

The Alabama Fire Ant Management Program



**PROGRESS REPORT
FY 2001**



**Entomology &
Plant Pathology**

Table of Contents

Introduction	2
Personnel & Cooperators	5
Educational Materials, Presentations, Publications	6
Development and Dissemination of Materials that Increase Public Knowledge of Fire Ant Biology and Management	12
Evaluation of Integrated Pest Management Methods For Red Imported Fire Ants in Alabama	17
The Effect of Complex Tritrophic Interactions Involving Red Imported Fire Ants on Biological Control	19
Fungal Antagonistics Associated with Imported Fire Ants in Alabama	20
Identifying Differentially Expressed Genes between Queens and Workers of the Imported Fire Ant, <i>Solenopsis Invicta</i> B.	22
Heat Tolerance, Desiccation Tolerance and Water Budgets of Red Imported Fire Ants	24
Implementation of a Fire Ant Management Program in the Tuscaloosa School System	25

Introduction

Activities and Accomplishments of The Alabama Fire Ant Management Program FY-2001

Imported fire ants are found in every county in Alabama and affect the lives of every household. Recent studies estimate the annual loss to households in Alabama to be over \$175 million dollars. These estimates are only for households and do not reflect other affected entities such as agriculture, businesses, airports, golf courses, schools, utilities, and others. Effects of imported fire ants on domesticated and wild animals and plants are reported but are difficult to estimate.

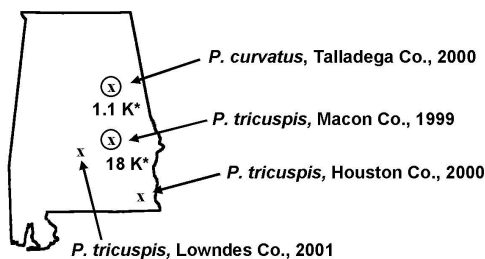
The Alabama Fire Ant Management Program, based at Auburn University, conducts research and educational programs on imported fire ants. This year, colleagues at the Tuskegee Cooperative Extension System joined the project. Our goal is to develop long-term management programs that will make the fire ant easier to live with and to transfer this information to Alabama residents, and others, in a timely manner.

Unfortunately, the biology of the fire ant does not allow the development of an eradication program, such as was successful with the boll weevil. Research studies are designed to develop strategies to reduce populations of fire ants and to maintain these populations at an acceptable level. Educational programs include information on the biology of the fire ant that is needed to properly design a control strategy for a local area.

Evaluation of Integrated Pest Management Methods for Imported Fire Ants

In conjunction with the Alabama Cooperative Extension System, the Tuskegee Cooperative Extension System and the USDA-ARS, the Alabama Fire Ant Management

Pseudacteon spp. release sites in Alabama



Program has made four releases of phorid flies in Alabama as a biological control agent for imported fire ants. *Pseudacteon tricuspis* was released in Macon (1999), Houston (2000), and Lowndes (2001) counties. *Pseudacteon curvatus* was released in Talladega County (2000). This is the first successful release of this species in the United States! Local populations are established, and have spread. As of Fall 2001, the flies had spread about 1 mile from the Talladega site and 3 miles from the Lowndes site. The flies released in

Macon County have spread about 11 miles from their release site (approx. 380 sq. mi.)!

Two long-term demonstrations for management of imported fire ants were established in Baldwin (1997) and Montgomery (1998) counties. Treatment plans were developed based on the property's use patterns so as to target high-use areas and leave low-use areas to maintain natural control. Using baits twice a year at the recommended rate, imported fire ant populations have been maintained at acceptable levels (90% control) for four years at the homestead site and adjacent hay field of a Montgomery County farm. Similar results were attained at Pine Rest Cemetery in Baldwin County using baits at less than recommended label rates. While control of imported fire ants was lower, populations of other ants increased over 1000% (these ants compete with imported fire ants). Maintenance at these sites has been returned to the

stakeholders and local Extension agents. Re-infestation patterns will be monitored to demonstrate effectiveness of control strategies and to develop yearly management plans if the stakeholders discontinue control.

Imported Fire Ant Education and Outreach

Exhibits for the Alabama National Fair and the Southeastern Agricultural Exposition were developed and well received by the public. The exhibits include informational posters, publications, children's activity books, live fire ants, a live decapitating fly demonstration, and casts of fire ant tunnel systems which spark curiosity in the 8,000 - 10,000 passers by. Approximately 1,000 publications and 7,000 activity books were distributed at this year's fair alone! These exhibits give us a chance to explain basic fire ant biology to children as well as offer management strategies to their parents.



The Alabama Fire Ant Management Program, in conjunction with personnel from Auburn University, Alabama A & M, and the Alabama Cooperative Extension System developed a grant, with input from county agents, farmers, and other stakeholders, for education and outreach. SARE Professional Development Program has matched funds with the Alabama Fire Ant Management Program to provide training on sustainable, site specific management of imported fire ants. A team-based approach was used to develop educational aids, e.g. poster sets, two types of mound models, videotapes, a CD-ROM, acrylic ant circles demonstrating polymorphism, and an in-service training for county agents and key stakeholders. The "Train the Trainers" program trained 29 county agents who, in turn, trained at least 4000 people in county meetings!

The educational aids have been distributed to 11 extension offices across the state for use by county agents. In addition, the Alabama Fire Ant Management Program has purchased five Herd® spreaders and seven small bait spreaders. These are located in regional county extension offices and are available for use by extension agents and stakeholders across the state.

The Science of Fire Ants workshop is geared toward middle school science teachers. The workshop includes hands-on science projects that the teachers can pass down to their students. Projects include imported fire ant work distribution and food preferences, the imported fire ant life cycle, and ant identification using keys. All projects demonstrate the scientific hypothesis procedure and require data collection, data analysis, and a summary of results. At the close of the workshop, teachers are given a science project pack providing methodology and materials to conduct imported fire ant experiments in their own classrooms and schoolyards. The workshop trained 85 teachers who will teach science to approximately 3,300 students in Alabama!



