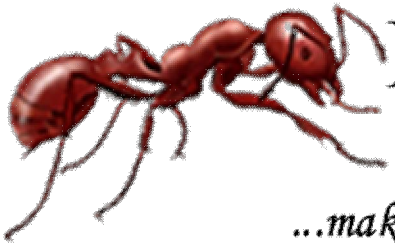
The Alabama Fire Ant Management Program



...making fire ants easier to live with.

PROGRESS REPORT
FY 2003

Entomology and Plant Pathology

AUBURN UNIVERSITY

INSTRUCTION · RESEARCH · EXTENSION

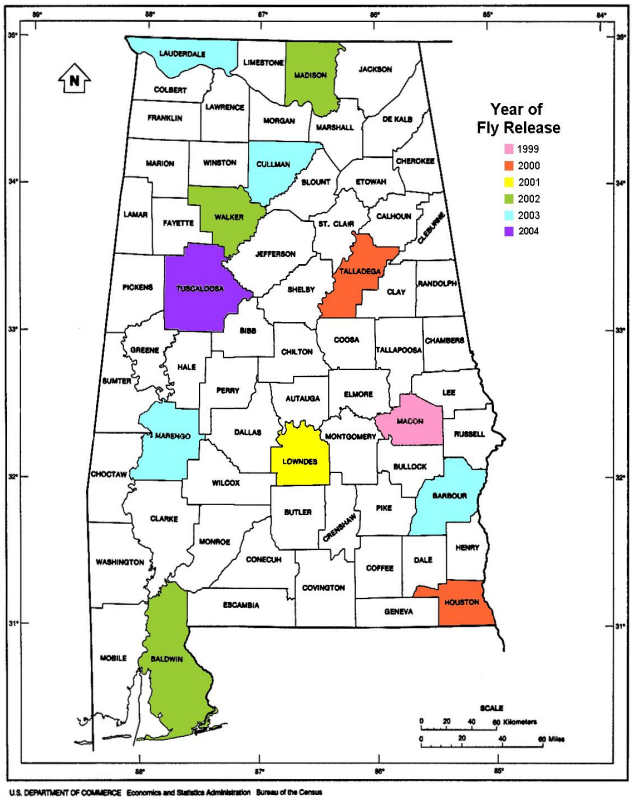
Edited by L.C. "Fudd" Graham and Vicky Bertagnolli

Table of Contents

The Alabama Fire Ant Management Program
...making fire ants easier to live with.

FY2003 Introduction & Summary

Evaluation of Integrated Pest Management (IPM) Methods for Imported Fire Ants: 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.



Pseudacteon tricuspis was released in Macon County in the spring of 1999, Houston County in September 2000, Lowndes County in 2001, Baldwin County in 2002 and Marengo and Barbour counties in 2003. Three years after their initial release, the Macon County flies have spread approximately 30 miles, reaching the Alabama/Georgia state line. Flies have been recovered from all but the Barbour County site. A new release in Tuscaloosa County was just completed.

Pseudacteon curvatus was released in Talladega County in the spring of 2000 and has spread approximately 12 miles from the release site. This was the first successful release of this species in the United States. *P. curvatus* was released in Walker and Madison counties in August and September 2002 and in Lauderdale County and Cullman County in 2003.

A survey is currently underway to catalogue all ant species present in Alabama. This will provide information on native and other imported species of ants competing with imported fire ants. Imported fire ants are collected and mapped to establish the ranges of the two fire ant species (and the hybrid) present in Alabama. This information is required so that phorid fly releases are conducted in localities with the correct fire ant species.

A bait product trial for Aventis Environmental Science was completed at Moton Field Municipal Airport in Tuskegee, AL. Fire ant baits are also being evaluated in areas with phorid flies to determine if the biological control agents delay reinfestation by fire ants.

Imported Fire Ant Education and Outreach: The Alabama Fire Ant Management Program's educational exhibit participated in Auburn University's College of Math and Science YES Camp, the Alabama National Fair, the Southeastern Agricultural Exposition, Dothan's 60th Annual National Peanut Festival, The Baldwin County Fair and fairs in Walker and Barbour counties. In July, the exhibit participated in the Annual Oxbow Meadows Insect Festival in Columbus, GA. The exhibit includes informational posters, publications, children's activity books, preserved specimens, live fire ants, live decapitating flies, a live decapitating fly demonstration, and casts of fire ant tunnel systems which spark curiosity in the thousands of passers-by. Approximately 1,500 publications and 12,000 activity books were distributed this year. These exhibits give us a chance to explain basic fire ant biology to children as well as offer management strategies to their parents. The Science of Fire Ants workshop was presented to Dr. Wayne Clark's Entomology for Educators Class.

We continued our education efforts in fire ant management. We particularly wanted to get information to the employees at garden centers because they advise so many homeowners on fire ant management and to extend our efforts to Alabama cattlemen because Alabama's four million acres of grass pastures harbor approximately 160 million fire ant colonies.

Videoconferencing was used to bring the expertise of two Extension specialists from Texas A&M University to county agents and cattlemen in three Alabama counties. The presentations prepared for this training session were re-recorded by the Texas Cooperative Extension Service and distributed on DVD. A companion publication, 'Managing Fire Ants in Cattle Production Systems', was authored by specialists at Auburn University and Texas A&M University, and will be published in spring 2004.

County agents from Dale, Henry, and Houston counties, in cooperation with the National Peanut Festival, implemented a bait demonstration. A 50 acre area of the fair grounds was treated with recommended baits in September. Data suggests that the 125,000 fair attendees had no complaints regarding fire ant infestations.

Fire Ants in Crops: Imported fire ants are efficient and voracious predators of most major insect pests in crops, especially cotton, but not in soybean. Fire ants are less effective predators in soybean even though they are abundant in Alabama soybean fields. Previous data suggest that fire ants increase aphid survival through predator interference. Presently, however, Alabama soybean does not host aphids, but the soybean aphid has begun to invade North America. Future work will determine if the increase

in soybean aphids will increase imported fire ant predation on crop pests.

Energy Costs in Red Imported Fire Ants: All animals require energy to develop, grow, and move. Experiments are being conducted to determine the amount of energy fire ants need while resting, moving, working, and searching for food. By measuring how much energy fire ants use to work and bring food back to the colony, we can optimize the size and weight of bait granules to develop more effective bait products.

Gene Manipulation as a Tool for Imported Fire Ant Control: Isolation, characterization, and genetic manipulation of the gene(s) involved in development and reproduction are continuing. Results suggest that three genes (the vitellogenin gene, putative pheromone binding gene, and cytochrome P450 expression) play a role in growth and reproduction of the fire ant. Understanding the molecular basis of development, reproduction, and caste differentiation of the fire ant could lead to the development of novel strategies to manage the fire ant. It will also provide a solid framework for designing future experiments on gene regulation in growth, reproduction, and caste differentiation. This work is the first attempt to manipulate the fire ant genome.

