Exotic Ants

Biology, Impact, and Control of Introduced Species

EDITED BY

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24

Control of the Introduced Pest *Solenopsis Invicta* in the United States

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Introduction

Two species of imported fire ants were introduced into the U.S. at Mobile, Alabama (Lofgren et al. 1975). The black imported fire ant, *Solenopsis richteri* (Forel), was introduced around the early 1900s while the red imported fire ant, *Solenopsis invicta* (Buren) probably entered in the late 1930s or early 1940s (Buren et al. 1974). The red imported fire ant (RIFA) is the most widespread of the two and presents the greatest problem. From Mobile, the RIFA have spread naturally by such means as mating flights and floating of colonies on rivers and streams after floods. Most importantly, the ant has spread artificially with the aid of man during shipment of nursery stock containing queens and small colonies. Currently, the RIFA infest more than 106 million hectares in 11 southern states and Puerto Rico.

Since their introduction, populations of *S. invicta* have not only expanded their range throughout the southeastern and southwestern United States, but the total number of colonies (mounds) has greatly increased, especially in states such as Texas which has a greater proportion of multiple queen (polygynous) colonies than colonies with a single queen (monogynous) (Porter et al. 1991).

S. invicta has become a serious pest of man throughout its range (Lofgren et al. 1975, Lofgren 1986, Adams 1986). They continue to spread with small infestations recently appearing in New Mexico, Arizona, California, and Virginia. The increasing incidence of the

polygyne (multiple queen) form poses additional problems not only to humans and agricultural crops, but also to wildlife, especially surface-active animals (Porter and Savignano 1990; see also Vinson, Chapter 21; Jusino-Atresino and Phillips, Chapter 22). The most serious problems occur when people who have been stung become hypersensitive to the proteinaceous component of the venom resulting in anaphylactic shock and death. For additional reviews on the impact of fire ants on man and his environment see Adams and Lofgren (1981), Adams (1986), Lofgren (1986), deShazo et al. (1990), and MacKay et al. (1992).

Wherever these ants have become established, they have caused serious problems by their stinging, mound-building, and feeding habits. Because of this, they have been the object of research and control efforts for more than 4 decades. When one considers the many problems that *S. invicta* have caused people, it is little wonder that methods for their control are very important.

Control

It seems that there are as many control recommendations for fire ants as there are fire ant colonies. These range from "home remedies" to "high tech". Most home remedies involve treating individual mounds with an assortment of products including gasoline and other petroleum derivatives, solutions of soaps and detergents, bleaches, wood ashes, vinegar, grits, yeasts, citrus peels and watermelon rinds. The "high tech" solutions involve the use of microwaves, electrical probes, and explosives, all of which are of dubious value in controlling fire ants. Also, another remedy is to dig up a mound and place it on top of another mound with the expectation that the ants will fight, thus eliminating both colonies. As with most home remedies, the large majority simply do not work. Some are not only ineffective, but can be dangerous to use and can cause damage to the environment (e.g. gasoline, other petroleum products, lye, bleaches, microwaves, and explosives).

Chemical. Chemicals are the most widely used and, for the present time, most effective control method available against fire ants. There are many chemicals and they can be applied in several ways but generally 2 approaches are used: (1) contact insecticide treatments with drenches, sprays, dusts, granules, aerosols, and fumigants, and (2) toxic baits. Both contact insecticide treatments and baits have advantages and disadvantages with the specific situation determining which to use.

Contact insecticide treatments. The first use of chemicals as contact insecticides for the control of fire ants began as early as 1937 with the use of calcium cyanide dust applied to individual mounds (Eden and