Heat and Desiccation Tolerances and Water Budgets of Red Imported Fire Ants

Many imported fire ants are observed dying on disturbed mounds and on bare soil during hot, dry weather. Several experiments are being conducted to determine the effects of hot, cold

and arid conditions on ant mortality. These studies will provide information on the ability of imported fire ants to survive in various environmental conditions. The findings will be incorporated into management plans for imported fire ants.

Gene Manipulation as a Tool for Imported Fire Ant Control

Isolation, characterization, and genetic manipulation of the gene(s) involved in development and reproduction will provide useful information for developing additional strategies for control of the imported fire ant. The long-term practical goal is to develop novel strategies to manage the red imported fire ant and to reduce the impact of pesticides on the environment. Our research will provide information on the molecular basis of development and reproduction in the imported fire ant. This work is the first attempt to manipulate the insect genome to better manage the red imported fire ant!

Fire Ants in Crops

Imported fire ants are efficient and voracious predators of most major insect pests in crops (bad bugs can do good). Studies were conducted supporting the idea that fire ants are economically important predators and are probably the single most important predator of most pests in cotton. The results of this study suggest that imported fire ants are also major intraguild predators of many important biological control agents.



Densities of ladybird beetles, spiders, and big-eyed bugs were all significantly higher in fields with reduced fire ant populations than in fields with relatively large fire ant populations.

Fungal Antagonistics Associated with Imported Fire Ants in Alabama

Groups of fungi associated with imported fire ants in Alabama are being isolated for possible microbial insecticide activity. These fungal isolates could potentially be microbial insecticides and will be screened for efficacy of fire ant control. Of 33 different genera of fungi that have been isolated from fire ants, approximately 10% are considered insect pathogens. Several genera of fungi isolated from the Alabama fire ants have never been isolated from imported fire ants previously. However, the natural incidence of colonization of imported fire ants by fungi in Alabama is less than 1%.

Implementation of a Fire Ant IPM in the Tuscaloosa School System

In May 2000 the principal investigators trained the custodians from the three demonstration schools in order to turn responsibility of the Tuscaloosa school fire ant management demonstration over to them. We explained the purpose of the project, the principles of fire ant mapping, and demonstrated the use of the equipment that can be used to apply fire ant bait. Unfortunately, there was no interest in continuing the program in the following year. Bait application equipment, purchased by the Alabama Fire Ant Management Program, is available at the Tuscaloosa County Extension Office.

Resources in 2001 were redirected to Houston County. A community-wide fire ant demonstration was started there in fall 2001. Results on efficacy should be available in spring 2002.



Alabama Fire Ant Management Program Personnel and Cooperators

Auburn University
Department of
Entomology and
Plant Pathology



Alabama A & M
Department of Plant and Soil
Science



Ken Ward, Ph.D.
Rufina Ward, Ph.D.

Advisory Committee

Michael L. Williams, Ph.D. and Department
Chair

Arthur G. Appel, Ph.D.

Kathy L. Flanders, Ph.D.

L.C. "Fudd" Graham, Ph.D.

Beth Guertal, Ph.D. – Department of
Agronomy and Soils

USDA-ARS

Sanford D. Porter, Ph.D.

David Oi, Ph.D.



Alabama Agricultural Experiment Station

Local Cooperators

Joe Carothers - Houston County

Jim Davis - Lowndes County

Mike Duke - Talladega County

Tim & Susan Gaasch - Macon County

Beth Guertal - Lee County

Robert Harris - Montgomery County

Dean & Harold Humphries - Macon County

George Hunter - Lowndes County

Pyron Keener - Montgomery County

John McDaniel - Houston County

Greg Myrick - Talladega County

Sarah & David Spivey - Baldwin County

Gina & Joe Touchton - Lee County

Carol & Michael Williams - Macon County

Micky D. Eubanks, Ph.D.

Ping Hu, Ph.D.

Nannan Liu, Ph.D.

Kathy S. McLean, Ph.D.

Gary R. Mullen, Ph.D.

Vicky Bertagnolli

Linda Carter

Chad Harvey

Ian Kaplan

Marla Tanley

Yuping Wei

Alabama Cooperative Extension System

Larry J. Craft

Ken W. Creel

David Lee Daniel

Henry D. Dorough

Marla Faver

Rickey G. Hudson

Richard W. Murphy

Michael N. Oglesby

Reafield Vester



Acknowledgements

Bob Cartwright - Syngenta

Joe Chamberlin - Valent USA Corp.

Wayne Lohman - Top Pro Specialties

Jim Merrick – Aventis

Kyle Miller - BASF

Doug VanGundy - Wellmark

Tuskegee Cooperative Extension System

George Hunter

Sincere apologies to anyone inadvertently
omitted from this list.