Ovarian and Embryonic Development of Fire Ants: Although ants are widely studied, this is the first study on embryonic development of the ant family, Formicidae. Results indicate that ants possess specific development patterns differentiating them from other Hymenopteran orders.

What else we accomplished: Dr. Michael L. Williams was elected President of the Southeastern Branch of the Entomological Society of America for 2003-2004.

18 Publications 32 Scientific presentations 17 Mass media 6 Displays 20 Outreach presentations

The Alabama Fire Ant Management Program
...making fire ants easier to live with.

Alabama Fire Ant Management Program Personnel and Cooperators

AuburnUniversity
Department of Entomology & Plant Pathology

Advisory Committee
Michael L. Williams, Ph.D. & 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 & Soils

Micky D. Eubanks, Ph.D.
Henry Fadamiro, Ph.D.
Ping Hu, Ph.D.
Nannan Liu, Ph.D.
Vicky Bertagnolli
Jason Forster
Chad Harvey
Ian Kaplan
John Styrsky
Marla Tanley

Alabama Cooperative Extension System
Danny Cain – Walker Co.
David Lee Daniel – Lowndes Co.
Henry D. Dorough – Talladega Co.
Marla Faver – Baldwin Co.
Rickey G. Hudson – Houston Co.
Charlie Mason – Barbour Co.
Richard W. Murphy – Houston Co.
Charles Pinkston – Cullman Co.
Kevan Tucker – Marengo Co.

Tuskegee Cooperative Extension System
George Hunter

Acknowledgements
Mel Garbett – Ambrands, Inc.
Doug VanGundy – Wellmark International

Alabama Department of Agriculture & Industries

Alabama Agricultural Experiment Station

Alabama A & M
Department of Plant & Soil Science
Ken Ward, Ph.D.
Rufina Ward, Ph.D.

USDA-ARS
Sanford D. Porter, Ph.D.
Anne-Marie Callcott
Larry Thead, Ph.D.
Doug Streett, Ph.D.

Local Cooperators
Mr. & Mrs. F.D. Alexander – Cullman Co.
Joe Carothers - Houston Co.
Lynn Crocker – Marengo Co.
Jim Davis - Lowndes Co.
Mike Duke - Talladega Co.
Lee Fenn – Barbour Co.
Tim & Susan Gaasch - Macon Co.
Butch Garner – Macon Co.
Dorman Grace – Walker Co.
Beth Guertal - Lee Co.
George Hunter - Lowndes Co.
Mark Kaiser & Hillandale Farms – Baldwin Co.
Pyron Keener - Montgomery Co.
Col. Roosevelt "Ro" Lewis (Ret.) - Moton Field Municipal Airport – Macon Co.
John McDaniel - Houston Co.
Abbot Cletus Meagher & St. Bernard Abbey Farm – Cullman Co.
Merkel Field Sylacauga Municipal Airport
Greg Myrick - Talladega Co.
Tony & Diane Silva - Macon Co.
Sarah & David Spivey – Baldwin Co.
Todd Storey & Auburn-Opelika Robert G. Pitts Airport – Lee Co.
Talladega Superspeedway – Talladega Co.
Joe Touchton - Lee Co.
Carolyn & Michael Williams - Macon Co.

Sincere apologies to anyone inadvertently omitted from this list

Educational Materials, Presentations, Publications

Publications

Appel, A. G., M. J. Gehret, and M. J. Tanley. 2003. Repellency and toxicity of mint oil granules to red imported fire ants (Hymenoptera: Formicidae). J. Econ. Entomol. (Submitted).

Eubanks, M.D., S.A. Blackwell, C.J. Parrish, Z.D. DeLamar, and H. Hull-Sanders. 2002. Intraguild predation by an invasive ant: The effects of red imported fire ants on beneficial arthropods in cotton. Environmental Entomology 31:1168-1174.

Flanders, K. 2003. Fire Ant Control Materials for Homeowners. Alabama Cooperative Extension System Circular ANR-175a.

Flanders, K. 2003. Imported Fire Ants in Lawns, Turf, and Structures. Alabama Cooperative Extension System Circular ANR-175, Revised.

Flanders, K. L. and F. Graham. Revised 2003. Getting the most out of your fire ant bait application. Circular ANR-1161 Alabama Cooperative Extension System (ACES), 4 p.

Flanders, K. L., S. Porter, and D. Oi. 2003. Biological control of imported fire ants. Circular ANR-1149 ACES, 2 p. revised.

Flanders, K. L., X. P. Hu, and F. Graham. What is the best way to control fire ants? Timely Information Sheet, Pest Management Series, Alabama Cooperative Extension System.

Graham, L. C. ♣Fudd♠, Sanford D. Porter, Roberto M. Periera, Henry D. Dorough, and Amber T. Kelley. 2003 Field releases of the decapitating fly *Pseudacteon curvatus* (Diptera: Phoridae) for control of imported fire ants (Hymenoptera: Formicidae) in Alabama, Florida, and Tennessee. Florida Entomol. 86: 335-340.

Graham, L.C., S.D. Porter, V.E. Bertagnolli. In Press. Phorid flies in Alabama: A tale of two species. J. Agric Urban Entomol. Fall 2004.

Harvey, C.T. and M.D. Eubanks. 2003. Effect of habitat complexity on biological control by the red imported fire ant (Hymenoptera: Formicidae) in collards. Biological Control.

Harvey, C.T. and M.D. Eubanks. In review. Fire ants do not interfere with parasitism of cole crop caterpillars. Entomologia Experimentalis et Applicata.

Hooper-Bùi, L. M., A. G. Appel, and M. K. Rust. 2002. Preference of food particle size among several urban ant species. J. Econ. Entomol. 95: 1222-1228.

Kaplan, I., and M.D. Eubanks. 2002. The effects of an ant – aphid mutualism on biological control: fire ants protect cotton aphids from predation. Environmental Entomology 31:1175-1183.

Kaplan, I. and M.D. Eubanks. In review. Effects of a keystone interaction on an arthropod community. Ecology.

Kaplan, I. and M.D. Eubanks. 2002. Higher-order predation by red imported fire ants (Hymenoptera: Formicidae) and its impact on cotton aphid (Homoptera: Aphididae) populations. Pp. 43-44 in Proceedings of the 2002 Imported Fire Ant Conference.

Kaplan, I. and M.D. Eubanks. 2002. The effect of red imported fire ants on cotton aphid outbreaks in Alabama cotton. P. 4, 2001 Cotton Research Report, Research Report Series, Number 22, K.S. McLean and D.L. Monks, eds. Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama.

Liu, Nannan and Lee Zhang. 2004. CYP4AB1, CYP4AB2, and GP-9 gene overexpression associated with workers of the red imported fire ant, *Solenopsis invicta* Buren. Gene 327, 1-7.