Arant 1949). Since that time numerous chemicals have been tried with mixed results. For a historical perspective of the early control programs with contact insecticides, see Collins 1992. Presently, there are several chemicals used against *S. invicta* as contact insecticides (Drees and Vinson 1991). The majority of contact insecticides presently registered for fire ant control are used in emulsifiable concentrate form as drenches. Other formulations of chemicals are used as pressurized sprays, dusts, granules, and fumigants. Boiling water can also be used to treat ant mounds (Tschinkel and Howard 1980), but gave poor control in tests against large mounds (D. F. Williams, unpublished data) and would be ineffective against multiple queen colonies. As always, caution should be used in handling all chemicals including hot water, which can cause serious burns. The following is a list of the advantages and disadvantages of using contact insecticides in treatments against fire ants. The advantages include: (1) fast kill; (2) only target ants are affected; (3) moisture and rainfall usually have little affect on treatments; (4) special equipment is not needed; and (5) excellent shelf-life. The disadvantages include: (1) too labor intensive for treating large areas; (2) soil type and moisture may affect treatment; (3) seasonal weather effects can influence control; (4) it is not easy to kill the queen(s) in the colony; (5) only ants in the mound are contacted, foraging workers usually are not killed; (6) it causes frequent colony movement requiring retreatment, and (7) a large amount of pesticide (active ingredient) is applied.

Broadcast treatments using toxic baits. Broadcast application of toxic baits is generally considered the most effective and efficient method to control numerous colonies over a large area and to maintain control for a long period (Williams 1983, Banks 1990, Collins 1992). The method of using toxic baits usually results in killing or sterilizing the colony queen(s) and this eliminates the entire colony. Because large areas are treated, this method can slow down reinfestation by the migration of colonies from untreated areas. Although mating flights will occur and newly-mated queens from these flights will inundate a recently treated area, several months are required before these new queens will produce incipient colonies of sufficient size to present a problem. For an extensive review of the development of toxic baits, the reader should refer to Lofgren et al. 1975, Williams 1983, Banks et al. 1985, Lofgren 1986, Banks 1990, and Collins 1992.

In 1957, the U.S. Department of Agriculture began a comprehensive search for an effective toxic bait against fire ants which resulted in the development of a bait containing the chemical, mirex (Lofgren et al. 1962, 1963, 1964).

In 1978, serious concerns regarding mirex residues in the environment led the U.S. Environmental Protection Agency to ban its use (Johnson 1976). The loss of mirex for the control of fire ants initiated a concerted effort to discover new chemicals, especially ones that were more environmentally acceptable. The difficulty of discovering chemicals for use as baits for fire ants can be explained by the fact that although more than 7,100 chemicals have been evaluated in the USDA's laboratory since 1958 (Williams 1983, Banks et al. 1992), only 5 have been commercially developed (Collins 1992).

New baits developed in the early to mid-1980s were based on a formulation similar to that of mirex bait, i.e., a chemical (the toxicant) dissolved in once-refined soybean oil and applied to a corn grit carrier (Williams et al. 1980; Lofgren and Williams 1982; Williams 1983; Banks et al. 1983, 1988). Because they degrade rapidly and leave no residues, the new toxicants are less hazardous to the environment. Some give excellent control when used as broadcast treatments against *S. invicta* (Collins et al. 1992). However, like all baits, they still present problems such as (1) the formulations are attractive to nontarget ants that may also feed on the bait and become similarly affected (Williams 1986), (2) the new baits are formulated with increased amounts of soybean oil (20-30% soybean oil versus 15% with mirex) which can cause dispersal and flowability problems (D. F. Williams, unpublished data), (3) the extremely small amount of total baits needed per hectare requires special equipment for application (Williams et al. 1983), (4) rancidity of the soybean oil can result in poor shelf-life of the formulations, and (5) the newer baits are higher in cost.

The toxic baits registered and currently available for control of imported fire ants are as follows: (1) Amdro (a.i., hydramethylnon--American Cyanamid,Wayne, NJ, USA); (2) Affirm or Ascend (a.i., abamectin--Merck & Co, Rahway, NJ, USA); (3) Bushwhacker (a.i., boric acid--Bushwhacker Associates, Inc., Galveston, TX, USA); and (4) Logic or Award (a.i., fenoxycarb--Ciba-Geigy, Greensboro, NC, USA). Three other chemicals (pyriproxyfen--Sumitomo Chemical Co., Osaka, Japan); sulfluramid (Griffin Corporation, Valdosta, GA); and teflubenzuron (Shell International Chemical Co., London, UK) have given excellent results in tests against *S. invicta*. However, none are currently registered for use against fire ants. Efficacy tests by researchers with the U.S. Department of Agriculture of several of these chemicals as baits in broadcast application is shown in Table 24.1. Most of the baits above are formulated by dissolving the active ingredient in once-refined soybean oil which is then impregnated on a corn pellet carrier for dispersal. These baits can act in several ways such as a stomach poison (Amdro,

