United States
Department of
Agriculture

Animal and
Plant Health
Inspection
Service

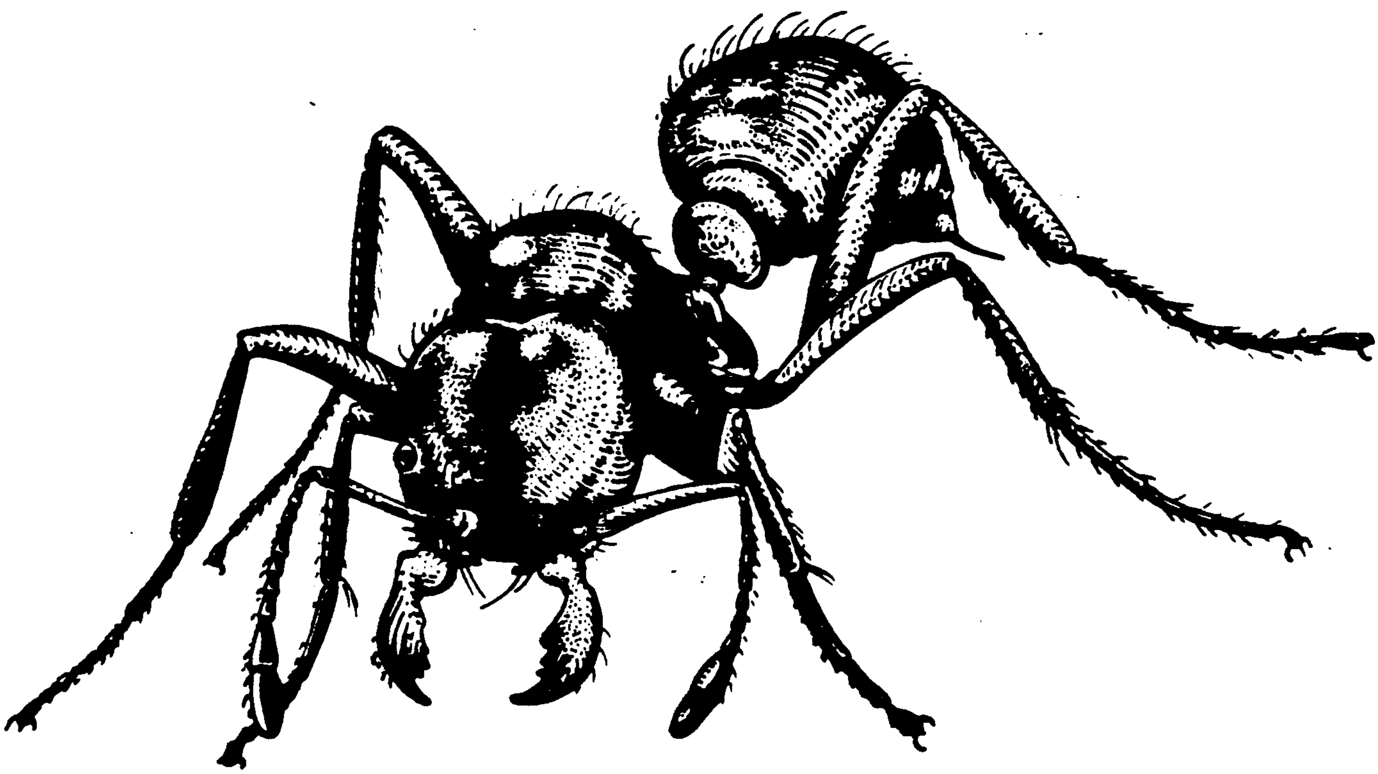
Environmental
Protection
Agency

Proceedings of the Symposium on the Imported Fire Ant

[redacted]

June 7-10, 1982
Atlanta, Georgia

[redacted]



[redacted]