Vogt, J. T., T. G. Shelton, M. E. Merchant, S. A. Russell, M. J. Tanley, and A. G. Appel. 2002. Efficacy of three citrus oil formulations against *Solenopsis invicta* Buren (Hymenoptera:

Formicidae), the red imported fire ant. J. Agric Urban Entomol. 19: 159-171. (Published 2003).

Xu, Y., Hu, X.P., and Williams, M. 2003. Morphological Embryonic Development of the Imported Red Fire Ant *Solenopsis invicta* Buren (Hymenoptera: Formicidae) Proceedings of 2003 Red Imported Fire Ant Conference (in press).

Presentations

Appel, A. G., and M. J. Tanley. 2003. Repellency and toxicity of mint oil granules to red imported fire ants. Imported fire ant conference, Palm Springs, CA.

Appel, A. G., and M. J. Tanley. 2003. Effects of temperature and relative humidity on water regulation of alate red imported fire ants. Imported fire ant conference, Palm Springs, CA (poster).

Appel, A. G. 2003. Insecticides and formulations used to control household pests, In-service county agent training program, Alabama Cooperative Extension System, Auburn, AL. Streaming video internet session.

Appel, A. G. 2003. How to control ants, bees and wasps, In-service county agent training program, Alabama Cooperative Extension System, Auburn, AL.

Appel, A. G. 2003. Miscellaneous stinging and poisonous pests you may encounter, Alabama Cooperative Extension System, Auburn, AL.

Appel, A. G. 2003. Products and formulations used in ant control, In-service county agent training program, Alabama Cooperative Extension System, Columbiana, AL.

Bertagnolli, V.E., L.C. Graham, A.G. Appel. 2003. Seasonal effects of temperature on red imported fire ants. Entomological Society of America, Southeastern Branch Meeting, Baton Rouge, LA.

Bertagnolli, V.E., L.C. Graham, A.G. Appel. 2002. Seasonal variation in temperature sensitivity of the red imported fire ant. Entomological Society of America Annual Meeting, Fort Lauderdale, FL.

Bertagnolli, V. E., L. C. Graham, A. T. Kelley, and R. Lumpkin. 2002. An IPM pilot project in the Auburn City School System: A model for the state of Alabama. Poster presented at the 76th annual meeting of the Southeastern Branch of the Entomological Society of America, Little Rock, Arkansas.

Eubanks, M.D. and I. Kaplan. Potential economic benefits and costs of the red imported fire ants in Southeastern cotton. 2002 National Beltwide Cotton Insect Conference, Atlanta, Georgia, January 2002.

Eubanks, M.D. Pervasive invasives and complex food webs: the effects of fire ants on biological control. Departmental Seminar, Department of Entomology, University of Illinois, November 2003.

Graham, F. 2003. Phorid flies in Alabama: A tale of two species. F. S. Arant Entomology Club, Department of Entomology and Plant Pathology, Auburn University, Auburn, AL.

Graham, L.C., S.D. Porter, V.E. Bertagnolli. 2003. Phorid flies in Alabama: A tale of two species. Entomological Society of America, Southeastern Branch Meeting, Baton Rouge, LA.

Graham, L.C., S.D. Porter, V.E. Bertagnolli. 2002. Phorid flies in Alabama: Have fire ant populations been affected? Entomological Society of America Annual Meeting, Fort Lauderdale, FL.

Graham, L. C., V. E. Bertagnolli, S. D. Porter, H. D. Dorough and A. T. Kelley. 2002. Establishment of the phorid fly, *Pseudacteon curvatus*, in Alabama for biological control of imported fire ants. Poster presented at the 76th annual meeting of the Southeastern Branch of the Entomological Society of America, Little Rock, Arkansas.

Harvey, C.T. and M.D. Eubanks. Effects of red imported fire ants and habitat complexity on biological control in collards. 2002 Imported Fire Ant Conference, Athens, Georgia, March 2002.

Harvey, C.T. and M.D. Eubanks. Red imported fire ants: Positive contributors to biological control in cole crops. Annual Meeting, Southeastern Branch Meeting of the Entomological Society of America, Little Rock, Arkansas, March 2002.

Harvey, C.T. and M.D. Eubanks. Effects of habitat complexity on food webs. Annual Meeting, Ecological Society of America, Savannah, GA, August 2003.

Hu, X.P., Burkett, N. How to Manage Household Ants and Cockroaches (Fire ant embryonic development was presented as part of the presentation). In-service training: IST2703. 4-H Center, February 2003.

Kaplan, I. and M.D. Eubanks. Keystone mutualisms and the ecological consequences of manipulation: cascading effects of an ant-aphid interaction. 87th Annual Meeting, Ecological Society of America, Tucson, Arizona, August 2002.

Kaplan, I. and M.D. Eubanks. Higher-order predation by red imported fire ants (Hymenoptera: Formicidae) and its impact on cotton aphid (Homoptera: Aphididae) populations. 2002 Imported Fire Ant Conference, Athens, Georgia, March 2002.

Kaplan, I. and M.D. Eubanks. Ant-aphid mutualism disrupts biological control: red imported fire ants mediate population dynamics of cotton aphids. Annual Meeting, Southeastern Branch Meeting of the Entomological Society of America, Little Rock, Arkansas, March 2002.

Kaplan, I. and M. D. Eubanks. Aphids as beneficial insects? Effects of a cotton aphid-fire ant mutualism on biological control. Annual Meeting, Imported Fire Ant Conference, Anaheim, CA, March 2003.

Kaplan, I. and M. D. Eubanks. Aphids as beneficial insects? Effects of a cotton aphid-fire ant mutualism on biological control. Annual Meeting, Entomological Society of America, Southeastern Branch Meeting, Baton Rouge, LA, March 2003.

Kaplan, I. and M. D. Eubanks. Aphids as beneficial insects? Effects of a cotton aphid-fire ant mutualism on biological control. Annual Meeting, Beltwide Cotton Conference, Nashville, TN, January 2003.

Kaplan, I. and M.D. Eubanks. Multrophic effects of a fire ant – cotton aphid mutualism. Annual Meeting, Ecological Society of America, Savannah, GA, August 2003.

McLean, K. S., and F. Graham. 2002. The science of fire ants: a workshop for science teachers. Poster presented at the 76th annual meeting of the Southeastern Branch of the Entomological Society of America, Little Rock, Arkansas.

Porter S. D., S. J. Johnson, L. C. Graham, P. M. Horton and T. Lockley. 2002. Release and establishment of the fire ant decapitating fly, *Pseudacteon tricuspis,* in the southeastern United States. Poster presented at the Annual Meeting of the Entomological Society of America, Ft. Lauderdale, Florida.

Styrsky, J.D. and M.D. Eubanks. Differential effects of a higher order predator in two agroecosystems. 87th Annual Meeting, Ecological Society of America, Tucson, Arizona, August 2002.

