Mississippi Areawide Fire Ant Suppression Program: Unique Aspects of Working with Black and Hybrid Imported Fire Ants[1]

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ABSTRACT Chemical and biological controls for imported fire ants (*Solenopsis invicta* Buren, the red imported fire ant, *S. richteri* Forel, the black imported fire ant, and their hybrid) are being investigated and demonstrated in a multistate, multiagency Areawide Management Program. The Mississippi component of the program offers the unique opportunity to implement the latest control technologies against monogyne (single queen) black and hybrid imported fire ant colonies because sites in the other participating states (Florida, South Carolina, Texas, and Oklahoma) are dominated by polygyne (multiple queen) red imported fire ant colonies. Several observed and potential differences were examined between populations of black/hybrid fire ants and populations of red imported fire ants. Lower nest density of monogyne black and hybrid fire ant populations (range = 19–52% of mean nest density at other sites) required modification of sampling protocols. *Pseudacteon curvatus* Borgmeier (Diptera: Phoridae), a phorid fly collected from Las Flores, Argentina, where *S. richteri* is present, was established at the Mississippi sites because it preferentially attacks black and hybrid imported fire ants; at the other sites, *P. tricuspis*, a phorid that parasitizes red imported fire ants, has been released. Other potential differences in management of black, hybrid, and red imported fire ants are discussed.

KEY WORDS *Solenopsis invicta*, *Solenopsis richteri*, phorid flies, *Thelohania*, biological control

Areawide Pest Management Programs are conducted by the US Department of Agriculture's Agricultural Research Service (ARS) against various insect pests, with the overall goals of reducing costs to homeowners and producers, reducing worker risk, reducing environmental impact of pest management practices, and establishing sustainable biological controls. The Areawide Fire Ant Suppression program in Florida, Mississippi, South Carolina, Texas, and Oklahoma (http://www.ars.usda.gov/fireant/index.htm; last accessed 13 May 2004) involves the use of biological control organisms in an attempt to prolong the effective life of

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insecticidal bait treatments. Specific objectives include release and spread of natural enemies of fire ants, integration of baits and biological control to obtain 80% reduction of fire ants over large areas, and restoration of ecological balance in the environment by reducing population densities of invasive fire ants.

Mississippi Study Sites

Implementation of the Areawide Fire Ant Suppression program in northern Mississippi provides a unique opportunity to study black and hybrid imported fire ants [*Solenopsis richteri* Forel (BIFA) and *S. invicta* × *richteri* (HIFA) (Hymenoptera: Formicidae), respectively], and to apply the latest control technologies against them. Although study sites in other cooperating states are dominated by polygyne (multiple queen) red imported fire ant [*S. invicta* Buren (RIFA)] colonies, study sites in Grenada County, Mississippi (control; bait only), and Clay County, Mississippi (treatment; bait + biological control), contain a mixture of monogyne (single queen) BIFA and HIFA colonies (D.A. Streett, unpublished data). The Mississippi study sites are all grazed pasture, primarily fescue (*Festuca* sp.) and Bermuda grass [*Cynodon dactylon* (L.) Pers.] with mixed grasses and forbs. All sites consist of a large central area that receives aerial insecticidal bait applications as necessary to keep fire ant populations below a treatment threshold (10% of original mound density), and a peripheral area that receives nothing (control sites) or biological control organisms (treatment sites; Fig. 1).

Imported Fire Ant Species

Published information on the biology and ecology of black and hybrid imported fire ants is scarce relative to published reports on red imported fire ants (*S. invicta* Buren; RIFA). Until 1972, black, red, and hybrid fire ants were not differentially recognized in the United States. Wilson (1951) noted the presence of three forms of imported fire ants, a black form, a red form, and intermediates; by 1949 the black form was restricted to the periphery of the range of imported fire ants in the U.S., and the red form was rapidly expanding. References to *S. saevissima* in the U.S. continued through at least 1971 (e.g., Markin et al. 1971), and in 1972 two separate species were recognized, although hybridization was not detected at that time (Buren 1972). *Solenopsis invicta* × *richteri* was recognized when Vander Meer et al. (1985) characterized cuticular hydrocarbons and venom alkaloids of *S. invicta*, *S. richteri*, and their hybrid. A search of CAB abstracts (CAB International Publishing, Wallingford, UK) from 1986 to the present yielded 654 hits for *Solenopsis invicta* versus 72 hits for *Solenopsis richteri*. Despite the difference in the amount of work devoted to the two species, BIFA are no less of a pest than RIFA where they occur in the U.S. Several potential differences between RIFA, BIFA and HIFA were considered at the outset of this study. Areas of interest that might affect the implementation or outcome of the Areawide program in Mississippi included sampling and treatment thresholds (nest density and dispersion, and temperature relations) and biological control agents (parasitoids, pathogens, social parasites).

