REPRINTED FROM

Fire Ants and Leaf-Cutting Ants

Biology and Management

edited by Clifford S. Lofgren
and Robert K. Vander Meer

Westview Press / Boulder and London

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History of Imported Fire Ants in the United States

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While hundreds of exotic insect species have found their way into the United States, it is doubtful that any have made their presence any more well-known than the red and black imported fire ants (IFA), Solenopsis invicta and Solenopsis richteri (=Solenopsis saevissima var. richteri). Their mound-building habits, voracious appetite, aggressive stinging behavior, and reproductive capacity have brought them into direct contact and conflict with humans at work and at play, and in urban or rural situations. It is no wonder then that during their relatively short sojourn of about 60 years in this country they have been the center of controversy. While the politics surrounding IFA is an interesting topic in itself, my goal in this paper is to review information on their introduction and spread, and the efforts that have been made to understand and control them.

The earliest records of the IFA are found in reports by Loding (1929), Creighton (1930), Smith (1949), and Wilson and Eads (1949). Their reports allow us to piece together the early history. The first collections of IFA were made in Mobile, Alabama by Loding (1929); they were identified later by Creighton (1930) as S. saevissima var. richteri. At that time the ants were limited to the northwestern part of Mobile and the nearby town of Spring Hill. Creighton (1930) reported that W. P. Loding, who was an amateur entomologist, estimated they were introduced into the Mobile area around 1918, possibly in ballast or dunnage discarded from ships. Loding believed that their early spread was hampered by the Argentine ant, Iridomyrmex humilis, another introduced species that occurred in large numbers in the same area. By 1931 they were found in three other small communities in Mobile County and the city of Fairhope in neighboring Baldwin County (Smith 1949). Six years later they were so abundant in Baldwin County and had caused so much concern that four County, State, and Federal agencies combined in an effort to control them with a calcium cyanide (48%) dust (Eden and Arant 1949). Approximately 2,000 acres of vegetable cropland were

involved; over 80% extermination of active mounds was reported.

The onset of World War II apparently caused a temporary cessation of control and research on IFA; but shortly thereafter, a period of intense research and survey began. By this time, the IFA had spread to adjoining counties in Mississippi, and isolated infestations were found over 150 km away in Selma, Alabama, and Meridian and Artesia, Mississippi (Wilson and Eads 1949). This heralded the fact that the IFA had successfully established their foothold in Mobile and were being transported long distances by some unknown means. Research on their biology and control was initiated at Mississippi State University (Lyle and Fortune 1948) and Auburn University (Eden and Arant 1949). In 1948, the state of Mississippi made a $15,000 appropriation to begin a control and eradication program.

In 1949, the U.S. Department of Agriculture (USDA) made a "hurried" survey to determine the IFA distribution and established a research station at Spring Hill, Alabama (Smith 1949). Also in 1949, the Alabama Department of Conservation employed two scientists, E. O. Wilson, Jr. and J. H. Eads, to study the distribution, biology, and economic importance of IFA. Their report contains the first study of the classification, distribution, biology, and economics of IFA and documents their potential for economic damage to crops and wildlife (Wilson and Eads 1949). The first USDA survey report was also released in 1949 and revealed light to heavy IFA infestations in 14 counties in Mississippi, 12 in Alabama, and 2 in Florida (see Fig. 1). They suggested that individual queens or small colonies were artificially spread by car, rail, or air transportation or in commercial or other products. They recognized, but did not realize, the importance of IFA dispersal with nursery plants (Bruce et al. 1949).

A scientific problem also arose at this time concerning the occurrence of black and red forms of IFA. The original collections by Creighton (1930) were a deep brownish-black to blackish color with a reddish-yellow band at the base of the gaster. In the 1940s, however, another atypical form with a reddish color and a blackish gaster without the band was described by Smith (1949). Wilson and Eads (1949) also reported the two color phases and the apparent domination of the red form. In general, these scientists concluded that the black form was introduced first but did not become well-established in Mobile. The red form entered the picture, probably in the 1930s, and slowly began to dominate because of its greater adaptability to the prevailing environmental conditions (Wilson 1959). Wilson (1951) considered the two forms as races of a highly variable South American species. While there were continuing discussions about the significance of the two forms and their biological significance, no firm conclusions were drawn until the revisionary work of Buren (1972), which will be discussed later.