Styrsky, J.D. and M.D. Eubanks. Variation in the effects of a keystone predator on community structure. Annual Meeting, Ecological Society of America, Savannah, GA, August 2003.

Tanley, M. J., and A. G. Appel. 2003. Performance of organic insecticides as individual mound treatments against red imported fire ants. Imported fire ant conference, Palm Springs, CA (poster).

Xu, Y., Hu, X.P. and Williams, M. 2003. Embryology of imported red fire ant. Red Imported Fire Ant Conference. March 30 – April 1 Palm Springs, California.

Mass Media

- Magazine article, Fire Ants: The Past, the Present, the Future, Alabama Coop Magazine
- Three newspaper articles on Cullman County phorid fly release
- Six television spots on Cullman phorid release
- Television spot on Marengo County phorid release - WAKA
- Newspaper article on Marengo County phorid release
- Newspaper article on Barbour County phorid release
- Television spot at School Day during Baldwin County Fair
- Television spot on School IPM – Channel 9, WTVM

ACES Press Releases

- 2 ACES press releases on Marengo County and Cullman County phorid release

Educational Displays

- Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Ag Roundup on Auburn Campus, (Nov. 1, 2003).
- Prepared educational booth on The Alabama Fire Ant Management Program at 60th Annual National Peanut Festival in Dothan, Alabama, (Oct. 31-Nov. 8, 2003).
- Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Sunbelt Agricultural Exposition in Moultrie, Georgia, (Oct. 14-16, 2003).
- Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Alabama National Fair, (Oct. 3-12, 2003).
- Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Oxbow Meadows Insectival Festival. Columbus State University, Columbus, Georgia, (7/13/03).
- Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Callaway Gardens. Pine Mountain, Georgia.
- Prepared and staffed children's educational booth on The Alabama Fire Ant Management Program at Baldwin County Fair Gardens. Robertsdale, Alabama.
- Prepared educational booth for use at fairs in Walker and Barbour Counties.

Other Outreach Activities

- Fire Ant Control Options for the Homeowner in Pests and Pesticides In-Service Training, via streaming video, Feb. 11, 2003.
- Fire Ant Biology and Management in Household Ants In-Service Training, Feb. 13, 2003.
- Fire Ant Training for Lowe's Employees, Huntsville, February 19, 2003. (12 people)

- Fire Ant Workshop for Retailers, Montgomery Co. Extension Meeting, March 3, 2003. (18 people)
- Fire Ant Management for City and County Grounds Personnel, Muscle Shoals, March 17, 2003. (10 people)
- Declare WAR on Fire Ants, Muscle Shoals, March 17, 2003. (25 people)
- Fire ant management meeting for Wal-Mart Employees, Guntersville, March 20, 2003. (Flanders and Wheeler) (9 people)
- Managing Fire Ants, in Alabama Turfgrass Association Sports Turf Short Course, Mobile, March 25, 2003. (35 people).
- Managing fire ants in cattle operations, Auburn, Al, videoconferenced to Colbert and Baldwin Co. April 15, 2003 (Flanders, Drees, and Barr). (15 people)
- Fire Ant Management for Lawn and Garden Center Personnel, Mobile CO., April 21, 2003. (for this meeting we developed bookmarks with fire ant information and information about the local office of the Alabama Cooperative Extension System. (25 people)
- Managing Fire Ants, in Alabama Turfgrass Association Sports Turf Short Course, Birmingham, May 21, 2003. (75 people)
- Fire Ant Biology, Forestry of Youth Field Day and Tour, Bullock Co., May 12 and May 14. (240 people)
- Stop Chasing those fire ants around, North Shelby Co., May 29, 2003. (20 people)
- Managing fire ants in cattle operations, Repton, AL June 10, 2003. (12 people)
- Tour of fire ant facilities for YES Camp. Auburn University College of Science and Mathematics, (6/26/03).
- Montgomery Beef Producers – presentation
- Five visits to State House
- Extension in-service training presentation on fire ant stings
- CSREES presentation on Alabama Fire Ant Management Program
- Five training visits to Pritchard, AL on school IPM
- Nine presentations at 4-H Farm Safety Day
- Tour for School IPM training video with Joe Debrow, Dept. Ag. & Ind.
- Alabama Turfgrass Meeting - presentation

Field Demonstrations and Experiments

- April 2003 *P. curvatus* released in Lauderdale County
- April 2003 *P. tricuspis* released in Marengo County
- May 2003 *P. curvatus* released in Cullman County
- September 2003 *P. tricuspis* released in Barbour County
- One fire ant bait trial was completed for Aventis Environmental Science at Moton Field Municipal Airport in Tuskegee, AL.
- Fire ant bait trials in Talladega, Sylacauga and Notasulga in conjunction with ongoing phorid fly projects.

Honors and Awards

- Dr. Michael L. Williams was elected President of the Southeastern Branch of the Entomological Society of America for 2003-2004.

Fire Ant Education and Outreach

Kathy Flanders, Lawrence "Fudd" Graham, Kathy Lawrence, and Vicky Bertagnolli

Objectives

1) Provide the public with information about fire ants with exhibits at the Alabama National Fair, the Southeastern Ag Expo, the Peanut Festival, and other events.
2) Conduct education programs for future school teachers, garden center personnel, and other teacher/trainers to develop a statewide base of fire ant "experts."

Fire ant Educational Exhibit

An exhibit was prepared for the Alabama National Fair by Fudd Graham and Vicky Bertagnolli. The exhibit includes informational posters, publications, children's activity books, preserved specimens, live fire ants, live decapitating flies, a live decapitating fly demonstration, and casts of fire ant tunnel systems which spark curiosity in the thousands of passers-by. This exhibit is always 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 gives us a chance to explain the basics of fire ant biology to the children, and both the basics of fire ant biology and management to their parents. The booth was staffed for the duration of the fair by participants of the Alabama Fire Ant Management Program.

At Moultrie, Georgia's Southeastern Agricultural Exposition, the exhibit was voted the best of the Auburn University exhibits for the second year in a row. It drew crowds of people to look at two species of decapitating fly attacking fire ants.

The exhibit was on display at Auburn University's College of Agriculture Annual Ag Roundup at the newly built Ag Heritage Park. It was also invited to the Turfgrass Field day, but we were unable to staff it due to previous commitments.

The exhibit is now being used not only by the Alabama Fire Ant Management Program, but also by county agents. Extension agents in Houston and Henry counties worked with Master Gardeners to staff the exhibit at its first appearance at Dothan's 59th Annual National Peanut Festival in Dothan where workers distributed approx. 3000 coloring books. Charlie Mason used the exhibit for two educational programs in Barbour County. Danny Cain used the exhibit at the week long Walker County Fair. Graham staffed the exhibit at School Day during the Baldwin County Fair. The exhibit was also used at the Annual Oxbow Meadows Insect Festival in Columbus, GA and at Callaway Gardens in Pine Mountain, GA.