TABLE 24.1. Efficacy of some chemicals tested as baits in broadcast applications against natural infestations of the red imported fire ant, *S. invicta*.

Chemical Name[a]	*Tradename(s)*	*N*[b]	*AI (g/ha)*	*% reduction in population index after weeks indicated.*[c] *6-10*	*12-14*	*16-18*	*>20*	*References*
abamectin	Affirm, Ascend	4	0.015-0.49	85	87	91	--[d]	Lofgren and Williams 1982
fenoxycarb	Logic, Award	11	6.2-25.1	94	96	84	92	Banks et al. 1983 Callcott and Collins 1992
hydramethylnon	Amdro	9	4.2-10.4	86	91	64	79	Williams (unpublished data) Banks et al. 1992
pyriproxyfen	Nylar	12	5.3-24.5	83	89	--[d]	87	Banks and Lofgren 1991
sulfluramid	----	8	6.7-10.1	93	92	92	79	Banks et al. 1992
teflubenzuron	----	3	0.051-0.2	77	85	83	--[d]	Williams and Banks (unpublished data)

[a] All baits were formulated in a soybean oil-pregel defatted corn grit mixture containing the active ingredients.
[b] N=Number of tests.
[c] See Lofgren and Williams 1982 for explanation of method of determining the population index. Percentages are means of the population index.
[d] Data not recorded for this period.

boric acid, and sulfluramid), an insect growth regulator (Logic or Award) or a reproductive inhibitor (Affirm or Ascend).

The advantages of using baits include: (1) they are easy to use; (2) soil types do not effect efficacy; (3) one or two treatments is generally sufficient for long term (several months to a year) control; (4) the toxicant is spread to all members of the colony therefore, colony movement is not a problem; and (5) treatment requires a very small amount of toxicant, thus, less contamination of the environment. The disadvantages include: (1) most baits currently on the market give very slow kill or control; (2) nontarget ants may feed on bait; (3) the time of application in relation to temperature may be critical; (4) moisture and rainfall may affect ability of the ants to harvest the bait; (5) special equipment is needed to apply extremely small quantities of bait; and (6) poor shelf life.

Mechanical and cultural control. Several mechanical and electrical devices have been developed to control individual mounds of fire ants. These include microwave units, electrical probes, heating elements, explosive charges, steam probes, and mechanical borers. Although some of these devices will kill individual colonies of fire ants, most are expensive, labor intensive, and of questionable value (Hamman et al. 1986, Drees and Vinson 1991). Various cultural methods have been tried in which mounds were knocked down during cooler months by dragging steel beams across fields, using different tillage methods prior to planting crops, or burning fields in efforts to reduce or eliminate *S. invicta* (Blust et al. 1982, Morrill and Green 1975, Sauer et al. 1982, Collins 1992). In most cases, little reduction of the population occurred with any of these methods, and in those few circumstances where a small reduction did occur, the populations quickly returned to previous levels. Physical removal of colonies from an area by digging them up is effective if the queen is also removed with the colony. However, this is a very labor intensive method and control would be limited because the probability of removing the queen is small, and in the case of multiple queen colonies, there is almost no chance of removing all of the queens. Finally, this method is potentially hazardous because of the danger of incurring fire ant stings.

Biological control. Although research in the area of biological control of fire ants has been underway for several years, the results have been disappointing so far. For example, tests have shown that a parasitic mite, *Pyemotes tritici*, which has been marketed for fire ant control, is ineffective (Jouvenaz and Lofgren 1986). Several organisms kill newly-mated fire ant queens as they alight from mating flights (Whitcomb et al. 1973, Nickerson et al. 1975), however, organisms that will eliminate an entire colony have not been found. Patterson (see Chapter 25)

lists several pathogens and parasites that have been investigated as potential agents for the biological control of fire ants. Consequently, this method of control will not be discussed here.