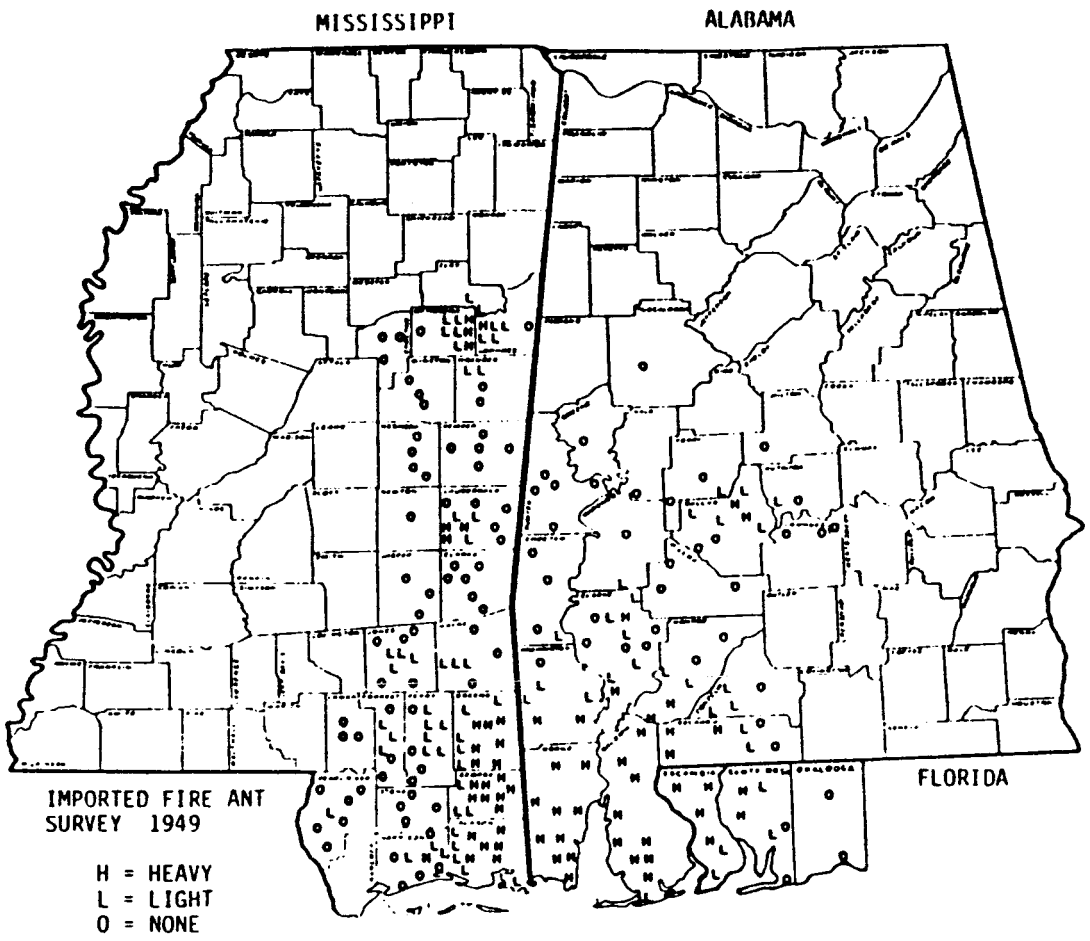

FIGURE 1. Map from Bruce et al. (1949) showing counties surveyed in Alabama and Mississippi and found non-infested (O) or heavily (H) or lightly (L) infested with imported fire ants.

With the continuing expansion of IFA infestations, research was accelerated at Auburn University, Mississippi State University, and a newly organized USDA laboratory at Spring Hill, Alabama. The USDA also initiated a full-scale survey to delimit spread of the IFA throughout the south. It was this survey that first brought to everyone's attention the extent of the IFA problem and the part that the sale of nursery plants played in the spread of IFA (see Fig. 2). In fact, once the direct link between nurseries and IFA spread became obvious, the survey was limited to nurseries because they were easy to locate and inspect. At the conclusion of the survey, the IFA had been found in 102 counties in 10 states (Alabama, Arkansas, Georgia, Florida, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Texas). Infestations had been located west as far as Houston, Texas; east and north to the Carolinas; and south to central Florida (Culpepper 1953; Fig. 2).