Educational programs for future school teachers, garden center personnel, and other teacher/trainers

The Science of Fire Ants workshop was presented to 20 students in Dr. Clark's Entomology for Educators Class. We expanded our education efforts in fire ant management. We especially wanted to get information to the employees at garden centers because they advise so many homeowners on fire ant management and to extend our efforts to Alabama cattlemen because Alabama's four million acres of grass pastures harbor approximately 160 million fire ant colonies.

Videoconferencing was used to bring the expertise of two Extension specialists from Texas A&M University to county agents and cattlemen in three Alabama counties. The

presentations prepared for this training session were re-recorded by the Texas Cooperative Extension Service and distributed on DVD. A companion publication, 'Managing Fire Ants in Cattle Production Systems', was authored by specialists at Auburn University and Texas A&M University and will be published in spring 2004.

County agents from Dale, Henry and Houston counties, in cooperation with the National Peanut Festival, implemented a bait demonstration. A 50 acre area of the fair grounds was treated with recommended baits in September. Data suggests that the 125,000 fair attendees had no complaints regarding fire ant infestations.

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

Lawrence Graham, Kathy Flanders, Henry Fadimiro, Vicky Bertagnolli, Dept. Entomology, Auburn University, Henry Dorough, Rickey Hudson, Michael Oglesby, Marla Faver, Danny Cain, Alabama Cooperative Extension System

Objectives

1) Continue to monitor reinfestation of fire ants at rural agricultural operations/cemeteries following four years of IFA control using baits.
2) Release and evaluate the effectiveness of two species of phorid fly.
3) Determine the effect of PGPR's on fire ant populations.
4) Determine effect of *P. curvatus* activity on foraging fire ants.
5) Determine habitat preferences of phorid flies.
6) Begin survey of location of red, black and hybrid fire ants in Alabama
7) Begin survey of polygyne IFA sites in Alabama

1) Data were collected in Montgomery and Baldwin counties at a rural agricultural operation and two cemeteries. The data will be used to assess reinfestation by fire ants and effects on other local ant populations following four years of IFA control using baits

2) Two biological control agents of fire ants, known as phorid flies or decapitating flies, have now been released in twelve counties in Alabama, and are established in ten (four releases in FY2003). *Pseudacteon tricuspis* has been successfully established in Macon County, Lowndes County, Houston County, Baldwin County and Marengo County. To date, flies have spread over 30 miles and 5 miles, respectively from the Macon and Lowndes sites. Flies are present at the Houston County site, but movement of the flies from the release site has not been detected. A release of *Pseudacteon tricuspis* was conducted in Barbour County in September. Flies have not been seen at the site yet, but a thorough search will not be conducted until late spring/early summer. A seventh release of *Pseudacteon tricuspis* in Tuscaloosa County was completed in April 2004. *Pseudacteon curvatus* is successfully established in Talladega County, Walker County and Cullman County. Flies have spread over

15 miles from the Talladega release site. Two releases of this species were conducted in 2002. The first release of *Pseudacteon curvatus* was in 2002 by Ken Ward and Rufina Ward of Alabama A&M near Huntsville in Madison County. They made a second release of this species in 2003 in Lauderdale County. The Lauderdale, Cullman and Walker release sites are part of a multi-state cooperative study with Auburn University, Alabama A&M University, and Tennessee State University.

The release in Baldwin Co. generated good publicity for the program, with four television news spots, two newspaper articles, and two ACES press releases. Press coverage was also good at the Huntsville release and the Walker County release.

Data are collected twice yearly at all sites in cooperation with the USDA in Gainesville, FL, Biloxi, MS and Starkville, MS and fly dispersal is monitored. A paper on the first successful release of *P. curvatus* in the United States is in the fall issue of the *Florida Entomologist.*

Fire ant bait trials were established in areas where each phorid fly is established (Talladega and Macon Counties) and at a site with no phorid flies (Sylacauga). Data are currently being collected monthly at all three sites.

3) PGPR's were applied to a test site in Lee County. Data are still being collected on fire ant mortality at the site.

4&5) Sampling is currently underway monthly to determine the diurnal pattern of phorid activity at both the Macon Co. site (*P. tricuspis*) and the Talladega Co. site (*P. curvatus*). Data were collected in cooperation with S. Porter, Gainesville, FL on host specificity of *P. curvatus* on imported and native ants. Data on other foraging activity and habitat preference were not taken due to excess rainfall during the summer that delayed data collection at all phorid sites and shifted priorities.

6&7) A grid was established for the state of Alabama and ants have been collected for species determination. No polygyne sites were noticed at the sites through visual assessment, but

mounds were not sampled since ants for species determination were collected during late June and July when high temperatures made collection of queens difficult.

In addition, 69 acres of fire ant bait trials were established in cooperation with Aventis Environmental Science and Valent Biosciences Corporation in 2002 to evaluate fire ant baits. Final data were collected in these trials in June 2003.

Why Are Fire Ants Less Effective Predators of Soybean Pests than Cotton Pests?

Micky D. Eubanks

We have previously documented intense predation of insect pests by the red imported fire ant, *Solenopsis invicta* (Buren) (Hymenoptera: Formicidae) in cotton, but not in soybean. Fire ants are less effective predators of insect pests in soybean even though fire ants are very abundant in Alabama soybean fields. We tested the hypothesis that high densities of trichomes (hair-like structures, fig.1) on soybean plants interfered with fire ant foraging and prevented fire ants from being effective predators of caterpillars, plant bugs, and other crop pests. Trichomes are far denser on the stems and leaves of soybean plants than on cotton plants. We conducted a series of greenhouse and field experiments using different isolines of soybean (nearly genetically identical varieties) that differed only in the number of trichomes (trichome density) to test this hypothesis. We predicted that fire ant predation of crop pests would be most intense on the soybean variety with no trichomes (glabrous), moderately intense on the variety with few trichomes, and least intense on the soybean variety with very dense trichomes. The results of greenhouse and field experiments, however, did not support our hypothesis. Although the abundance of some pests (e.g., leafhoppers and treehoppers) and some beneficial insects (e.g., big-eyed bugs) were affected by trichome density, the abundance of fire ants was not affected by trichome density. In addition, the number of prey captured by fire ants on soybean plants was not affected by trichome density. We believe that

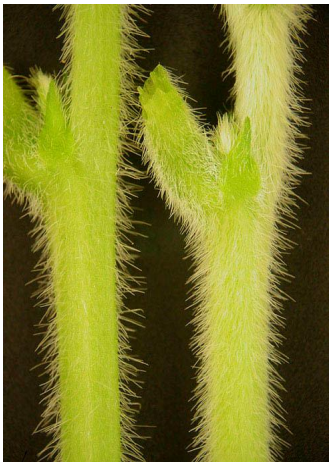


Figure 1. Hair-like structures on soybean plant called trichomes.

the presence of aphids in cotton and not differences in plant morphology are responsible for the strong impact of fire ants in cotton versus soybean. We have previously shown that fire ants are strongly attracted to cotton aphids because the aphids produce a rich sugary excretion called honeydew. Fire ants harvest this sugary secretion and aggressively defend this resource. They defend the aphids by viciously attacking all other insects on the cotton plants, including pest insects such as caterpillars and beneficial insects such as big-eyed bugs. Alabama soybean does not presently host aphids, although the soybean aphid, *Aphis glycine* (fig.2), has recently begun to invade North America and will probably arrive in Alabama within the next year or two. Future research will determine if the arrival of the soybean aphid stimulates fire ants to attack large numbers of insects in soybean as they do in cotton.