Summary and Conclusion

Since its introduction into the United States over 50 years ago, *S. invicta* presently infests more than 106 million hectares in eleven states and Puerto Rico. More recently, colonies have been found in New Mexico, Arizona, California, and Virginia but reportedly have been eliminated in New Mexico and California.

This ant has had a substantial impact in the U.S. on humans, agriculture, wildlife and other organisms in the environment, and has caused damage to roads, electrical equipment, roofing materials, and telephone junction boxes. The most serious problem caused by this ant is its stinging of humans which in some cases, has caused serious injuries and even death of hypersensitive individuals.

Control of the fire ant usually consists of the use of chemicals using two approaches: (1) application of contact insecticide treatments and (2) broadcast treatments with toxic baits. Contact insecticide treatments are advantageous in that they act quickly (a few hours or days), and are applied directly on the mound, thus mainly affecting fire ants while minimizing exposure to non-target ants. The disadvantages are that the queens often escape treatment so complete elimination of the colony does not occur, small mounds are not seen and therefore not treated, and applying treatments is labor intensive.

The advantages of broadcast bait treatments are that they are more economical because they are less labor intensive, larger areas can be treated quickly, and small unseen colonies are also eliminated. The disadvantages are that the baits are relatively slow-acting (requiring several weeks), treatments can be greatly effected by weather conditions, and baits are not specific to fire ants and can harm nontarget ant species.

Imported fire ants are an increasing urban and public health problem in the southern United States due to a concurrent rise in both human and fire ant populations. This fact assures an increasing chance of contact between the two. These confrontations will result in the demand for additional measures to manage this pest. This will require control in a variety of situations and habitats, and their suppression or elimination will depend on better management techniques.

Research programs are focusing on studying the biology and behavior of this pest and developing newer methods of control that

utilize biorational and other agents that will have less impact on the environment and are less dangerous to use. It is of utmost importance that safer methods be discovered, especially given that these ants are becoming a greater problem in our urban environment.

The development of newer, safer and more environmentally compatible chemicals, formulations, and methods of control, such as biological control, are needed and should be a high priority in fire ant research. Finally, continued research in basic biology, ecology, and population dynamics of this pest ant is mandatory if we hope to be able to implement a holistic approach for control.

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Resumen

La hormiga roja de fuego, *Solenopsis invicta* Buren fue introducida accidentalmente en los Estados Unidos hace casi 50 años y actualmente infesta mas de 120 millones de hectareas en 11 estados y en Puerto Rico. Esta hormiga ha causado un gran impacto en los seres humanos, la agricultura, la fauna y otros organismos que componen el medio ambiente, y ha causado daño a las vías de comunicación y a muchas clases de equipo electronico. El daño mas grave es causado al picar los humanos lo cual a veces resulta en muerte.

El control de la hormiga de fuego consiste en (1) el uso de insecticidas de contacto y (2) tratamientos de cebo al voleo. Las ventajas de los insecticidas de contacto es que actuan rápidamente regularmente en pocas horas o días y usualmente solamente la hormiga es afectada. Las desventajas es que las reinas se escapan del tratamiento, y en consecuencia la colonia no es eliminada, los montículos pequeños al no ser observados fácilmente, no son tratados, y la aplicación es muy laboriosa, intensiva y puede ser usada únicamente en areas pequeñas.

Las ventajas del tratamiento de cebos aplicados al voleo es que son mas económicos, se pueden tratar rapidamente areas de gran extensión, requieren menor labor y las colonias poco visibles son eliminadas. Las desventajas son su lenta acción, lo cual requiere varias semanas para un control, los tratamientos son afectados por el estado del tiempo, y los

cebos no son especificos unicamente para las hormigas de fuego y pueden en consecuencia afectar otras especies.

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