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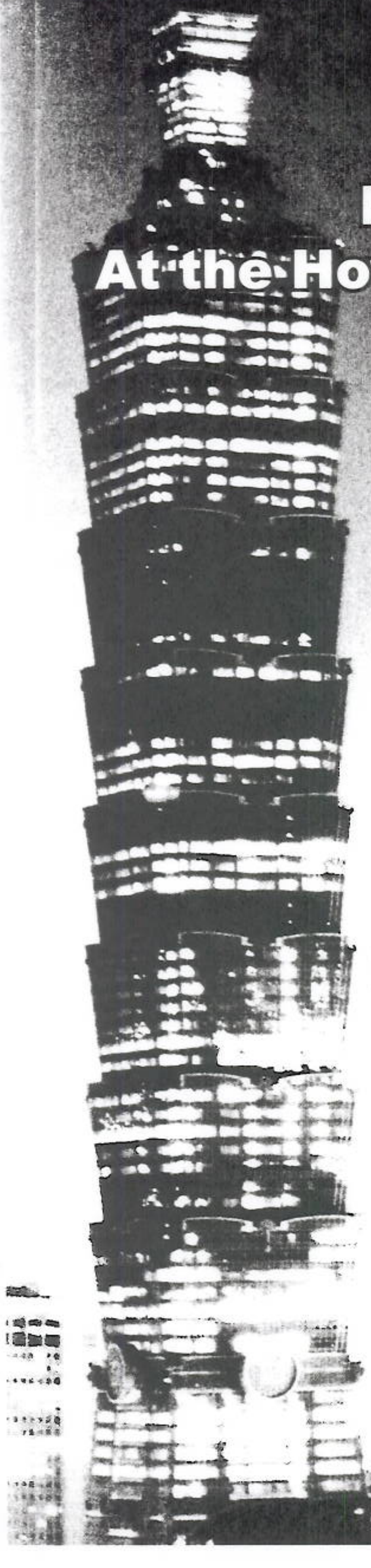

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Evolution of Fire Ant Control

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Abstract

The imported fire ants that entered the United States over 70 years ago have spread within the country to over 129.5 million ha. Efforts to stop the expansion and suppress fire ant populations have resulted in changing methods of control. Initial efforts focused on treating individual nests with highly toxic insecticides available at that time. Large-scale eradication and control programs saw a shift from aerial applications of the acutely toxic contact insecticide heptachlor, to applications of the less toxic mirex formulated into a bait. Unfortunately, mirex accumulated in the environment and its use was banned. However, mirex bait has served as a model for the development of currently available fire ant baits which contain more environmentally compatible active ingredients. Recently, insecticides with long residual activity against fire ants and fast-acting baits have become available, providing new options for the control of fire ants. Concurrent with the development of bait formulations for fire ant control, there was interest in the utilization of biological control agents. Within the last 10 years, the release and/or discovery of parasites and pathogens from South America in the United States, can potentially hamper fire ant populations. Fire ant management practices are evolving to integrate both chemical and biological controls to secure site-specific, long-term suppression of fire ants.

Introduction

Imported fire ants, *Solenopsis invicta* and *Solenopsis richteri*, are stinging, invasive ants from South America that continue to plague the southern USA. They now infest over 129.5 million hectares in the USA with *S. invicta*, being the predominate species. The majority of research and control efforts are for *S. invicta* (hereafter referred to as fire ants) and most control recommendations are applicable to both species. Fire ants are now a worldwide concern with infestations confirmed in Australia, Southeast Asia, and Mexico. The annual economic impact of fire ants in the USA is estimated to be over $6.5 billion USD (excluding lawsuits [see below]) across both urban and agricultural sectors. In addition, their dominance in natural ecosystems has reduced biodiversity and harmed wildlife. The painful, burning sensation that is inflicted by the sting of a fire ant is the most recognizable hazard to humans. While one sting is painful, it is not uncommon for a person to receive numerous stings simultaneously when ants swarm out of their nest to attack an intruder. This greatly intensifies the pain and can cause panic, thus, fear and anxiety of these ants can be present in heavily infested or newly-infested areas. In addition, it is conservatively estimated that 1% of stung individuals in the USA are allergic to the venom and at risk for anaphylaxis. Deaths from fire ant stings have been reported, and lawsuits have resulted in awards of over $1 million USD.

In the southern USA, eradication is no longer considered possible, and instead, integrated pest management (IPM) for fire ants is evolving. The evolution of fire ant control strategies is an interesting mix of politics and science. The nasty sting and ubiquitous presence of fire ants makes its control politically expedient, and hence, the availability of funding, makes fire ants the most intensely studied ant. The historical transition of fire ant control strategies in the USA is summarized in Table 1. The rapid and extensive spread of the stinging fire ant in the southern USA resulted in drastic attempts to eliminate or control the problem quickly. Unfortunately, fire ants, with their tremendous reproduction, mobility, and ability to occupy a wide range of habitats, made eradication highly unlikely. With eradication in the southern USA no longer an option, greater emphasis was placed on basic biological research which ultimately improved control methods. Fire ant bait technology has improved with different active ingredients providing more flexibility in developing IPM programs for fire ants. Molecular tools have been used to find new fire ant pathogens such as viruses. The utilization of biological control agents offers the potential of self-sustaining suppression of fire ant populations.