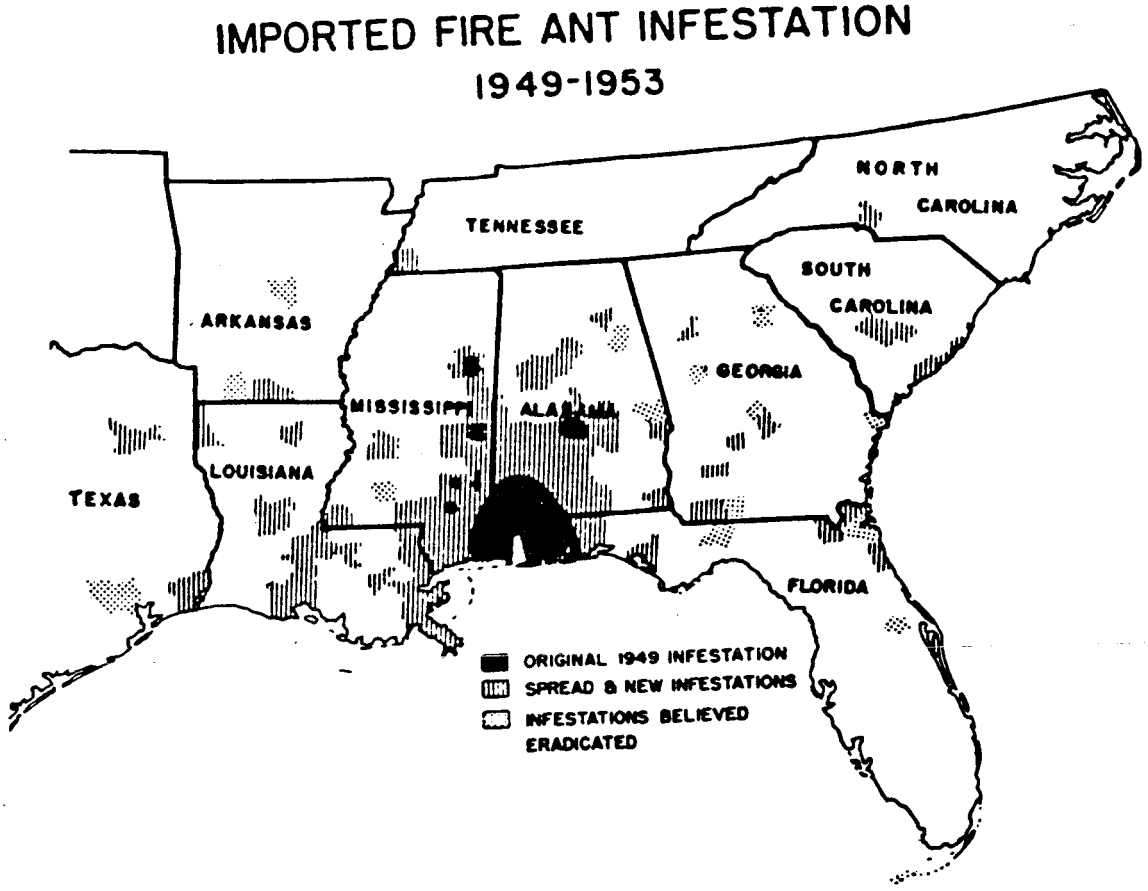

FIGURE 2. Distribution of imported fire ants in 1953 after an intensive 4-year nursery survey in all southern states in the U.S. (Culpepper 1953).

The extent of the IFA spread at this time was truly amazing considering that the red form, which occurred in all areas except northeast Mississippi and northwest Alabama, had only been known to occur in the United States for about 10 years. To date, no additional states are known to be infested and the small infestation in Tennessee was eradicated. In 1981, IFA were found in Puerto Rico (Buren 1982). The dramatic spread of the IFA was, undoubtedly, attributable to their high reproductive capacity (3 to 5 thousand queens per colony per year; Lofgren and Weidhaas 1972) and their propensity for invading soil with nursery plants. Lack of spread farther north is probably attributable to their limited cold tolerance (see Francke and Cokendolpher, Chapter 9). The southernmost infestations of the black form in Argentina are about 35° to 38° latitude which compares to the northernmost spread of either the black or red forms in the U.S. (Buren et al. 1974).

