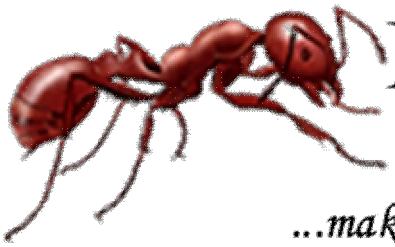
The Alabama Fire Ant Management Program



...making fire ants easier to live with.

PROGRESS REPORT
FY 2004

Entomology and Plant Pathology

AUBURN UNIVERSITY

INSTRUCTION · RESEARCH · EXTENSION

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

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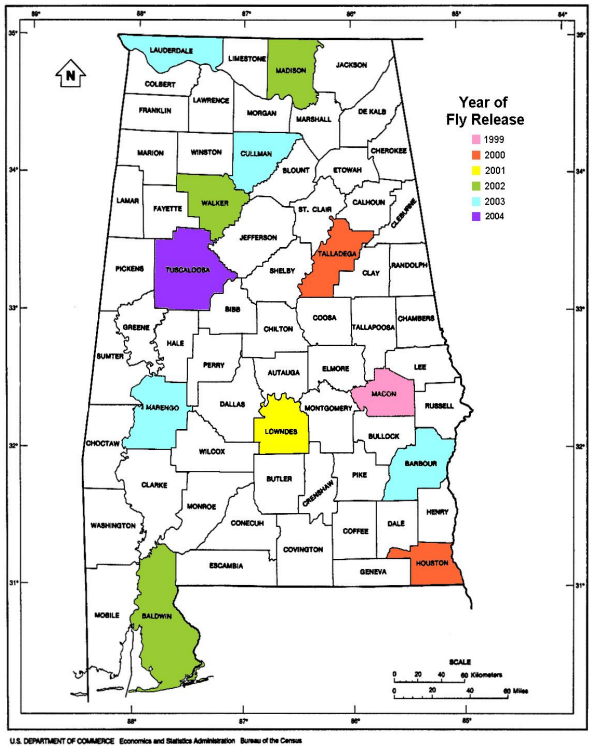
The Alabama Fire Ant Management Program
...making fire ants easier to live with.

FY2004 Activities and Accomplishments

The Alabama Fire Ant Management Program, in conjunction with the Alabama Cooperative Extension System, the Tuskegee Cooperative Extension System, Alabama A&M, the USDA-APHIS and the USDA-ARS, is making fire ants easier to live with.

Probably the only people in Alabama that have not tangled with fire ants are visitors that go directly from their car to the hotel room and back. Most people who have had the opportunity to stray off concrete or asphalt have been attacked by fire ants, or will be.



Imported fire ants are found in every county in Alabama and affect the lives of every household. The annual loss to households in Alabama is estimated to be $175 million dollars. Economic losses to agriculture, businesses, airports, golf courses, schools, utilities, and others are not included. Imported fire ants impact domesticated and wild animals and plants, but economic losses are difficult to estimate.

Not one, but two species of imported fire ant were accidentally introduced from South America. The black imported fire ant can be found in small areas of northern Alabama. The red imported fire ant occupies the southern two-thirds of Alabama and a hybrid of the red and black occupies most of the northern third. No natural enemies came with them.

There are over 20 species of phorid or decapitating fly in S. America and it is a natural enemy of the fire ant. Two species of phorid fly have been introduced into fire ant populations in 12 counties in Alabama. *Pseudacteon tricuspis* prefers the red imported fire ant and is established in South Alabama. *Pseudacteon curvatus* prefers the black or hybrid fire ant and is established in North Alabama. The release of *P. curvatus* in Talladega Co. was the first successful release of this species in the United States.

Phorid flies have become established and have spread over 35,000 square miles of Alabama. Near Sylacauga, the ranges of the two flies have overlapped. This is the second site in the United States to have two species of the fly established in one area. A third fly will be released in Alabama in 2005 and a release of P. *tricuspis* will be attempted on the hybrid fire ant.

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.

Education and outreach are an important part of our program. Gwen Roland of Common Ground Newsletter, a publication of Southern Region Sustainable Agriculture and Research Education, said **"you folks at Auburn have done the best job I've seen of assembling consumer info on this pest".** Her article deals with how to avoid bottlenecks in disseminating information by using our tiered approach to get a multiplier effect. Our fire ant educational exhibit drew crowds at the Alabama National Fair, the National Peanut Festival, Ag Roundup, the Southeastern Agricultural Exposition, the Louise Kreher Forest Ecology Preserve, the Oxbow Meadows Insect Festival, Callaway Gardens' Insect Encounters Weekend, Montgomery Zoo's Earth Day Safari, and School Day at the Baldwin County Fair. It was also used by Extension Agents and Master Gardeners in Houston, Henry and Barbour counties.

In-service trainings were held for county agents and stakeholders on fire ant management. Information packets on fire ants were sent to 690 stakeholders who had attended our fire ant train-the–trainer meetings in FY02 and FY03. These stakeholders included Master Gardeners, certified crop advisors, cattlemen and pesticide dealers.