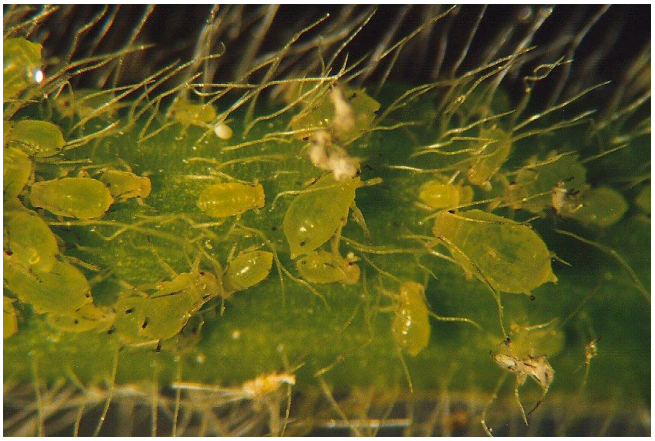


Figure 2. Soybean aphids, *Aphis glycine*.

Energetics of Foraging and Load Carriage and Temperature Acclimation of Red Imported Fire Ants, *Solenopsis invicta* Buren

Arthur G. Appel and Lawrence C. Graham

Energetic costs of movement and foraging speed of red imported fire ants: Results

Various sized red imported fire ant, *Solenopsis invicta* Buren, workers were confined individually in specially designed 64 cm long running tube respirometers. The position of the ant within the running tube and the amount of CO_2 produced by the ant were recorded every 0.5 seconds for 1 hour. Dry, CO_2 – free air was drawn through the running tube at a rate of 100 ml/min and into a Sable Systems TR-3 respirometry system. CO_2 production data were converted from ppm to rates of µl/h; position data were differentiated with respect to time (min) resulting in speed in units of cm/min. For sustained movements, average ant speed ranged from 28 to >110 cm/min and increased linearly with ant size (mass; mg) as seen in Fig. 1. Individual ants were, however, capable of brief (1-5 sec) bursts that reached speeds of >2,000 cm/min.

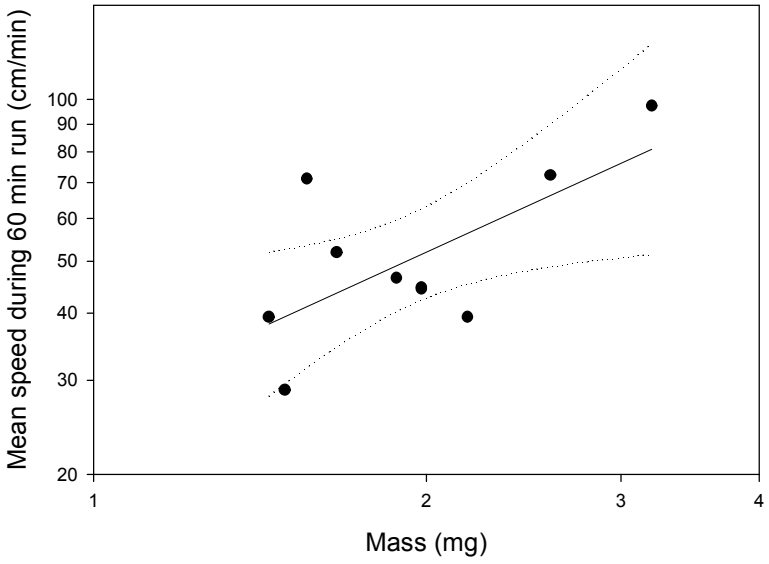


Figure 1. Effects of red imported fire ant worker size (mass; mg) on average running speed.

Individual recordings of ant movement and CO_2 production were dissected into periods of movement and resting. Resting ants had CO_2 production rates that averaged ≈2 ml/h (Fig. 2). Ants that moved produced significantly more CO_2 than resting ants. CO_2 production rates increased linearly with increasing ant speed (Fig. 2).

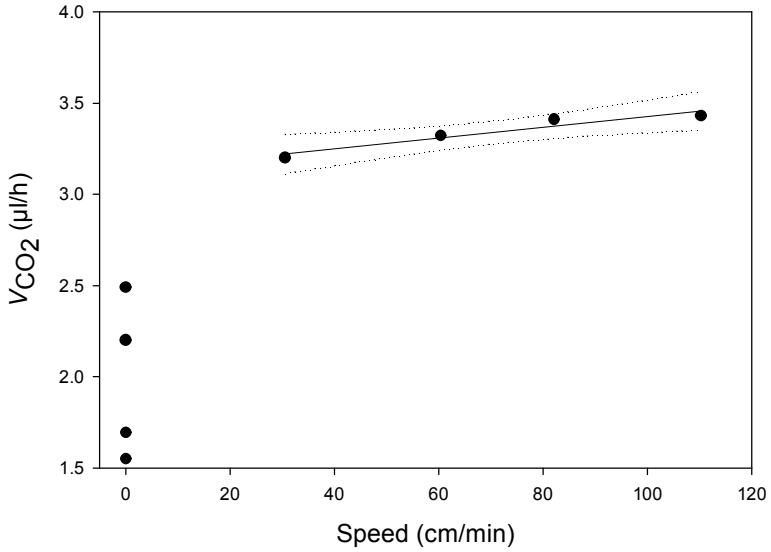


Figure 2. Comparison of CO_2 production rates by moving and resting worker red imported fire ants.

Practical applications of this research

All animals require energy to develop, grow, and move. We are measuring the amount of energy (as CO_2 production) that fire ants need while they are resting and moving. For a fire ant colony to survive and grow, workers must travel to bring food (energy) to the colony. Workers are able to measure the energy value of food, and then carry pieces of food back to the colony. By measuring how much energy it takes for a worker fire ant to move at different speeds and to carry different amounts of food, we can optimize the size and weight of granules of fire ant bait. In addition, we can measure the energetic costs that fire ants incur when they are attacked by phorid flies.