Educational Materials, Presentations, Publications

Presentations

- Appel, A.G. Ant biology and current trends in ant control. University of Nebraska Pest Control Conference, Lincoln, Nebraska, 2001.
- Appel, A.G. Designing and evaluating individual mound treatments for control of red imported fire ants. Fire ant in-service training, Auburn, Alabama, 2001.
- Bertagnolli, V. E., L. C. Graham, A. T. Kelley, and R. Lumpkin. 2001. An IPM pilot project in the Auburn City School System: A model for the state of Alabama. Poster presented at the Annual Meeting of the Entomological Society of America, San Diego, California.
- Blackwell, S. M.D. Eubanks, C. Parrish and Z. DeLamar. The impact of red imported fire ants on cotton pests. Annual Meeting, Entomological Society of America, Montreal, Canada, December 2000.
- DeLamar, Z., M.D. Eubanks, S. Blackwell, and C. Parrish. Do red imported fire ants suppress soybean pests? Annual Meeting, Entomological Society of America, Montreal, Canada, December 2000.
- Eubanks, M.D. Complex interactions involving fire ants and specialist natural enemies: disentangling a trophic mess. Symposia on the Interactions between Generalist and Specialist Natural Enemies, Annual Meeting, Entomological Society of America, San Diego, California, December 2001.
- Eubanks, M.D. Pervasive invasives and complex trophic interactions: fire ants and biological control. Department of Entomology, Clemson University, December 3, 2001.
- Eubanks, M.D. Evaluating the efficacy of natural enemies for suppressing, controlling, and regulating pest abundance. Department of Entomology, Oregon State University, October 10, 2001.
- Eubanks, M.D. Higher order trophic interactions and the predictability of biological control. Department of Entomology, Oregon State University, October 8, 2001.
- Eubanks, M.D. Benefits of sustainable agriculture for pest management. Department of Entomology, Pennsylvania State University, September 27, 2001.
- Eubanks, M.D. Higher order trophic interactions and the predictability of biological control. Department of Entomology, Pennsylvania State University, September 26, 2001.
- Eubanks, M.D. Pervasive invasives and complex trophic interactions: the impact of red imported fire ants on biological control. Annual Meeting, Ecological Society of America, Madison, Wisconsin, August 2001.
- Eubanks, M.D. Complex trophic interactions involving red imported fire ants and agricultural pests. Annual Meeting, Southeastern Branch of the Entomological Society of America, Augusta, Georgia, March 2001.
- Eubanks, M.D. Complex trophic interactions and the impact of fire ants on biological control. 2001 Imported Fire Ant Research Conference, San Antonio, Texas, March 2001.
- Eubanks, M.D. Pervasive invasives and complex trophic interactions: The impact of fire ants on biological control. Department of Biology, University of Mississippi, February 16, 2001.
- Eubanks, M.D. The impact of complex trophic interactions involving red imported fire ants on biological control. Department of Entomology, University of Georgia, February 8, 2001.

- Eubanks, M.D., S. Blackwell, C. Parrish, and Z. DeLamar. Pervasive invasives and complex trophic interactions: Fire ants and biological control. Annual Meeting, Entomological Society of America, Montreal, Canada, December 2000.
- Eubanks, M.D. Direct and indirect effects of red imported fire ants in agroecosystems. Department of Entomology, Auburn University, November 20, 2000.
- Eubanks, M.D. Pervasive invasives and complex trophic interactions: The impact of red imported fire ants on biological control. Department of Entomology, Virginia Tech University, November 2000.
- Flanders, K. L., L. C. Graham, K. E. Ward, R. N. Ward, and K. M. Creel. 2001. We can do something about fire ants: Training professional and developing teaching materials in sustainable fire ant management. Poster presented at the Annual Meeting of the Entomological Society of America, San Diego, California.
- Flanders, K. L. Managing imported fire ants. Training Session for Certified Crop Advisers, December 17, 2001, Auburn, AL.
- Flanders, K. L. Stop chasing those fire ants around. Alabama Urban Forester's Association Annual Meeting, November 1, 2001, Mobile, AL.
- Flanders, K. L. Fire ant biology and management, In-Service Training for Nursing Home Administrators, October 30, 2001, Dothan, AL.
- Flanders, K. L. Fire Ants! Ogletree Elementary School Bug Out, October 23, and October 25, 2001, Auburn, AL.
- Flanders, K. L. Fire ants and white grubs. Winfield Agorama Field Day, August 25, 2001, Winfield, AL.
- Flanders, K. L. Fire ant educational materials. Regional County Agent In-Service Training, August 9, 2001, Monroeville, AL.
- Flanders, K. L. Fire ant sampling methods. County Extension Agent In-Service Training, July 24, 2001, Auburn, AL.
- Flanders, K. L. Update on fire ant control materials. County Extension Agent In-Service Training, July 24, 2001, Auburn, AL.
- Flanders, K. L. How to conduct a fire ant bait demonstration. County Extension Agent In-Service Training, July 24, 2001, Auburn, AL.
- Flanders, K. L. Fire ants - what works, what doesn't. 5th Annual Landscape and Turf Seminar, Birmingham Botanical Gardens, Nov. 2000.
- Flanders, K. L. Stop chasing those fire ants around. Restricted Use Pesticide Dealer Meetings, Cullman, AL, Dec. 2000.
- Flanders, K. L. Stop chasing those fire ants around. Restricted Use Pesticide Dealer Meetings, Headland, AL, Dec. 2000.
- Flanders, K. L. Stop chasing those fire ants around. Restricted Use Pesticide Dealer Meetings, Montgomery, AL, Dec. 2000.
- Flanders, K. L. Heads off fire ant control. 2000 Professional Nurserymen/Landscape Mini-Conference, October 2000, Auburn, AL.
- Flanders, K. L. Update on Fire Ant Control Materials. County Extension Agent In-Service Training, June 27, 2001, Auburn, AL.
- Flanders, K. L. How to conduct a fire ant bait demonstration. County Extension Agent In-Service Training, June 26, 2001, Auburn, AL.
- Flanders, K. L. Site specific fire ant management. County Extension Agent In-Service Training, June 26, 2001, Auburn, AL.