PROCEEDINGS OF THE SYMPOSIUM ON THE IMPORTED FIRE ANT

June 7 - 10, 1982

ATLANTA AMERICAN HOTEL

ATLANTA, GEORGIA

SYMPOSIUM COORDINATOR:

Fred H. Tschirley

EDITOR:

Susan L. Battenfield

ORGANIZED AND MANAGED BY:

Inter-Society Consortium for Plant Protection

SPONSORED BY:

Environmental Protection Agency

USDA, Animal, Plant Health Inspection Service

September 1982

PANEL III

POPULATION DYNAMICS OF THE IMPORTED FIRE ANT

Fowden G. Maxwell, Chairman
Texas A & M University

W.A. Banks, Reporter, USDA-ARS
Gulfport, Mississippi

J.L. Bagent
Louisiana State University

W.L. Buren
University of Florida

Oscar Franke
Texas Tech University

Steven Risch
Cornell University

Ann Sorenson
Texas A & M University

W.L. Sterling
Texas A & M University

Jerry L. Stimac
University of Florida

INTRODUCTION

The imported fire ants, *Solenopsis richteri* Forel and *Solenopsis invicta* Buren were introduced into the United States in the early 1900's and late 1930's, respectively, at the port of Mobile, Alabama. The spread of these ants, primarily *S. invicta*, from this area was dramatic. Surveys conducted by the U.S. Department of Agriculture in the late 1940's and early 1950's revealed that IFA were present from Miami, Florida, to San Antonio, Texas, and as far north as Memphis, Tennessee, and eastern North Carolina. Today it is found on about 240 million acres in ten states; within this geographic area, mound densities range upward to 600 per acre. *S. invicta*, the red IFA, occupies over 95% of the infested area, while *S. richteri*, the black IFA, infests northern Mississippi and Alabama.

IFA are found in many habitats, but tend to favor open or sparsely-forested areas. Levels of infestation vary widely within the habitat types. However, the factors influencing these levels are not clearly defined.

EXTRINSIC FACTORS

Abiotic

The role of abiotic factors, especially temperature and humidity, on the distribution and abundance of IFA are being investigated. Because the IFA prefer high relative humidities and moderate temperatures, they probably will not spread further north, although they may be able to survive in protected areas if accidentally introduced.

Natural spread of *S. invicta* through the desert southwest will be very slow if it occurs. However, based on comparisons with closely related *Solenopsis* species, *S. invicta* probably can establish and survive in the southwest and along the west coast. Artificial introduction by human activities may greatly hasten spread through this area.

The effect of moisture (mode, amount, and timing) on reproductive potential is unclear. Variability in this factor may strongly influence the ability of the ant to produce mating flights and colonize the southwest and far west.

Biotic

Despite intensive searches, no effective parasites or pathogens on the IFA have been found in the U.S. Predators have been found, but their role in regulating IFA populations has not been studied in depth. *S. invicta* queens are attacked and killed by a variety of predators from the time they take flight until they successfully establish a colony. *Neivamyrmex opacithorax* has been reported to prey on larvae of *S. richteri* Also the thief ant, *Solenopsis molesta*, has been found living in the nests and preying on the eggs and young larvae of both IFA species. In southern Mississippi, the ant, *Paratrechina melanderi*, has been found preying on *S. invicta* eggs.

The IFA in South America are beset by a number of diseases, parasites, and competitors. Thus far, none of these have been shown to influence population density; however, this may reflect a lack of detailed studies that could be alleviated if long term research in South America were performed by competent scientists provided with adequate technical support.

Although no definitive studies have been conducted on habitats prior to and as the IFA colonizes an area, observations indicate that the IFA populates new areas with 15 to 40 mounds per acre. In areas where control measures have been applied or other ecological disturbances have occurred, a large number (100+ per acre) of small colonies may establish a year or two later. In time the number of colonies decreases to predisturbance levels or higher. These temporal changes in IFA populations may be due to intraspecific competition among *S. invicta* colonies and interspecific competition among *S. invicta* and other ant species. Such inter- and intraspecific competition needs to be studied.