With the expansion of global commerce, introductions of fire ants into new areas are likely to continue. The fire ant invasion of the USA has provided valuable lessons, technology, and knowledge on fire ant control and biology. This has provided a basis for the ongoing development of fire ant IPM as well as recent eradication programs. Furthermore, the fire ant experience can serve as a blueprint from which informed decisions and responses can be formulated for other invasive ant species.

Table 1. Chronology of events related to imported fire ant control in the USA (adapted from Drees and Gold 2003).

Year	Chemical Control Events	Year	Biological Control Events
1918	Estimated arrival of black imported fire ant, *Solenopsis richteri*, into Mobile, Alabama, USA.		
1933	Estimated arrival of red imported fire ant, *Solenopsis invicta*, into Mobile, Alabama, USA.		
1937	Federal, state, and county control program treated individual nests with calcium cyanide dust on 800 ha in Alabama.		
1948	Chlordane dust used to treat individual nests in the states Mississippi, Alabama, and Louisiana.		
1957	State of Arkansas conducts 4858 ha eradication project with aerial application of heptachlor (2.24 kg AI/ha). U.S. Dept. Agriculture (USDA) begins a federal-state cooperative control and eradication program with aerial and ground applications of heptachlor and dieldrin (2.24 kg AI./ha).		
1958	Fire ant quarantine implemented by the USDA		
Early 1960s	Heptachlor rate lowered to 0.28 kg AI./ha with 2 applications 3 and 6 months apart; Federal-state control and eradication program ends due to detrimental effects to wildlife, contamination of food and crops.	1962-69	Parasitic ant, *Solenopsis (Labauchena) daguerrei* evaluated in South America as a potential biocontrol.agent, but never introduced into USA.
1961-3	Fire ant bait containing active ingredient mirex developed and refined.		
1962-78	Mirex bait to applied to 56.7 million ha from the ground and aerially (often, bait applied three times to the same area; thus, approximately 19 million ha actually treated).		

(Table 1 continued) Chronology of events related to imported fire ant control in the USA.

Dates	Chemical Control Events	Dates	Biological Control Events
1967-70	Feasibility studies of using mirex bait to eradicate imported fire ants initiated by USDA, which concluded "…that technical problems we did encounter are surmountable and, therefore, total elimination of IFA [imported fire ants] from large isolated areas may be technically feasible" (Banks et al. 1973). However formal eradication program never implemented due to environmental concerns [see below], yet aerial bait applications continued to suppress fire ant populations [see 1962-78].		
Late 1960s	Mirex residues found in environment, non-target organisms, and toxic to estuarine organisms.		
1970-1	U.S. Dept. of Interior bans all mirex uses; U.S. Environmental Protection Angecy (EPA) issues notice of cancellation of mirex.	1971-9	Natural enemy surveys in South America and USA.
1977	Mirex reported to be a potential carcinogen; EPA cancelled registrations 31 December.	1973	Microsporidian (protozoan) pathogen of fire ants *Thelohania solenopsae* found in Brazil.
1978-80	Amdro® (hydamethylnon) fire ant bait developed with registration in 1980.		
1983	Prodrone, first insect growth regulator (IGR) registered by EPA.		
1985	Logic® (fenoxycarb), another IGR, registered by the EPA.		
1986	Ascend®/Affirm® (abamectin) registered by the EPA.	1986	Microsporidian (protozoan) pathogen of fire ants, *Vairimorpha invictae*, from South America described.

(Table 1 continued) Chronology of events related to imported fire ant control in the USA.

Dates	Chemical Control Events	Dates	Biological Control Events
1986-95	Site-specific, goal-oriented IPM programs and the Two-Step Method (broadcast bait application followed by treatment of hazardous nests with faster-acting contact insecticides) for fire ant management developed and widely adopted.	1987-2003	Isolates of the insect pathogenic fungus *Beauveria bassiana* evaluated as biopesticides and biological control agents.
1993-7	Community-wide fire ant management demonstrated.		
		1996-2007	*T. solenopsae* found in USA; infections widespread in multiple queen fire ant populations.
1998	Fire ant baits containing IGRs pyriproxifen and methoprene registered. Methoprene bait can be applied in croplands, unlike other available baits.	1997	Fire ant decapitating phorid fly, *Pseudacteon tricuspis*, released and establishes in the USA.
		2001	Fire ant decapitating phorid fly, *Pseudacteon curvatus*, released and establishes in the USA.
2000	Fire ant baits containing spinosad and fipronil registered by EPA. Contact granular fipronil product was registered; has residual activity that inhibits re-infestation for several months.	2002-3	A protozoan, *Mattesia sp*., and two fungi found in fire ants collected in the USA.
		2003-6	Fire ant decapitating phorid fly, *Pseudacteon litoralis*, released, and established (Alabama).
2000-4	Unsuccessful eradication attempt in California.		
2004	Fire ant bait with indoxacarb registered by EPA, provides faster control than typical fire ant baits.	2004-7	Fire ant viruses SINV-1 and SINV-2 discovered in fire ants from the USA.
		2005	Nematode, *Allomeris sp*. discovered in fire ants in Argentina.
2000-7	Efforts to demonstrate fire ant control via integration of biological controls and insecticides.		

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