- Flanders, K. L. Fire ant sampling methods. County Extension Agent In-Service Training, June 26, 2001, Auburn, AL.
- Graham, L. C., A. T. Kelley, S. D. Porter and K. L. Flanders. .2001. Introduction of phorid flies for biological control of fire ants in Alabama. Poster presented at the 75th annual meeting of the Southeastern Branch of the Entomological Society of America, Augusta, Georgia.
- Graham, L. C., S. D. Porter, K. L. Flanders, A. T. Kelley, H. D. Dorrough and R. G. Hudson. 2001. Introduction of phorid flies for biological control of fire ants in Alabama. Poster presented at the Imported Fire Ant Conference, San Antonio, Texas.
- Graham, F. 2001. The Alabama Fire Ant Management Project. Conservation Practices and Research Committee Summer Meeting, Natural Resources Conservation Service, Auburn, Alabama.
- Graham, F. 2001. Fire ant management. 13th Annual Natural Resource Tour and Fish Fry, Montgomery County Natural Resources Planning Committee, Snowdoun, Alabama. (10/22/01).
- Graham, F. 2001. Fire ant safety (9). Progressive Farmer Farm Safety Day Camp. Lineville, Alabama (9/29/01).
- Graham, F. 2001. Review of educational materials developed as part of the SARE project. In-service training workshop session. Auburn, Alabama. (7/31/01).
- Graham, F. 2000. New and existing fire ant controls. Turf Unit Field Day, Auburn University. Auburn, Alabama. (7/25/01).
- Graham, F. 2001. Tour of alabama fire ant management project facilities. Conservation Practices and Research Committee Summer Meeting, Natural Resources Conservation Service, Auburn, Alabama. (7/17/01).
- Graham, F. 2001. Review of educational materials developed as part of the SARE project. In-service training workshop session. Auburn, Alabama. (6/27/01).
- Graham, F. and K. Flanders. 2001. The Alabama Fire Ant Management Project. In-service training workshop session. Auburn, Alabama. (6/27/01).
- Graham, F., V. Bertagnolli, C. Stanton and R. Ward. 2001. How can you tell a fire ant from another ant? In-service training workshop session. Auburn, Alabama. (6/27/01).
- Graham, F. 2001. Fire ants: biology and management. Marshall Co., Guntersville, Alabama. (6/21/01).
- Graham, F. 2001. Imported fire ants: biology and management. Morgan Co., Decatur, Alabama. (4/10/01).
- Graham, F. 2001. Fire ants: their biology and control. 12th annual Alabama Vector Management Society Meeting. Alabama Vector Management Society. Gulf Shores, Alabama.
- Graham, F. 2001. School IPM. Alabama Pest Control Association Winter Meeting, Alabama Pest Control Association, Auburn, Alabama.
- Graham, F. 2001. Fire ants: biology and control. Limestone Co., Athens, Alabama. (2/17/01).
- Graham, F. 2000. Fire ant biology and management. Auburn Rhododendron Club. Auburn, Alabama. (11/6/00).

- Harvey, C.T. and M.D. Eubanks. Effects of red imported fire ants on caterpillar-parasitoid interactions. Annual Meeting, Entomological Society of America, San Diego, California, December 2001.
- Harvey, C.T. and M.D. Eubanks. Effect of red imported fire ants on caterpillar-parasitoid interactions. Annual Meeting, Ecological Society of America, Madison, Wisconsin, August 2001.
- Harvey, C.T. and M.D. Eubanks. Effects of red imported fire ant on integrated pest management in agroecosystems. Graduate Student Forum, Auburn University, Auburn, Alabama, March 2001.
- Kaplan, I., M. Patrick, and M.D. Eubanks. Consequences of aphid protection by red imported fire ants on cotton aphid-natural enemy dynamics. Annual Meeting, Entomological Society of America, San Diego, California, December 2001.
- McLean, K. and F. Graham. 2001. Fire ant experiments/demonstrations for youth. In-service training workshop session. Auburn, Alabama. (6/26/01).

Publications

- Eubanks, M.D., S.A. Blackwell, C.J. Parrish, Z.D. DeLamar, and H. Hull-Sanders. In Review. Pervasive and intense intraguild predation by an invasive ant: The effects of red imported fire ants on beneficial arthropods. (submitted to *Oecologia* September 2001).
- Eubanks, M.D. 2001. Estimates of the direct and indirect effects of red imported fire ants on biological control. *Biological Control* 21:35-43.
- Eubanks, M.D. 2001. Complex trophic interactions and the impact of fire ants on biological control. Proceedings of the 2001 Imported Fire Ant Research Conference, San Antonio, Texas.
- Eubanks, M.D. 2001. The effects of red imported fire ants on insect pests and beneficial arthropods in Alabama cotton. Pp. 3-4, 2000 Cotton Research Report, Research Report Series, Volume 18, K.S. McClean and D.L. Monks, eds. Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama.
- Eubanks, M.D. 2000. Can bad bugs do good? The ecology of fire ants in Alabama agricultural crops. *Highlights of Agricultural Research* 46(1):3-4.
- Eubanks, M.D. 2000. Complexity begets stability revisited: The importance of variation in trophic interactions to the maintenance of biodiversity. Proceedings of the XXI International Congress of Entomology 1:219.
- Flanders, K. L., L. Weatherly, and L. Craft. 2001. Getting the most out of your fire ant bait. Alabama Cooperative Extension System Circular ANR-1161, Revised.
- Flanders, K. 2001. Imported Fire Ants in Lawns, Turf, and Structures. Alabama Cooperative Extension System Circular ANR-175, Revised.
- Graham, L. C., S. D. Porter, K. L. Flanders, A. T. Kelley, H. D. Dorough and R. G. Hudson. 2001. Introduction of phorid flies for biological control of fire ants in Alabama. Proceedings of the 2001 Imported Fire Ant Research Conference, San Antonio, Texas. pp.151-152.
- Hooper-Bui, L.M., A.G. Appel, and M.K. Rust. 2002. Preference of food particle size among several urban ant species. *J. Econ. Entomol.* (in press)

Stewart, S. D, L. C. Graham, M. J. Gaylor and L.A. Vanderberg. 2001. Combining exclusion techniques and larval death-rate analyses to evaluate mortality factors of *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae) in cotton, *Gossypium hirsutum* (L.). Florida Entomol. 84: 7-22.

Interstate cooperation

Our fire ant video was revoiced and re-issued as VHS 2559, Fire Ant Control Made Easy, Texas Imported Fire Ant Research and Management Plan.
How to Make a Mound Cast handout reworked for use by the Texas Imported Fire Ant Research and Management Plan.

Honors and Awards

Outstanding Extension/Regulatory Display, 2001 Annual Meeting of the Entomological Society of America, San Diego, California.

Mass Media

Television News Spot and Web Page on phorid release. WSFA, Montgomery, AL. 4/18/01.