S. invicta is an efficient colonizing species with a high reproductive capacity and excellent dispersal and habitat-finding abilities. This opportunistic species thrives in areas where lands are disturbed by any means (e.g. flooding, cultivation, and insecticide applications). In addition, once the IFA successfully colonize an area, there are no known competitors that can displace the IFA. Therefore, any management strategy should be directed at imposing mortality on IFA queens at rates that are discriminantly higher than mortality imposed on other ant species. Control tactics imposing indiscriminant mortality on all ants may strongly select for proliferation of the IFA.

INTRINSIC FACTORS

Reproductive Potential

One of the primary reasons for the success of the IFA in the United States has been their reproductive potential. The number of reproductives, frequency of flights, and climatic conditions are major factors in determining distribution and rate of spread. Most IFA mating flights occur during late spring and summer, but they may fly anytime during the year. Studies have shown that flight range depends on wind speed, rainfall, and temperature. Most queens land within a few miles from the source, but distances up to 12 miles have been documented, and it is suspected that the range may be much greater. Rate of spread has not yet been accurately ascertained.

An IFA colony may produce three to five *thousand* queens per year. Winged (alate) forms were trapped leaving mounds in four habitats in north Florida, and it was estimated that an average of almost 100 thousand alate queens flew from the mounds in one acre during one year. Most queens die during and after their mating flight; however, only a few queens need to survive to start new colonies. For example, if an acre is infested with 30 mounds, only 30 or 0.03% of 100,000 queens need to survive to replace the original population. Within the individual colony, large numbers of worker ants can be produced. Recent observations on colony growth within the laboratory indicate that most colonies one year or older contain at least 100 to 200 thousand workers.

Nest Site Selection

Newly-mated queens may select potential nesting sites during flight and after landing. Selection appears to be based on surface properties (e.g., moisture, soil type, topography, and reflectance). This behavior results in colonies being established in roadsides, playgrounds, shopping malls, housing developments, lawns, pastures, and some croplands. Heavily shaded areas (e.g., forests) are rarely infested.

Generation Time

Mean generation time is partly influenced by the time of year the colony is founded. However, 6- to 12-month old colonies can develop reproductive forms and stage mating swarms. With respect to mean generation times, no life tables (birth and death rates, age specific mortality) have been prepared for any IFA species on any part of their geographic range. These data are fundamentally important for sound management decisions.

Genetics

No studies have been conducted on the genetic diversity of *S. invicta* populations. If the original IFA inoculum into the U.S. was very small, there may be significantly less genetic diversity in the U.S. than in the South American population. The diversity of the U.S. population could affect the rate of spread of IFA to new habitats and the rate of evolution of resistance to various control measures.

Development

The ontogenetic development of individual ants has received some attention in the laboratory, as has the influence of some abiotic and biotic factors on the rate of development. The underlying principles of colony foundation, growth, and development are broadly known, but the role of ecological factors on the rate (i.e., the dynamics) of the process needs to be quantified.

Feeding Behavior

Because the IFA can exploit many different food sources, there are no known limits to its distribution based on feeding behavior. IFA colonies can survive considerable worker mortality because, under conditions of stress, feeding behavior is directed towards maintaining the queen. The present understanding of the dynamics of food distribution within the colony may result in the design of more effective bait formulations. Temporal changes in feeding preferences can affect management strategies where baits are used.

Endocrine Systems

Understanding the IFA endocrine system may lead to control tactics that affect colony integration and development. The endocrine system of IFA has been studied mainly from the standpoint of caste determination. Juvenile hormones play a major role in this. Juvenile hormone analogues that can severely disrupt the reproductive processes of IFA are being extensively studied as potential control agents.