Gene Regulation In Growth and Reproduction of the Imported Fire Ant: Cloning and Sequencing Full-Length of

Nannan Liu and Lee Zhang

Recently, 16 cDNA fragments, including the vitellogenin gene (*Vg1*) fragment, a putative pheromone binding gene (*Gp-9*), and two putative cytochrome P450 gene fragments, from the red imported fire ant have been identified in my laboratory. We have demonstrated that the expression of P450 genes, *Gp-9*, and *Vg1* are developmentally and caste specifically regulated in red imported fire ants. Levels of P450 mRNAs were undetectable in 3rd and 4th instars, worker pupae, and alate (mixed sex) pupae; readily detectable in male and female alates; increased in the queens; and rose to a maximum in workers. Levels of *Gp-9* mRNA were readily detectable in male alates; increased in female alates; and reached a maximum in workers. Levels of *Vg1* mRNA were only overexpressed in female alates and queens. Their caste- and developmental-specific overexpression suggests the functional importance of P450 genes, *Gp-9*, and *Vg1* in the development and caste differentiation of the red imported fire ant.

Insect cytochrome P450s are implicated in the biosynthesis and degradation pathways of endogenous compounds, such as pheromones, 20-hydroxyecdysone, and juvenile hormone, and thus, play important roles in insect growth, development, and reproduction. Although cytochrome P450s have been extensively studied in some insect species, almost nothing is known about functions of P450s in the social insects, including ants, wasps, bees, and termites. Thus, cloning and sequencing of the full-lengths of these two putative P450 fragments will enable us to investigate the functions of the genes in the red imported fire ant.

Current Study and Results

To isolate and amplify the 3' and 5' ends of the putative P450 clones, 3' and 5'-RACE was conducted using the Marathon^{Tm} cDNA Amplification Kit (Clontech) as described by the manufacturer. The sequences of the cDNA fragments amplified by 3' and 5'-RACE perfectly overlapped the sequences of the putative P450 clones, indicating that they are in fact the 3' and 5' ends of the putative P450 genes. The full-length cDNA sequence of the first P450 clone has an open reading frame of 1533 nt encoding a putative protein of 511 amino acids (Fig. 1). The putative protein sequence shared a 43% identity with *Blaberus discoidalis* CYP4C1 and *Helicoverpa zea* CYP4M7 and was thus named CYP4AS1 (accession number: AY345971) by the P450 nomenclature committee (D. Nelson, personal communication). The full-length cDNA sequence of the second clone has an open reading frame of 1389 nt encoding a putative protein of 463 amino acids (Fig. 2). The putative protein sequence shared a 51% identity with *Tribolium castaneum* CYP4Q2 and *Helicoverpa armigera* CYP4M4, and was thus named CYP4AB1 (accession number: AY345970) (Liu and Zhang 2003). *CYP4AB1* and *CYP4AS1* are the first two full-length cytochrome P450 genes cloned and sequenced from the fire ant and the social insects.

Figure 1. The cDNA/deduced protein sequences of *CYP4AS1*. Invariant and highly conserved motifs in CYP4AS1 are underlined and conserved residues are in bold. A polyadenylation signal is underlined and in bold

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M F I A L L L I I I V V Y L M C H C Y A Q
TATGGACCAAATGGACGATTAATCAATAAAATACCAGGACCACCAGGTTATCCAATTATTGGTAATTTATTCAACTTGCTGGAGTCTAGAGAGCAATTCTGGGAGACTTTATCG
Y G P N G R L I N K I P G P P G Y P I I G N L F N L L E S R E Q F W E T L S
ATTTTAAATGAGCAGTATTATCCTATTTATAAATTGCGAGCCTTTTTCAATTCTTTGGTATTTATCCGTCATCCCGATGATTTGGAGATAATTCTAAACAATACAAAACATATC
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N I L Q Q F V E I L I E E G E S M T R S L K N A G G T I T K D L V P F I S E
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Y T L N A I C E T A M G T S L Q E M G S F Q Q Q Y R K A V H R M G E L L V Y
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A
R A M R P W L K Y D W I F S L T S K G R E Q K K L L K I L H G F T E K V I A
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TG
K R K D Y H K R T K G Q Y L K N L N K D V V P N E T E T I G I K K K R F A
M
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L D L L I Q A S Q E G L L T D F D I R E E V D T F M F E G F D T T G M A M C
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F I L S L L A E H K D I Q D C V R K E I D A V M Q E N Q G K L N M K S L Q D
CTGCAGTATTTAGAGAGATGTATAAAAGAAGCGTTGCGTTTATATCCTAGTGTTTACTTCATATCACGGATTACTTCAGAAGAAACAGAATTAAAAACATATTTGATACCTGCC
L Q Y L E R C I K E A L R L Y P S V Y F I S R I T S E E T E L K T Y L I P A
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G T L V I L N F Y I T H R D S N F W P N P E V F D P D R F L P D N I R N R H
CCTTATTCGTACTTGCCATTCAGTGCTGGACCACGTAATTGCATCGGTCAACGATTTGCTTTACTGGAGTTGAAAGCAATGTTAGTCCCTTTGATTTACAACTTTTATTTGGAG
P Y S Y L P F S A G P R N C I G Q R F A L L E L K A M L V P L I Y N F Y L E
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P V D Y L E N Q R F G I D M I L R S L D P C R L K F V P I A T E G I *
GACAATTTAAATTCTAAGAAATAATGTTTTATATATAAATATTCAAA**AATAAA**GAAAATTACAGTTTTTATTATAAGCATTTGTAGATATGTATTAAC**AATAAA**GACATACATG

TAAAAAAAAAAAAAAAAAAAAAAA

Figure 2. The cDNA/deduced protein sequences of *CYP4AB1*. Invariant and highly conserved motifs in CYP4AB1 are underlined and conserved residues are in bold. A polyadenylation signal is underlined and in bold