With their "beachheads" established throughout the south, the IFA were free to spread to surrounding areas by both manmade and

natural means. Colony densities of 125 to 250 mounds per ha became common in prime pasture land. Intense concern spread among farmers as expressed by demands at the USDA Spring Hill Laboratory for over 5,000 information bulletins in one spring (Fig. 3). Finally, in 1957 the Southern Association of Commissioners of Agriculture passed a resolution recognizing the IFA as an economic pest. The resolution also petitioned the U.S. Congress, which was in session, to provide funds to the USDA to carry out a uniform control program without delay. On August 28, 1957, the U.S. Congress appropriated $2.4 million for IFA control and eradication (Canter 1981).

FIGURE 3. Demonstration to Alabama farmers by George H. Culpepper of imported fire ant control with chlordane drench. Picture from files of USDA in 1952.

In October of 1957, the Plant Pest Control Division, ARS, USDA, and the Southern Plant Board (an association of regulatory and control officials of the southern states) met in Memphis, Tennessee to develop guidelines for the program. The plans for control and eradication were based on the use of aerial or ground applications of granular heptachlor or dieldrin. In addition, a quarantine was proposed on shipment of sand and gravel, grass sod and nursery plants, stumpwood or timbers with soil attached, unless treated with chemicals to kill any associated ants. The quarantine became effective May 6, 1958 (ARS-USDA 1958).

At the same time the control program was initiated, it was recognized that a Methods Development Laboratory was needed to develop improved control techniques. Mr. W. F. Barthel (chemist) and I were selected to organize a USDA Methods Development Laboratory at Gulfport, Mississippi. Two primary goals were set: (1) find means to reduce the amount residual insecticide needed to achieve control and (2) develop a toxic bait.

Almost as soon as the Federal-State program started, problems were encountered. Some of the first applications of heptachlor (2.24 kg/ha) were made during the cold wet winter of 1957-1958. Shortly thereafter, mortality of wildlife, and in some cases cattle, were reported (George 1958). The actual truth of how much damage was due to insecticide and how much to the severe environmental conditions will never be known. The program continued during 1958; but in the spring of 1959, the dosage of heptachlor was reduced to 1.4 kg/ha and in February 1960, to two applications of 0.28 kg/ha spaced 3 to 6 months apart (Lofgren et al. 1961; Lofgren et al. 1965). Both changes were prompted by intense criticism by conservationists (Brown 1961) and were based on studies conducted by the Methods Development Laboratory. In 1960, another critical problem arose when FDA residue tolerances for heptachlor were reduced to zero on harvested crops (Canter 1981). This made the goal of eradication at that time impractical.

In 1961, the research efforts of the Methods Development Laboratory resulted in the formulation of mirex bait (Lofgren et al. 1963; Lofgren et al. 1964; Stringer et al. 1964). The bait consisted of the toxicant mirex dissolved in soybean oil and impregnated on corn cob grits. Various mirex concentrations and bait application rates were tested in 1961 and 1962. In 1963, the application rate was standardized at 2.8 kg/ha (8.4 g AI/ha); and in 1965, the rate was reduced to 1.4 kg/ha (4.2 g AI/ha). The switch to a bait caused a new problem—the lack of a chemical residue allowed the IFA to quickly reinfest the treated areas. This emphasized the need for repeated applications. However, the low application rate of mirex coupled with studies that revealed no apparent harm to wildlife relieved the immediate concerns of environmentalists about the control program (Baker 1963).

From 1964 to 1966, Federal funding decreased and it appeared that the Federal-State control program might be discontinued. However, the IFA continued to spread and to annoy and alarm farmers and urbanites alike. Consequently, the Southern Plant Board proposed to the USDA and Congress a stepped-up eradication effort using two to four applications of mirex bait. Since there was no research to verify the effectiveness of this treatment regimen for eradication, the Agricultural Appropriations Subcommittee of the United States Senate requested a study to evaluate its feasibility. Funds were transferred to the Insects Affecting Man and

Animals Research Laboratory, Gainesville, Florida, to initiate large-scale tests. Three different sites (Savannah, Georgia; Tampa-St. Petersburg, Florida; and Columbus-Starkville, Mississippi) were selected with the sizes varying from 103,600 to 862,750 ha. The results of the studies were published by Banks et al. (1973). They concluded that "we feel that technical problems we did encounter are surmountable and, therefore, total elimination of IFA from large isolated areas may be technically feasible."