Pheromones

Queen pheromones help regulate the social organization of the nest and influence reproductive potential. The queen attractant/recognition pheromone ensures that the queen is fed, groomed, and protected by her workers. This same pheromone is applied to eggs as they are laid, causing workers to care for the eggs. Queen pheromones regulate reproduction by (1) producing new queens (caste determination), (2) suppressing egg laying by virgin queens in the parental nest, and (3) causing workers to execute queens. These regulatory queen pheromones have considerable potential as control agents. Several components of the attractant/recognition pheromone have been chemically identified, and synthetic materials are currently being evaluated for biological activity.

The IFA also produce a brood pheromone and a trail pheromone. The brood pheromone elicits tending behavior by the workers to the larvae. The trail pheromone directs workers to newly-discovered food sources; some of its chemical components have been identified. These may be used to enhance the attractiveness of baits. The special advantages of using pheromones in control programs are that these naturally occurring compounds are highly specific to the IFA and should be environmentally safe.

BENEFICIAL AND DETRIMENTAL ASPECTS

Cotton

In the cotton agroecosystem, the IFA is both detrimental and beneficial. Negative effects occur from IFA stings to workers when hoeing, harvesting, or repairing equipment. The IFA is beneficial in controlling cotton pests, such as boll weevils. When four IFA's are found per ten plant terminals, boll weevils will be controlled 90% of the time. IFA are also considered to be a key predator of *Heliothis* species, such as the bollworm and the tobacco budworm. However, many natural entomophages feed on these *Heliothis* species, so if the IFA were removed, other entomophages may still maintain these pests below economically damaging levels.

Mound sampling is not an effective way to assess IFA density in a cotton field. During the early part of the growing season it may be difficult to find mounds in a field. A "beat bucket" sampler on plant terminals precisely determines the abundance of foraging worker ants and is useful when making management decisions for pests of cotton such as the boll weevil.

The IFA colonize cotton fields early in the growing season primarily in response to aphids as a source of honeydew. After colonization, the IFA tend to aggregate in the field primarily in response to aphid aggregation. The dispersion of worker ants in the cotton field is best described by a negative binomial distribution.

The IFA may kill other entomophagous arthropods. They have been observed consuming parasites of aphids and boll weevils. Although the IFA generally are thought to be effective predators on entomophagous species, other data indicate that they only minimally impact the abundance of most entomophages.

Sugarcane

Although the IFA is generally an excellent predator of the sugarcane borer in sugarcane fields, at harvest time IFA mounds may damage equipment and the ants may sting workers. Some sugarcane farmers would prefer to live without the IFA simply because of its sting. However, it is well documented that the IFA saves the sugarcane farmer an average of one to two insecticide applications per season by feeding on the sugarcane borer.

Sweet Potatoes

The IFA tend to infest entire fields of sweet potatoes, but greater numbers are found around the periphery of the fields. Since all sweet potatoes must be harvested by hand, even in highly mechanized farms, IFA create problems with the laborers in the harvesting process.

IFA prey on the egg and larvae of the banded cucumber beetle and the sweet potato weevil. When IFA are controlled, both insects and their damage increase in sweet potato fields. In fact, the statewide problem with these two pests increased immediately after large scale control measures were initiated for the IFA. More research, however, is needed to determine if this resurgence is due partly to the reduction of predators other than the IFA.

Soybeans

The IFA is considered to be a nuisance pest on soybeans, grain sorghum, and corn and may be of economic significance where ants are very abundant or where seed has not been well covered at planting. Definitive economic assessments of losses in these crops is generally not available and there is a need for additional unbiased research on the impact of IFA on these crops.

In soybean fields, IFA interfere with harvest and feed on germinating soybean seed. Large IFA mounds, particularly around the borders of soybean fields, frequently clog the cutter blade of combines. Thus, a problem is posed to the person removing the ants, dirt, and debris by hand.