TTGCTCTGCTTCGGACCACGCGGGTGCACGCGGGATTCGTGAGGCCGAGTCCCGAATCCCGGTTTA
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AGGA
GAGAAAGCGTGCGGAGGAACAGGAGAGGAC**ATG**CCAAGACAACATCTTATAAATCTTCTGTTTTCACTTTGTGACAAATATTATCCAATTTTTAGAACGTGGGCTTTCTTTGAA
M P R Q H L I N L L F S L C D K Y Y P I F R T W A F F
E
GGTTTCGTATCTATTCGTCATCCCGATGATCTGGAGGTAATACTAAACAGTTCAACAAATATCGAAAAGAGTAGAATTTACTCTGTATTACATCCTTGGTTCGGTTTGGGTCTT
G F V S I R H P D D L E V I L N S S T N I E K S R I Y S V L H P W F G L G
L
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L T S G G S K W H S R R K I L T P T F H F N I L Q Q F V E I L I E E G E S
M
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A
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G
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M N S V Q Q E Y R K A V H R M G E L F I Y R L V R H W L I S D W I F A L T S
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T
Q G R E Q V K I L K I L H G F T N K I I A E R K D Y H K R T N G Q Y L K N
F
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N Q S I I T D N E E I V G S K K K R L A M L D F L I Y A S Q E G H L T D V
D
ATTAGAGAGGAAGTCGATACTTTTATGTTCGAGGGTCATGATACTACATCAACCAGTCTTTGCTATACTTTAGCATTACTGGCCGAAAACAAAGATATTCAGGATCGTGTTCGA
I R E E V D T F M F E G H D T T S T S L C Y T L A L L A E N K D I Q D R V
R
CAAGAAGTTGATCTTGTTATGCAAGAAAATGAAGGAAAACTTACTATAAAATCGCTACAAAATCTACAATACTTAGAGAGATGTATAAAAGAATCTTTGCGTTTATATCCGTCT
Q E V D L V M Q E N E G K L T I K S L Q N L Q Y L E R C I K E S L R L Y P S
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V Y F I S R I T T E E A Q L K S H L I P V G T I M H L H I Y G V H R D P N F
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W P N P D V F D P D R F L P E N S R N R H P Y S Y I P F S A G P R N C I G Q
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CCTCTTGGTGGGCATCGAATAAAATTCATCCCAATCGCCACAAAATGCATATAGGCAAACTTCATAAAACAACTTCATAAAACGACAAATGTTTTGTAAAATACAGAATATTA
P L G G H R I K F I P I A T K C I *
TACGTATTTGTAAAAATACACAAAC**AATAAA**AATGTAATTTCTTTCTAAAAAAAAAAAAAAA

Significance, Anticipated Results and Future Direction

The long term goal of our project is to understand the molecular mechanisms in the regulation of the development, reproduction, and caste differentiation of the imported fire ant in order to manage this pest species. Our current investigation of the gene expression in the imported fire ant provides important information for understanding the molecular basis of development and reproduction in the red important fire ant. It also provides a solid framework for designing future experiments on gene regulation in growth, reproduction, and caste differentiation of the imported fire ant. These experiments include 1) the isolation and characterization of 5' promoter regions of the differentially expressed genes to understand how the gene expression is regulated in different life stages and castes, and 2) the study of the regulation of juvenile hormone (JH) on the vitellogenin gene, the putative pheromone binding gene, and P450 genes expression in the red imported fire ant.

Ovarian and embryonic development of the fire ant (*Solenopsis invicta*) – A foundation to understand the effect of fire ant control products

Xing Ping Hu and Michael L. Williams

Abstract

Although ants are one of the most extensively studied insect groups, this represents the first study on embryonic development of the ant family (Formicidae). Fire ants have many characteristics that differentiate them from other Hymenoptera. One characteristic is that fire ants have a unique long-germ type pattern. Fire ants also possess a unique balstokenisis which consists of three consecutive embryonic movements and a unique germ band extension pattern where the extension of the anterior end is immersed anterodorsally into the yolk mass. Our findings make a contribution to insect evolutionary theory, expand our knowledge of fire ant community structure and management during the early stage of its life cycle, and can be used to develop improved approaches to IFA management.

Results

Monogyne queens were collected in the field and reared in the laboratory. Three queens were dissected at daily intervals to determine ovarian development. Eggs were collected daily and cultured in an incubator to obtain age-identified eggs for embryonic study.

The reproductive system of a virgin alate upon eclosion was nearly complete and was functional. Each ovariole contained well-defined germarial and vitellogenic tissues as well as trophic eggs at various stages of development.

Queens started to lay eggs within 48 hours of eclosion and the process of embryo development took 6 – 9 days at 25°C.

Newly laid eggs are ellipsoid and averaged 0.45 ± 0.02 mm in length and 0.28 ± 0.02 mm in maximal width. Five distinctive stages were identified. At stage one, a long germ band formed and developed at the posteroventral side of the egg. At stage two, the posterior end of the germ band curved around the posterior pole of the yolk mass onto the dorsal surface, while the anterior end immersed anterodorsally into the yolk mass. Segmentation was completed and the appendages appeared concurrently. At stage three, the germ band shortened and widened with the head and the tail moving towards the anterior and posterior poles respectively. At stage four, the embryo head rotated from the dorsal side to ventral side, followed by dorsal closure. At the last stage, once the embryo began to take the form of a larva with the head directed backwards, the egg was ready to hatch.

The Hymenoptera are believed to be the most evolved order of insects, and ants the most evolved group of Hymenoptera. The new findings from this study indicate that ants are indeed a special insect group with specific embryonic development patterns. The new findings are:

- The early embryonic patterning of *S. invicta* was of the long-germ-type, and the embryonic primordium was long and composed of the incipient regions that would produce the head lobes, gnathal parts, thorax, and the abdomen.
- Blastokenisis in *S. invicta* was more well-defined than in other previously studied Hymenopteran groups. It showed three successive embryonic movements: elongation of the germ band, shortening and widening of the germ band, and the displacement of the head anteriorly.

- Germ extension occurred in both anterior and posterior directions, quite different than any other Hymenopterans that only proceeded at the posterior end.
- Unlike other insects where dorsal closure takes in all the yolk materials, fire ant embryo dorsal closure required the majority of the yolk materials, but left about 1/5 of the yolk balls outside of the head region. The evolutionary significance of this phenomenon needs future investigation.

Biodiversity and Distribution of Ants (Hymenoptera: Formicidae) in Alabama

Michael L. Williams and Jason Forster

The only definitive survey of ants in Alabama was conducted in the mid 1940's by L. C. Murphree while scouting for Argentine ants for the U. S. Bureau of Entomology. Survey results of the ants recovered in Alabama were submitted by Mr. Murphree as part of a Masters thesis at Mississippi State in 1947. In this thesis, 47 species of ants are recorded to occur in Alabama, but Mr. Murphree also stated, "It is probable that the ant fauna of Alabama contains at least 125 or more species, in view of the fact that 140 species have already been recorded for Mississippi and about 100 each for South Carolina and Florida."

The intent of this project is to establish baseline information on the diversity and distribution of ants in Alabama. This information is important to the fire ant research and education program in the state in many ways, such as: 1) understanding the impact of fire ants and their management on native ant populations; 2) re-establishment of native ant populations in fire ant managed areas; 3) distribution and range of hybrid fire ant populations in Alabama; 4) comparison of ant species composition in phorid fly release sites versus phorid free sites; and 5) competitiveness of different ant species with fire ants.

Objectives

1) Survey the ant fauna of the eleven physiographic and ecologically unique regions of Alabama to determine species biodiversity and distribution of ant populations in the State.
2) Incorporate representative species of ants collected into the AU Entomological Collection to serve as voucher and reference collections for future research and identification projects.

Procedures

For the Alabama ant survey, both active and passive sampling methods will be employed to collect ants from all eleven physiographic regions in the state. Sampling methods will primarily entail direct field collection, utilization of bait stations (both sugar and protein based), the use of pitfall traps, and Berlese extractions. Collected ants will be returned to the laboratory where they will be sorted, cataloged, preserved, identified and incorporated into the AU Entomological Museum Collection.