parasitic mite of insects that does not normally attack fire ants. However, when applied in large numbers to fire ant colonies under laboratory conditions, straw itch mites will feed on immature ants. Published field research evaluating commercially available straw itch mites applied as directed to fire ant colonies have reported insignificant levels of control (Thorvilson et al. 1987). Moreover, the straw itch mite is widely regarded as a pest and, as its name implies, can cause skin irritation in humans.

The *Pymotes* mite and parasitic nematodes have been available for sale as individual mound treatments. Their high cost may prohibit large-scale use. Also, their effects, if any, are generally limited to the treated ant colonies and are not expected to persist in the environment or spread from colony to colony. However, additional research may improve strains and delivery methods of the nematodes and mites to make them effective biological control agents.

Some Potential and Natural Enemies of Red Imported Fire Ants

Pathogens

- *Thelohania solenopsae* (Protozoa: Microspora: Thelohaniidae). Produces large cysts in adult ants; found in adult and immature ants.

- *Vairimorpha invictae* (Protozoa: Microspora: Burenellidae). Does not produce cysts; found in adult and immature ants.

- *Mattesia geminata* (Protozoa: Neogregarinida: Lipotrophidae). Spores found in immature fire ants, and infected individuals die in the pupal stage.

- *Beauveria bassiana* (Fungi: Deutero-mycotina). A strain of this common fungus grows internally in adult fire ants and causes their death.

Parasites

- Parasitic fly. *Pseudacteon* and *Apodicrania* spp. (Diptera: Phoridae). Larvae are internal parasites, but few (1 percent to 3 percent) of the ants are parasitized. Egg-laying attempts by adult flies prevent daytime ant foraging behavior, providing time for native ants to forage.

- Parasitic ant. *Solenopsis daguerri.* (Hymenoptera: Formicidae). Workerless, obligate parasitic ant.

- Strepsiptera. Tiny insect parasites of fire ants.

- Parasitic wasp. *Orasema* spp. (Hymenoptera. Eucharitidae). Females lay eggs on plant tissue. After eggs hatch, the planidia (first stage larvae) are phoretic on worker ants. In the nest, planidia feed externally on ant pupae, and adult ants fail to emerge.

- Nematodes. *Tetradonema solenopsis* (Nematoda: Mermithoidea: Tetradonematidae). Commercially available species include *Steinernema caropcapsae* and *Heterorhabditis heliothidis*.

- Mites. *Pyemotes ventricosus* (Acarina: Pyemotidae). Common in the U.S. These mites are not normally found attacking fire ants but will feed on fire ants if applied in large numbers.

Predators

- Several different kinds of insects live in fire ant colonies and feed on immature ants. These include species of beetles (Scarabaeidae, Histeridae and Chrysomelidae), true bugs (Hemiptera: Lygaeidae) and silverfish (Thysanura). None of these are being considered at this time as biological control agents.

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For more information regarding fire ant management, see Extension publications B-6043, *Managing Red Imported Fire Ants in Urban Areas*; B-6076, *Managing Red Imported Fire Ants in Agriculture*; B-6099, *Broadcast Baits for Fire Ant Control*; or L-5070 *The Texas Two-Step Method Do-It-Yourself Fire Ant Control for Homes and Neighborhoods*. Also visit our web site at http://fireant.tamu.edu.