While the eradication trials were in progress (1967-1970), applications of bait were being made in most states. During the 9-year period of 1967 to 1975, approximately 45,281,380 ha were treated (USDA, unpublished report). Since the treatment regimen involved three applications, the actual territory receiving mirex bait was about one-third this amount. Amazingly, the cost of some treatments was only $0.74 per ha including bait, aircraft, and the electronic guidance system.

All was not peaceful, however, during this time period. In the late 1960s, it became evident that even with an application rate of 4.2 g per ha, mirex residues were appearing in a variety of nontarget organisms (Markin et al. 1974; Spence and Markin 1974). It was soon obvious that mirex had a very disadvantageous characteristic—it biodegraded very slowly in the environment. This finding aroused the fears of environmental groups once more. In 1970, a court injunction to halt the use of mirex was requested by the Environmental Defense Fund (EDF) and the Committee for Leaving the Environment of America Natural (CLEAN) and filed in the U.S. District Court in the District of Columbia. Also in 1970, the U.S. Department of Interior banned the use of mirex on public lands they managed (Canter 1981). While the injunction was denied, a series of similar requests for injunctions were filed over the next few years; and in 1973, the newly formed Environmental Protection Agency (EPA) called for a public hearing to determine whether uses of mirex should be cancelled or amended. These hearings lingered on for 3 years. Finally, the Allied Chemical Corporation, the manufacturers of mirex bait, decided to discontinue its formulation. Their manufacturing plant at Prairie, Mississippi was sold to the State of Mississippi. A nonprofit agency (Mississippi Authority for Control of Fire Ants) operated the plant until 1977 when agreement was reached between this agency and EPA to cancel all mirex registrations (Johnson 1976). The public hearing on mirex initiated by EPA in 1973 was terminated and no judicial ruling was issued.

While all of the above activities were occurring, some very important research was underway. Dr. William F. Buren, a scientist with the U.S. Public Health Service, but with an avocation for ant taxonomy, began a study of the red and black forms of the IFA. He obtained specimens from their entire range in the U.S. and concluded that they were two separate species based upon (1) the lack

of evidence for hybridization and (2) the lack of phenotypic variability (Buren 1972). He supported his conclusion with comparisons with similar specimens of the red form from the state of Mato Grasso, Brazil, and the black form from Uruguay and Argentina. In his revision (Buren 1972), he assigned the currently accepted scientific names: Solenopsis invicta Buren (the red imported fire ant) and Solenopsis richteri Forel (the black imported fire ant).

Buren's revision appeared to clarify the red and black form problem once and for all; but as has happened all too often during the long drama of the IFA versus man, his revision may not be the final word. Recent chemical data on venom, hydrocarbons, and trail pheromones give conclusive evidence for hybridization in the areas of Alabama and Mississippi where the two color forms interface (Vander Meer, Chapter 26; Vander Meer et al. 1985).

The early 1970s also saw a great upsurge in research activity on all phases of IFA biology, physiology, behavior, and control. This was spurred on by the one-time release of over $1 million by the USDA for cooperative research with university scientists. Over 16 separate research groups were involved in studies on everything from the toxicology of IFA venom, to the effects of juvenile hormones, and to the beneficial behavior of IFA as predators of pest insects. Several of the states, especially Texas, Mississippi, and Florida, provided funds to continue long-term research. With the demise of mirex in 1977, the USDA also expanded its research program on toxicants, insect growth regulators (IGRs), pheromones, biocontrol, biology, ecology, and economics. The current status of all of this research is reviewed in other chapters of this book. Bibliographies of research on IFA have been published by Banks et al. (1978), Wojcik and Lofgren (1982), and Wojcik (in press). A symposium on IFA was held January 1982 in conjunction with the Southeastern Branch Meeting of the Entomological Society of America, Mobile, Alabama. The papers presented were published in The Florida Entomologist, volume 66.