Outreach

Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Ag Roundup on Auburn Campus (Oct 20, 2001).
Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Sunbelt Agricultural Exposition in Moultrie Georgia (Oct 16-18, 2001).
Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Alabama National Fair (Oct 4-14, 2001).
The Science of Fire Ants, 2 laboratory courses Entomology for Educators class; how to use imported fire ants for science projects, Auburn University, Auburn, AL, July 24, 2001.
The Science of Fire Ants, 2 hour training courses (3) for high school teachers; how to use imported fire ants for science projects, Auburn University, Auburn, AL, June 25-27, 2001.
Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Oxbow Meadows Insectival Festival. Columbus State University, Columbus, Georgia. (6/16/01).
Prepared acrylic ant mounts to show polymorphism in fire ants for SARE project; to be used by county agents for educational purposes, 2001.
Prepared four posters for SARE project; to be used by county agents for educational purposes (Biological control of fire ants using phorid flies; Using baits to manage fire ants; Fire ant biology: colony establishment; Fire ant biology: life in the mound), 2001.
Prepared video on fire ant control for SARE project.
Prepared PowerPoint presentation for SARE project.
Prepared models of fire ant mounds for SARE project.

Other Outreach Activities

Flanders

Answered 42 phone calls on fire ants
Reviewed one manuscript on fire ant management

Graham

44 calls on fire ants

Field Demonstrations & Experiments

Fire ant management, F. Graham and V. Bertagnolli, Auburn University.

Tested new fire ant products for control of fire ants.

Fire ant management, F. Graham and V. Bertagnolli, Auburn University, L. Craft, Montgomery Co., M. Faver, Baldwin Co. Fire ant management demonstrations were evaluated at two livestock operations and two cemeteries.

Other

Fire Ant Biology and Management, Conservation Biology Lecture for D. Robinson's class, Auburn University, Auburn, AL, July 24, 2001.

Urban IPM: Inspection, Monitoring and the Art of Communication, half-day training course, Auburn Facilities Division, July 31, 2001.

Urban IPM: Inspection and Monitoring, one-day training course, Auburn Facilities Division, May 18, 2001.

IPM in Schools, 30 min training courses (2) for Auburn city school maintenance workers, Auburn High School, Auburn, AL, April 17, 2001.

IPM in Schools, half-day training course for PMP's, Prichard, AL, Jan.25, 2001.

Papers in Preparation

Liu, N. 2002. Isolation and characterization of two cytochrome P450 genes in the red imported fire ant, *Solenopsis invicta*. Insect Biochem. Mol. Biol

Zhang, L. and N. Liu. 2002. Differential gene expression between Queens and Workers in the red imported fire ant, *Solenopsis invicta*. Insect Biochem. Mol. Biol.

A research pre-proposal derived from this study was submitted to the Biogrants Program of Auburn University and has been chosen to develop into a full proposal.

Development and Dissemination of Materials that Increase Public Knowledge of Fire Ant Biology and Management

Kathy Flanders, Lawrence Graham, Arthur Appel, Xing Ping Hu, and Kathy McLean

Objective:

- 1) Develop and disseminate training materials on fire ant biology and management in Alabama.
- 2) Increase public knowledge of fire ant biology and management.

Exhibit at the Alabama National Fair & Southeastern Ag. Expo, October, 2001:

An exhibit was prepared for the Alabama National Fair by Lawrence Graham with the assistance of Vicky Bertagnolli, Research Assistant. The exhibit included informational posters, live fire ants, live decapitating flies, and plaster casts of fire ant tunnel systems. This exhibit was extremely popular. More than 7,000 fire ant coloring books, and more than 1,000 copies each of five fire ant fact sheets were distributed. Most of the children were fascinated, rather than repelled by the fire ants. This gave us a chance to explain the basics of fire ant biology to the children, and the basics of both fire ant biology and management to their parents. Participants of the Alabama Fire Ant Management Project staffed the booth for the duration of the fair.

We can do something about fire ants: Training professionals and developing teaching materials in sustainable fire ant management.

This project is coordinated by Kathy Flanders, Lawrence Graham, Ken Ward, and Ken Creel. Funding from the Alabama Fire Ant Management Program was used to match a grant that has been received from the SARE Professional Development Program. SARE provided \$21,227 in 2001, and will provide \$18,928 in 2002.

The goal of this project is to provide training on sustainable, site specific management of imported fire ants. This year, a slide set, a tutorial CD-ROM, four posters, two different types of educational mound models, and an acrylic mount of ant specimens were prepared. Each Cooperative Extension System Office in Alabama has, or will receive, a copy of the CD-ROM and slide set. These complement the videotape on fire ant management was sent to each office in

2000. Sixteen sets of the posters were distributed among the county offices. 18 mound models have been distributed. At least 8 acrylic mounts have or will be distributed by the end of January, 2002.

The new materials will be used by county agents to instruct other trainers and key stakeholders, including additional county agents, supervisors of farmer cooperatives, and master gardeners using a tiered training system. Personnel from Auburn University (1862 landgrant), Alabama A&M (1890) and the Alabama Cooperative Extension System are the major participants of this project.

The Science of Fire Ants, June 2001

This program was designed to increase the knowledge base about imported fire ants to middle school science teachers of Alabama. Middle school science teacher workshops were conducted at Auburn University in June. Drs. McLean and Graham assisted by graduate students, research assistants and student workers modeled hands on science with fire ants to 65 Alabama teachers. Applied science projects were set up for the teachers. The projects were designed for the teachers to use in their classrooms, increasing their students' knowledge about fire ants. Projects included charting the ants' life cycle through morphological observations of all stages of fire ant growth and development; determining preferred food sources utilizing various baits; and identifying pest ants using keys. The fire ant science projects demonstrate the scientific hypothesis procedure and require data collection, data analysis and summary of results. The teachers were each given a package of the science project materials to take back to their classroom for their use. The package included an ant farm, magnified observation chambers, test tubes and handouts describing experiments demonstrated.

We have increased the general public's knowledge about fire ants by reaching 65 current teachers. These teachers will teach science to approximately 3300 students in Alabama next

year. Teachers rated the workshop highly, indicating that the science was well presented and they will be able to incorporate the projects into their science classes next year.