IFA prey on several pests and serve as an important predator on many detrimental insects in soybean fields. Three-cornered alfalfa hoppers, stink bugs, and several lepidopterous soybean pests are reduced by IFA predation. Research in Louisiana has shown that insecticides that reduce IFA numbers actually increase the number of three-cornered alfalfa hoppers. No insecticides at this time give better than 60% control of this pest—the same control provided by IFA.

Forest

The Nantucket pine tip moth larvae are significantly reduced by the IFA. This pine pest infests pine branch tips, causing additional branching rather than the more preferred erect growth. The IFA has also been observed feeding on bark beetles in pine forests.

Pastures and Hay Fields

The IFA pose a problem with equipment in cutting hay and with bush-hogging operations of pastures. Large IFA mounds require that tractors be run at considerably less than maximum efficiency. Sickle blades and bush-hog blades are often broken as a result of the mounds. In addition, the small hay bales (60 to 100 pounds), if left on the ground overnight, attract large numbers of IFA, making it extremely uncomfortable for laborers to haul the hay. In general, IFA are considered a significant nuisance in and around hay fields and to a lesser degree in pastures.

The IFA, however, serves as an excellent predator of ticks, horn flies, and stable flies. In many areas, the IFA have reduced lone star tick populations so well that the tick is no longer considered economically important. IFA also reduces horn fly populations, but not as dramatically. Although leafhopper numbers are reduced by IFA predation, it is not known how much actual damage the leafhopper does to pastures.

Wildlife

IFA may kill young quail, rabbits, and other forms of wildlife, especially those that nest on the ground, and therefore, are more vulnerable during the early hours of life. The IFA probably are one of many native predators of these animals, as studies have not demonstrated reduced abundances of these animals due to IFA predation.

Song birds, field mice, etc., might be detrimentally affected by large numbers of IFA, but no studies document this effect.

Although the Louisiana Department of Wildlife has documented cases of both young quail and newly born rabbits being killed by IFA, they have also shown that quail numbers in the primary sugarcane producing parishes are greater now than they were in the late 1950's and early 1960's. In addition, rabbits are as abundant as they were before the IFA colonized the Florida Parish of Louisiana.

RESEARCH NEEDS

There are legitimate research needs for short-term chemical solutions to the IFA problem in particular areas and for long-term ecological management of IFA over the entire area of its distribution. We address here the biological information necessary for long-term IFA management. It is important to recognize that undue emphasis on short-term chemical solutions has two important negative consequences. First, the distribution of available funds will be disproportionately directed towards short-term solutions. Second, long-term IFA management can be more difficult due to adverse ecological consequences from an over-emphasis on chemical solutions.

RECOMMENDATIONS

1. Research the basic population dynamics of the IFA and related ant species in disturbed and non-disturbed habitats in the South American homeland and in the United States.
2. Develop life tables for IFA colonies in South and North America.
3. Assess potential biocontrol agents (parasites, predators, pathogens, and competitors) in Brazil and the United States.
4. Study the factors influencing mating flights and colony founding, particularly (a) abiotic factors influencing flight initiation, mating, and dispersal; (b) intrinsic factors influencing readiness to swarm; and (c) factors influencing nest site selection.
5. Investigate interspecific competition between IFA and other ants in vari-ous South and North American habitats. Also study interspecific competition in and on IFA populations found on the periphery of infested areas.
6. Investigate intraspecific competition among IFA colonies and the role it plays in determining population densities.
7. Investigate the intrinsic factors influencing the production of males and virgin queens.
8. Continue researching the endocrine and exocrine systems (hormones and pheromones); determine how these regulate reproduction.
9. Chemically identify pheromones, and evaluate their potential as control agents.

10. Analyze the genetic diversity (heterozygosity) of IFA in its South American homeland and in the U.S.
11. Evaluate the impact of the IFA on pests and beneficial arthropods in forest and agricultural ecosystems.
12. Determine how IFA populations effect wildlife and domestic animals.