While all of the control efforts and research were making the IFA the most studied ant species in the world, the IFA went about "doing what they do best"—reproducing. In a period of about 60 years, they expanded from a small foothold at Mobile, Alabama to about 10,930,000 ha at the time the Federal-State program started in 1957 and over 93,120,000 ha in 1985 (Fig. 4 and 5). When the acreage estimates are plotted (Fig. 6), it is evident that the population increased dramatically from 1955 to 1980. More recently, the rate of expansion has declined since the IFA are reaching their ecological limits in the currently infested areas (see Francke and Cokendolpher, Chapter 9). Any additional major expansion could occur only if the IFA become established along the West Coast of the U.S.

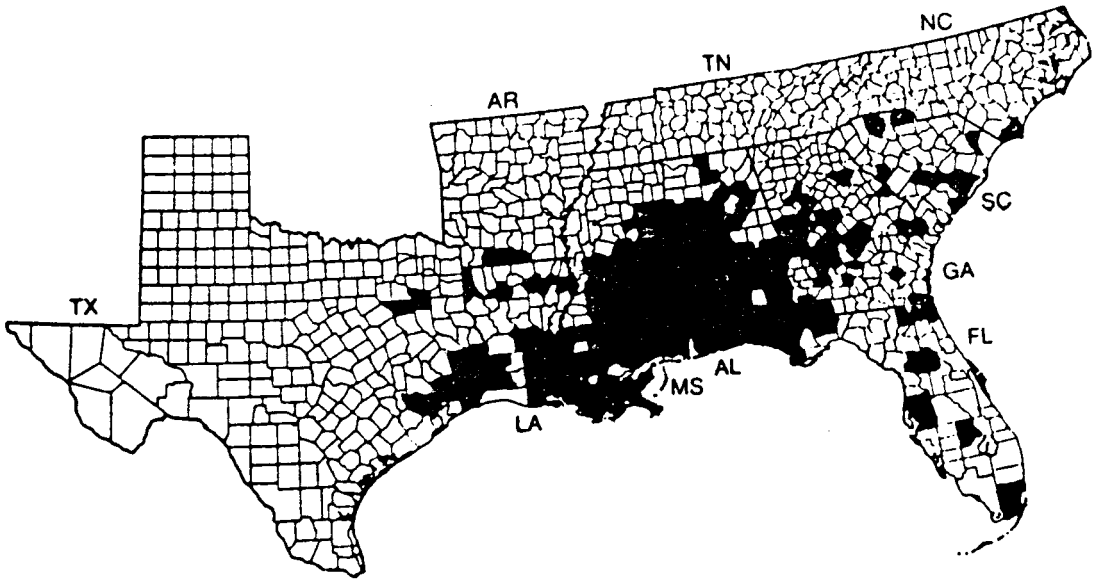

FIGURE 4. Distribution of imported fire ants at time of initiation of Federal-State Cooperative Imported Fire Ant Control Program in 1957.