Mound Density

Pretreatment mound densities at all the experimental sites are summarized in Table 1. Estimates are based upon absolute counts of mounds in 0.05 ha circular

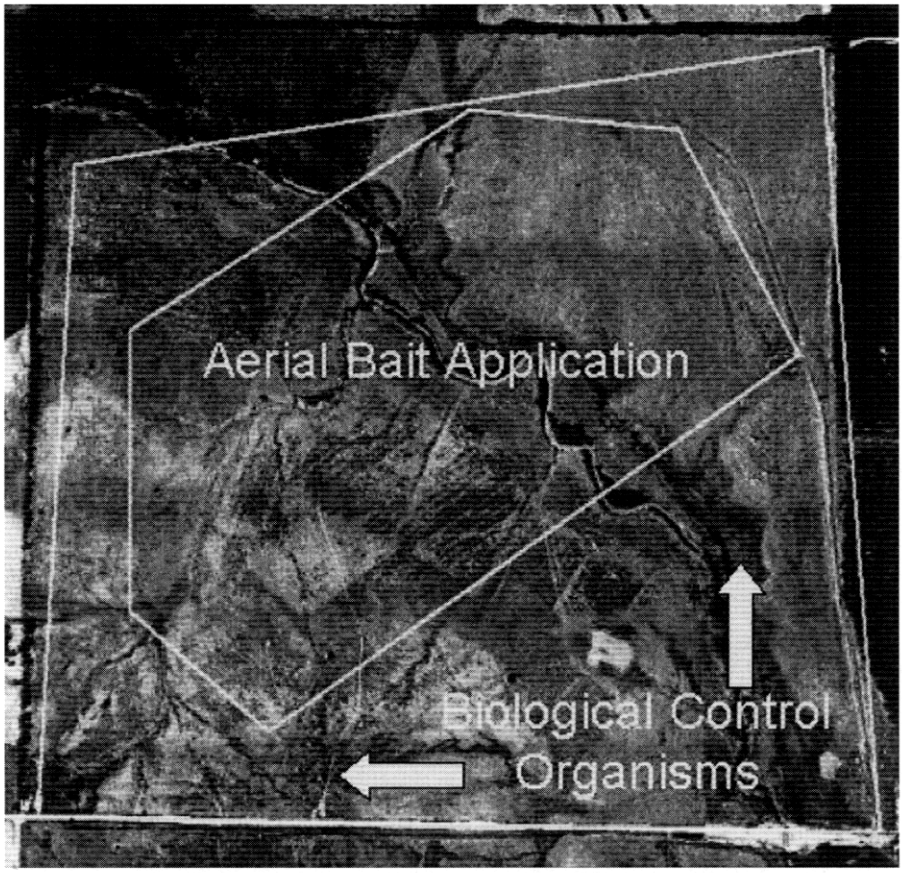

Fig. 1. Aerial digital mosaic of Clay Co., Mississippi Areawide Fire Ant Suppression site (Knox Farm). Image is slightly greater than 1.6 km on a side. The inner area bounded by the white line receives aerial bait application; biological control agents (phorid flies and microsporidia) are released in the area between the inner area and the outer boundary. Image copyright © GeoVantage, Inc.

plots (Florida, Texas, South Carolina, and Oklahoma) or 0.1 ha circular plots (Mississippi). Estimates of mound density at the Mississippi sites are relatively low in comparison to some published reports on RIFA [e.g., >250 mounds/ha, monogyne RIFA (Diffie & Bass 1994) and 475 mounds / ha, polygyne RIFA (Macom & Porter 1996)], and in comparison with the other sites. A wide range of mound densities (mounds / ha) was recorded at the Areawide Program sites [40 to 560 (Mississippi), 240 to 1,880 (Florida), 140 to 700 (South Carolina), 140 to 1,340 (Texas), and 140 to 720 (Oklahoma); R. M. Pereira, unpublished data)]. Low mean mound density at the Mississippi sites led us to increase the size of circular subplots to record a sufficient number of mounds per plot.

Table 1. Mean pretreatment imported fire ant mound counts at Areawide Fire Ant Suppression study sites.