County Extension agent in-service training

This program was designed to increase the imported fire ant knowledge base of county Extension agents. The two-day training session was held in Auburn, AL in June, 2001. A one-day makeup training was held in July. In total, 29 county agents were given information on how to conduct a fire ant control demonstration. Each agent was provided with the materials they need to establish and evaluate the demonstrations.

County agents who attended the fire ant in-service training session in April 2000 went back to their counties and conducted fire ant education projects. They were guest speakers at meetings of civic clubs, AARP, the Christian Women's Association, and an extended day program. Special programs organized by the county agents reached elementary school children, master gardeners, 4-H students, cattle producers, and the general public. These agents trained at least 4000 people about fire ants in the year following the in-service training session..

Color fact sheets

Fact sheets on fire ant management (ANR-175), and on getting the most out your fire ant bait (ANR-1161) were updated this year.

Outcomes:

Improved knowledge of fire ant biology and management strategies by the public and increased visibility of Alabama Fire Ant Management Program.

Fire Ant Management Program Booth At the Alabama National Fair



2000 Southern Region SARE Professional Development Program

We Can Do Something About Fire Ants -- Training Professionals and Developing Teaching Materials in Sustainable Fire Ant Management

The goal of this project is to provide training on sustainable, site specific management of imported fire ants. Site-specific fire ant management makes the most efficient use of on-farm and public resources. It takes advantage of natural biological controls, and enhances environmental quality by reducing the amount of pesticide applied. Reducing the impact of fire ants on humans, livestock, and wildlife will enhance the quality of life of farmers and of society as a whole.

An in-service training session will instruct Alabama Cooperative Extension System agents and key farmers in fire ant biology and sustainable fire ant management. During the first year of the grant budget period, trainees will develop educational materials to promote sustainable fire ant management. A video, a slide set, a tutorial CD-ROM, a poster, a travelling mound model, and a fire ant caste exhibits will be developed. In year 2, the new materials will be used to instruct other trainers and key stakeholders, including additional county agents, supervisors of farmer cooperatives, and master gardeners. Participatory training methods developed during a previous SARE will be used during this project. This project was designed with the input of county agents, farmers, and other stakeholders. Personnel from Auburn University (1862 land-grant), Alabama A&M (1890) and the Alabama Cooperative Extension System will be the major participants of this project. Funding from the Alabama Fire Ant Management Program will be used to match the proposed funding. We expect the multi-institutional partnership to endure beyond the life of the project, and that the general level of knowledge about fire ants and their management will increase as a result of this project.

SARE Project Teams

Project	video	slide/cd rom	poster/ant specimens	mound model
Project leader(s)	Kathy Flanders	Ken Ward Rufina Ward	Fudd Graham	Ken Creel
Project participants	Jeff Clary Rodie Ruffin Derek Bryan Larry Craft Rickey Hudson Kent Stanford Stan Roark Heath Potter Robert Murphy	Danny Cain Doug Chapman Larry Quick Bobby Wallace Dus Rogers Henry Dorough Mac Washington Timothy Reed Theodis Henderson	Chuck Browne Daniel Jones James Conway Jimmy Jones Chip East Allyn Crane	Eddie Wheeler Charles Pinkston Dan Porch Gregg Hodges Ronald Britnell Ronnie Lane Tinsely Gregg Steve Martin Tap Tapley
Proposed project review panel	Arthur Threatt Bob Bjornson Johnny Stele Virginia Morgan, Harry Wisdom Bart Drees Geri Cashion	Curtis Grissom Gary Shavers Mike Stroop Brenda Tapp Virginia Morgan Kyle Miller Laurence Mudge	Perry Mobley David Koon John Pulliam Jim Austin Carlos Holland Steven Joiner Virginia Morgan Brad Vinson Doug van Gundy	Rickey Colquitt Kevin Humphreys Bruce Houck David Hardrick Virginia Morgan Sanford Porter Patricia Cobb Mickey Lovett

Evaluation of Integrated Pest Management Methods For Red Imported Fire Ants in Alabama

Lawrence Graham, Kathy Flanders, Dept. Entomology, Auburn University, Henry Dorough, Rickey Hudson, Michael Oglesby, Alabama Cooperative Extension System, George Hunter, Tuskegee Cooperative Extension System, Ken Ward, Alabama A&M University

Objective 1: Demonstrate the efficacy and efficiency of targeted broadcast baiting and mound treatments in urban landscapes and rural agricultural operations/home sites.

In-county demonstrations of site-specific fire ant management using baits were conducted in Montgomery and Baldwin counties. At the Montgomery site, fire ant bait was broadcast according to label directions twice a year. The demonstration was initiated in 1998 and ended fall of 2001. Initial populations at the site ranged between 40 and 50 mounds per acre. Populations in the treated area were reduced to four to five (approximately 90% reduction) mounds per acre, and were maintained at that level during four years of the demonstration. At the Baldwin County site, established in 1997, baits were used at 0.25 - 0.5 label rate. Baits were applied in bands along paths in the cemetery to prevent staining of headstones by baits. Fire ant populations at this site have declined, but application methods are still being evaluated to maximize control at the site. However, populations of other ant species were monitored at this site and have increased over 1000% (138 mounds in 1997 to over 1500 mounds in 2001). Maintenance at these sites has been returned to the stakeholders and local Extension agents. Re-infestation patterns will be monitored to demonstrate effectiveness of control strategies and to develop yearly management plans if the stakeholders discontinue control.

Objective 2: Release and evaluate the effectiveness of three fire ant biological control agents: two species of phorid fly and a microsporidian.

In conjunction with Extension agents from the Alabama Cooperative Extension System, the Tuskegee Cooperative Extension System, and the USDA-ARS, the Alabama Fire Ant Management Program has made four releases of phorid flies in Alabama as a biological control agent for imported fire ants. *Pseudacteon tricuspis* was released in Macon (1999), Houston (2000), and Lowndes (2001) counties. The flies released in Macon County have spread about 11 miles from their release site (approx. 380 sq. mi.). The flies released in 2001 in Lowndes County have move 3 miles from the release site. To date, only one fly has been recovered from the Houston County site.