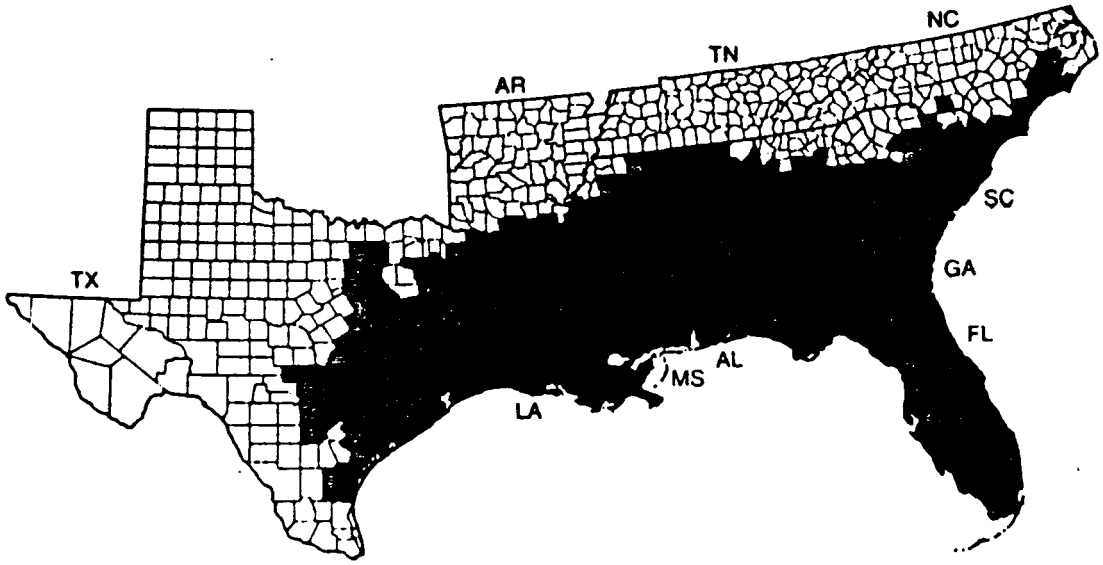

FIGURE 5. Distribution of imported fire ants in 1984.

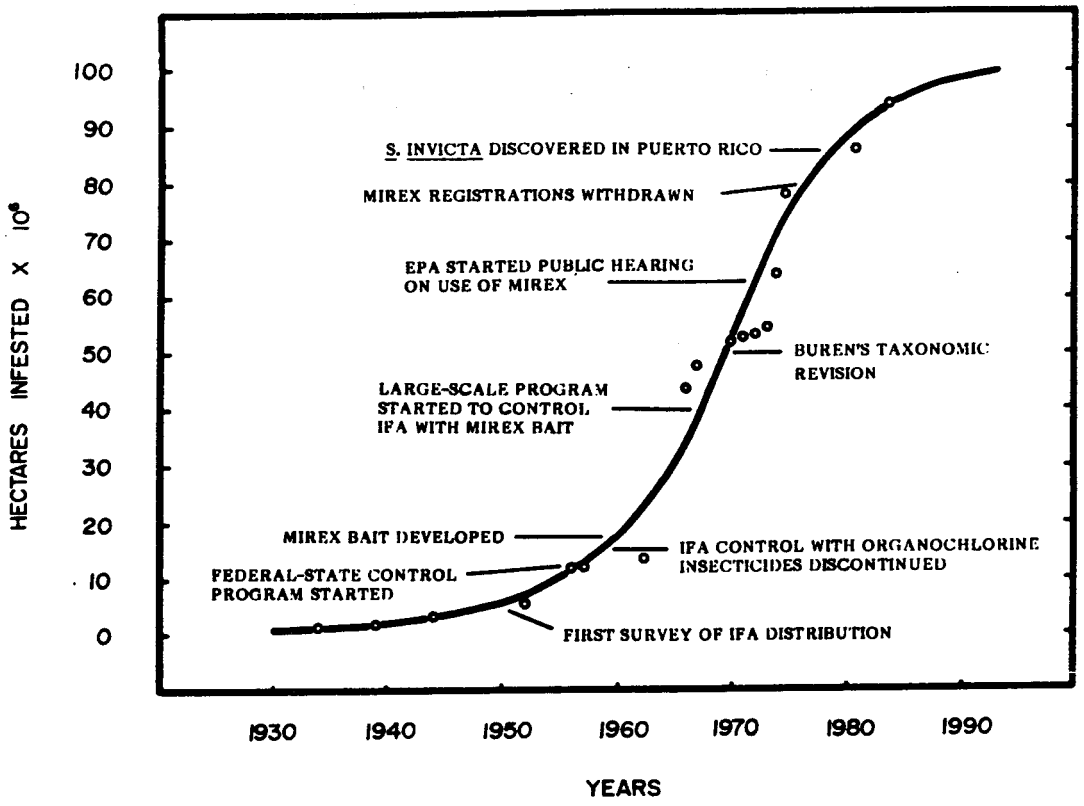

FIGURE 6. Graphic portrayal of the increase in area infested by IFA since 1935 with dates of significant events. Population estimates based on papers by Bruce et al. (1949), Culpepper (1953), Wilson (1951), and unpublished USDA reports.

Our conflicts with the IFA will continue for years to come. Their high reproductive capabilities, efficient foraging behavior, and ecological adaptability make it certain they will be here to perplex and harass us for years to come. It remains for us to develop means to live in accommodation with them. Hopefully, conferences such as this one will provide new insights for the achievement of this accommodation.

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