State	Site	N	Mean mounds/ha ± SD
Mississippi	Knox	50	145 ± 133
Mississippi	Prima	50	87 ± 61
Mississippi	Torrance	50	107 ± 36
Mississippi	Woodland	50	158 ± 60
Florida	Marianna	50	558 ± 446
Florida	Gainesville	50	652 ± 235
Texas	NK Ranch	50	482 ± 205
Texas	Five Eagle Ranch	50	590 ± 298
South Carolina	Abbeville	50	284 ± 111
South Carolina	Fairfield	50	350 ± 109
Oklahoma	Treated one	50	298 ± 100
Oklahoma	Treated two	50	356 ± 163
Oklahoma	Control	50	241 ± 120

Temperature Effects

Temperature relations in *S. richteri* and *S. invicta* × *richteri* have been the subject of physiological and behavioral studies and are important in terms of timing of bait placement (for control or for monitoring ant numbers). Optimal foraging temperature for *S. invicta* × *richteri* (about 29°C at 2-cm soil depth; J. T. Vogt, unpublished data) is similar to the optimal temperature for RIFA (Porter & Tschinkel 1987, Vogt et al. 2003); therefore, the baiting regimes applied to experimental sites with RIFA should yield similar results for sites with BIFA/ HIFA. Diffie & Sheppard (1989) detected no difference in supercooling abilities of red, black, and hybrid imported fire ant, but James et al. (2002) noted increased survival of HIFA relative to RIFA and BIFA following prolonged low temperature exposure. Interesting physiological differences may exist between the species and their hybrid but they do not seem to be reflected in temperature/foraging relations.

Parasitoids

Dipteran parasitoids in the genus *Pseudacteon* (Diptera: Phoridae) are an integral part of the Areawide program. Porter & Briano (2000) discovered that a strain of *P. curvatus* Borgmeier from Argentina strongly preferred BIFA to RIFA, with an intermediate preference for HIFA. This strain of *P. curvatus* was rapidly introduced and established in one of the Mississippi Areawide treatment sites (Vogt & Streett 2003), and has since been recovered at the second treatment site (J. T. Vogt, unpublished data). The other states involved in the program have released *P. tricuspis*, which exhibits a strong preference for RIFA. There are some interesting differences between the phorid species that may have implications for the Areawide program. For example, *P. curvatus* tends to attack very small fire ant workers, while *P. tricuspis* attacks medium workers (Morrison et al. 1997).

Wuellner et al. (2002) documented *P. curvatus* attacking isolated ants, and *P. tricuspis* attacking loosely grouped ants. This may have implications for the overall indirect effect of these parasitoids on ant activity and colony growth. Finally, *P. tricuspis* has been observed attacking worker ants along foraging trails and at disturbed mounds (Orr et al. 1997), and *P. curvatus* has been documented attacking only at disturbed mounds (Wuellner et al. 2002). Additional observation of the behavior of *P. curvatus* in the field is necessary to confirm this.

Pathogens

The other biological control organism currently being used in the Areawide program is the microsporidian *Thelohania solenopsae* Knell, Allen and Hazard (Microsporida: Thelohaniidae). This intracellular parasite of fire ants can cause smaller colonies and lower worker weight relative to uninfected colonies in RIFA (Williams & Oi 1998). To date, attempts to introduce this pathogen into HIFA and BIFA colonies at the Mississippi Areawide site have not resulted in spread of the pathogen between colonies (DAS, unpublished). Briano et al. (2002a) found that *T. solenopsae* infects South American RIFA and BIFA colonies at similar rates; however, field infections in the U.S. tend to predominate in polygyne RIFA areas (D. H. Oi, personal communication). Another microsporidian currently under consideration for release in the U.S. is *Varimorpha invictae* Jouvenaz and Ellis (Microsporidia: Burenellidae). In South America, *V. invictae* is more prevalent in RIFA than BIFA (Briano et al. 2002a).

Other Potential Biological Control Agents

A bacterium, *Wolbachia* sp., has been observed in RIFA and BIFA in South America (Shoemaker et al. 2000); however, the potential of this organism as a biological control agent has not been assessed. A recently discovered protozoan parasite tentatively identified as a *Mattesia* sp. may have biocontrol potential for RIFA (Pereira et al. 2002) but has not been observed in extensive observations of BIFA (RMP, unpublished). The social parasite *S. daguerrei* (Santschi) (Hymenoptera: Formicidae) can inhabit BIFA and RIFA colonies in South America, but attempts to artificially introduce and propagate the species in fire ant colonies have not been successful (Briano et al. 2002b), and, since this species can inhabit other *Solenopsis* spp. colonies, there may be host specificity concerns for release in the U.S.

Summary

Several differences exist between RIFA, BIFA, and HIFA that required consideration before implementing the Mississippi component of the Areawide Suppression of Fire Ants Project. For example, lower mound densities at the Mississippi sites required the use of larger subplots for sampling. In terms of biological control, the host-matching work of Porter & Briano (2000) allowed us to choose the phorid species best suited to our sites. Since comparative studies are lacking, attempts to establish additional parasites and pathogens at the Mississippi sites will yield new information on BIFA, HIFA, and potential for biological control.

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