Pseudacteon curvatus was released in Talladega County (2000). Local populations are established, and have spread. As of Fall 2001, the flies had spread about 1 mile from the Talladega site. This is the first successful release of this species in the United States.



Fire ant workers assume a characteristic defensive posture when attacked by a phorid fly (white circle).

The microsporidian, *Thelohania solenopsae*, was released in Macon Co. in 1998 into a pasture infested with red imported fire ants and in Madison Co. in August 2000 into a pasture infested fire ants that are hybrids of the red imported fire ant and the black imported fire ant. The Madison Co. release was coordinated by Ken and Rufina Ward with the Department of Plant and Soil Science at Alabama A&M University. To date, no infected fire ants have been recovered. Plans are being made for a new release in 2002.

The Effect of Complex Tritrophic Interactions Involving Red Imported Fire Ants on Biological Control

Micky D. Eubanks

We conducted a two-year sampling study and a series of greenhouse and field experiments to document the impact of red imported fire ants on beneficial insects in agroecosystems. We found that the density of 12 out of 13 natural enemies sampled on cotton plants in 1999 and eight out of eight sampled in 2000 were negatively correlated with the density of foraging fire ant workers. We found that red imported fire ants reduced the survival of ladybird beetles on caged cotton plants by 50% and green lacewing larvae by 38%. Fire ants did not, however, reduce the survival of spiders. We used commercially available fire ant bait to suppress fire ant populations in cotton fields during the 2000 growing season and compared the densities of beneficial arthropods in treated versus control fields. Densities of ladybird beetles, spiders, and big-eyed bugs were all significantly higher in fields with reduced fire ant populations than in fields with relatively large fire ant populations. The results of this study suggest that red imported fire ants are major intraguild predators of many important biological



control agents.

Fire ants attacking a beet armyworm in a cotton field

Fungal Antagonistics Associated with Imported Fire Ants in Alabama

Kathy S. McLean and Lawrence Graham

The objectives of this research are to identify naturally occurring fungi associated with fire ants in Alabama and to screen potential fungal isolates for possible microbial insecticide activity.

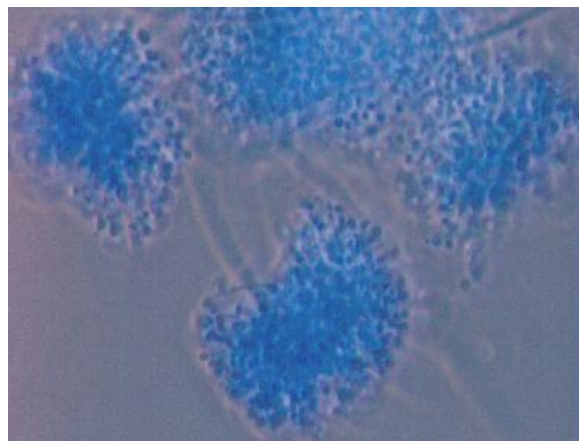
Dr. Graham and his technical assistants collected ants from ant mounds across the state of Alabama. Ants were kept in colonies in the lab and ants were collected as they died naturally. Initially dead ants were scanned utilizing dissecting microscope to observe any fungal spores attached to the ant's exoskeleton. Fifty ants from each ant mound were placed on nutrient mediums utilizing aseptic techniques to culture fungal isolates. All fungal isolates were identified, recorded, collected and for pathogenicity tests. Unknown isolates were subcultures for later identification.

To date 142 ant mounds have been sampled from 20 counties in Alabama. Dead ants were aseptically plated and fungal cultures collected. Thirty-three different genera of fungi have been isolated from the fire ants (Table 1). Of those genera isolated, approximately 10% are considered insect pathogens. *Beauveria sp.*, *Synnematium jonesii*, *Paecilomyces farinosus*, and *Verticillium lecanii* are insect pathogens and may be good candidates for biological control testing. However, of the 7100 ants examined only 7 individual ants have been colonized by a fungal insect pathogen. Thus the natural incidence of colonization in Alabama is less than 0.09%. Several genera of fungi isolated from the Alabama fire ants have never been isolated from fire ants previously. A bacterium was also isolated and identified as *Bacillus lentimorbus*, a known insect pathogen. We are in the process of collecting isolates of all the genera of fungi associated with fire ants in Alabama. These fungal isolates could potentially be microbial insecticides that will be screened for efficacy of fire ant control.

Table 1. Genera of fungi isolated from imported red fire ants in Alabama.

Acremoniella sp.
Alternaria alternata
Alternaria tenuissima
Aspergillus candidus group
Aspergillus fumigatus group
Aspergillus flavus group
Aspergillus parasiticus group
Arthriniium phaeospermum
Beauveria sp.
Chaetomium aureum
Chaetomium bostrychodes
Cladosporium cladosporioides
Cladosporium spp.
Curvularia lunatus
Cochliobolus sativus
Coniella fragariae
Drechslera spp.
Epicoccum purpurascens
Fusarium acuminatum
Fusarium chamydosporum
Fusarium equiseti
Fusarium oxysporum
Fusarium semitectum
Geotrichum candidum
Gliocladium viride
Hersutella sp.
Macrophomina phaseium
Nigrospora sphaerica
Paecilomyces farinosus
Penicillium common series
Penicillium citrinum
Penicillium lilacimum
Penicillium rugulosum series
Penicillium spp.
Periconia macrospinosa
Phoma spp.
Rhizopus stolonifer
Sardaria fimicola
Stigmella sp.
Synnematium jonesii
Talaromyces spp.
Thermomyces langinosus
Thielavia terricola
Tricoderma vardiaae
Tricholosporum beigelii
Verticillium lecanii

Zygorrhynchus heterogamus



Beauveria bassiana isolated from fire ants

Identifying Differentially Expressed Genes between Queens and Workers of the Imported Fire Ant, *Solenopsis Invicta* B.

Nannan Liu and Lee Zhang

Introduction

The red imported fire ant, *Solenopsis invicta* Buren, arrived in Mobile, Alabama from South America during the 1930's and has spread into much of the southeastern United States. Approximately 270 million acres currently are infested. A major limitation in control of fire ants is a lack of understanding of development, reproduction, and defense in fire ants, especially at the molecular level.

Many insect species have different forms with physiological differences. These differences are based on differential gene expression. Fire ant queens and workers are alternative forms of the adult female fire ant. The alternative forms enable fire ants to perform different, and mutually beneficial, roles. For example, queens produce materials that regulate development and reproduction of colony members, while workers develop enhanced defensive and sensory organs. These substantial physiological differences between queen and worker fire ants reflect the differential expression of genes that are present in both forms.

Current Study and Results

DNA microarray is a powerful and versatile technology that allows complex mixtures of RNA and DNA to be examined in a parallel and quantitative fashion. The first step in understanding the molecular basis of the development, reproduction, and defense systems of the fire ant is to isolate the gene(s) involved in the development and reproduction from the fire ant queens. We have used a combination of subtractive hybridization and cDNA microarrays (dot blot arrays) to monitor genes differentially expressed in fire ant queens and workers. We have constructed a fire ant queen-worker subtractive library. One thousand randomly selected clones from the queen-worker subtractive library have been isolated. cDNA fragments (inserts) from these plasmid DNAs were generated by polymerase chain reaction (PCR). Equal amounts (1 μ l \approx 200ng) of each PCR product were arrayed on parallel Nytran membranes (Schleicher and Schuell). By hybridizing the arrays with 32 P labeled cDNA probes of queens and workers, we obtained 16 cDNA clones from the subtractive library of that are specifically expressed in workers but not in queens.

The putative amino acid sequences of these cDNA clones were similar to 1) a pheromone binding protein, 2) an important family of transcription factors (believed to be involved in multiple signaling pathways important in developmental and metabolic processes), 3) an oxidoreductase enzyme family (the major metabolic enzymes), and 4) the vitellogenin gene. Eight cDNA fragments from the sample of queens failed to return significant matches with any existing sequences from either GenBank databases either because the fragments were too short or because they might be unique sequences that had not been published. Discovery of the vitellogenin gene fragment is exciting. This gene is the precursor of egg-yolk protein and is an important factor in reproduction and development.



Fire ant queen and eggs tended by workers.

Significance and Future Direction

The long-term practical goal of our project is to develop the novel strategies to manage the red imported fire ant and to reduce the impact of chemicals on the environment. By isolating the partial vitellogenin (Vg1) gene in the fire ant queen, we have provided a solid framework for designing future experiments. We plan to isolate and characterize the full length of the Vg1 gene from queens and then to initiate a study of genetic manipulation of the Vg1 gene in fire ant queens. Our overall research will provide the first information on the molecular control of development and reproduction of the imported fire ant. This is the first attempt to manipulate the insect genome to better manage the red imported fire ant.

Our research is expected to contribute conceptually, methodologically and materially toward minimizing the use of insecticides for fire ant control and reducing pesticide impact on the environment. Genetic manipulation of the vitellogenin gene in fire ant queens as a possible means of control is based on the species-specific principle that will leave other species unaffected and will be an effective, environmentally benign alternative to the use of insecticides for controlling the fire ant. This research will allow us to apply for research funding from both government agencies (USDA, NIH, and NSF) and industry. If successful, this landmark achievement and biotechnology would have a great impact on both insect pest management and the safety of environment.

Heat Tolerance, Desiccation Tolerance and Water Budgets of Red Imported Fire Ants

Arthur G. Appel and Lawrence Graham

Many imported fire ants are observed dying on disturbed mounds and on bare soil during hot, dry weather. Several experiments are being conducted to determine the effects of hot, cold and arid conditions on ant mortality.

Critical thermal maxima (CTMax) and critical thermal minima (CTMin) are being determined for red imported fire ants in the laboratory. Fire ants are collected from a field adjacent to our lab and are used the day of the collection. Ants are placed in a computer controlled temperature arena designed by the Agricultural Experiment Station Research Instrumentation group. Temperatures are increased or decreased at a rate of 1 °C per minute until the ant is knocked down. Data collection was initiated in May of 2001 and is ongoing. These data will be compared with ambient air and soil temperature data from the Auburn University weather station to determine seasonal changes in fire ant physiology. To date, the CTMax has remained fairly constant throughout the experiment, while the CTMin has fluctuated with field air and soil temperatures.

These studies will provide information on the ability of imported fire ants to survive in various environmental conditions. The findings will be incorporated into management plans for imported fire ants.



‘Sputnik’

Computer controlled temperature arena designed by the Agricultural Experiment Station’s Research Instrumentation group

Implementation of a Fire Ant Management Program in the Tuscaloosa School System

Lloyd Weatherly, Lawrence Graham, and Kathy Flanders, and Arthur Appel.

Objective: Transfer the Tuscaloosa school fire ant management demonstration over to the stakeholders.

Progress: During the past three years, we have developed a site specific fire ant management program for three Tuscaloosa schools. The strategy of mapping fire ant mounds to determine priority areas for treatment with a fire ant bait has worked well. After the second year of the program, fire ant mounds were reduced by 90%. The school principals are very pleased with the results. They have received fewer complaints about fire ants, and have not had to spend so much time or money on fire ant control. This year, we turned the management of the fire ants over to the school system employees.

In May 2000 the principal investigators trained the custodians from the three demonstration schools. We explained the purpose of the project, the principles of fire ant mapping, and demonstrated the use of the equipment that can be used to apply fire ant bait.

Bait was applied to parts of the school site in 2000. Unfortunately, there was no interest in continuing the program in the following year. We believe that the problem is that other insect control and grounds maintenance are contracted out. With custodians and other staff are busy with other duties, it is hard to get them interested in fire ant management. Bait application equipment is still available at the Tuscaloosa County Extension Office.

Resources in 2001 were redirected to Houston Co. A community-wide fire ant demonstration was started there in fall 2001. Results on efficacy should be available in spring 2002.