Our management recommendations are being used by Alabama Department of Mental Health facilities. The Auburn City School System now serves as a model for fire ant control on school grounds and athletic fields. Pest management professionals serving the schools in Elmore County, Geneva County, Alexander City and Lee-Scott Academy are also implementing the recommendations for fire ant control. County agents from Dale, Henry, and Houston counties, in cooperation with the National Peanut Festival, have a bait demonstration on the fairgrounds.

A 50 acre area was treated with recommended baits in September and the 125,000 fair attendees had no complaints regarding fire ant infestations. Also, 25,000 people were able to sit on the ground during the Movie Gallery Stage concert. Another demonstration site using our recommendations is Ag Heritage Park on AU's campus.

Since we cannot eradicate fire ants, knowledge of their biology is important. They can be beneficial in some crops. Data show that while fire ants in cotton increase aphid numbers, the aphid-tending ultimately decreases cotton damage from predators and increases cotton yields. This research project has used fire ant management monies to generate data that has resulted in over $160,000 in additional grants for fire ant research.

Basic research is continuing into the physiology and genetics of imported fire ants. By measuring how much energy is required for a fire ant worker to move at different speeds and to carry different amounts of food, we can optimize the size and weight of fire ant bait granules and measure the energetic costs that fire ants incur when they are attacked by phorid flies. We are developing the first state of the art database of genes that are differentially expressed between different life stages and worker and reproductive stages. The information on how these genes function

may lead to new fire ant management strategies.

The biology and host location behavior of phorid flies is also under investigation. Little is known of the biology of these flies or of the cues that these flies use to locate fire ants. Our research has shown that adult*s* that are fed sugar water live longer. Data indicate that flies live longer at lower temperatures, suggesting that lifespan may be limited in hot, summer days in Alabama and that microhabitat may be important in phorid survival. Current studies are underway to determine whether *P. tricuspis* can feed on floral nectar or aphid honeydew, to determine the olfactory cues used by *P. tricuspis* to locate ants and to determine the ant behaviors associated with *P. curvatus* attacks.

19 Publications 16 Scientific presentations 10 Mass media 10 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

Auburn University
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 Y. Fadamiro, Ph.D.
Nannan Liu, Ph.D.
Vicky Bertagnolli
Li Chen
Jason Forster
Chad Harvey
Ian Kaplan
Ebenezer Onagbola
John Styrsky
Marla Tanley

Alabama Cooperative Extension System
Danny Cain – Walker Co.
David Lee Daniel – Lowndes Co.
Henry D. Dorough – Talladega Co. & Autauga Co.
Josh Elmore – Autauga Co.
Marla Faver – Baldwin Co.
Rickey G. Hudson – Houston Co.
Jimmy Jones – Henry Co.
Charlie Mason – Barbour Co.
Michelle Mobley – Tuscaloosa Co.
Charles Pinkston – Cullman Co.
Kevan Tucker – Marengo Co.
Raefield Vester – Houston Co.

Tuskegee Cooperative Extension System
George Hunter – Lowndes Co.

Alabama Agricultural Experiment Station

Alabama Department of Agriculture & Industries

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

USDA-ARS
Sanford D. Porter, Ph.D.

USDA-APHIS
Anne-Marie Callcott
Ron Weeks, PhD.

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.
Dorman Grace – Walker Co.
George Hunter - Lowndes Co.
Mark Kaiser & Hillandale Farms – Baldwin 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.
Grouby Field Airport – Autauga Co.
Munny Sokol Park – Tuscaloosa Co.
Talladega Superspeedway – Talladega Co.
Carolyn & Michael Williams - Macon Co.

Acknowledgements
Kathie Kalmowitz – BASF Corporation
Taylor Pursell - Pursell Industries
Doug VanGundy – Wellmark International
Clete Youmans – BASF Corporation

Sincere apologies to anyone inadvertently omitted from this list

Educational Materials, Presentations, Publications

Publications

Appel, A. G., M. J. Gehret, and M. J. Tanley. 2004. Repellency and toxicity of mint oil granules to red imported fire ants (Hymenoptera: Formicidae). J. Econ. Entomol. 97: 575-580.

Appel, A. G., Na, J. P.-S., and Lee, C. Y. 2004. Temperature and humidity tolerances of the ghost ant, *Tapinoma melanocephalum* (Hymenoptera: Formicidae). Sociobiology. 44: 89-100.

Bertagnolli, V.E., L.C. "Fudd" Graham. 2004. Diurnal patterns of ovipositional activity in two *Pseudacteon* parasitoids (Diptera: Phoridae) in Alabama. pp. 66-69. *In* Proceedings of the 2004 Imported Fire Ant Conference, Baton Rouge, Louisiana.

Chen, L., Onagbola, E.O., and Fadamiro, H.Y. (in prep.). Effects of adult feeding, temperature, and mating on longevity of phorid fly *Pseudacteon tricuspis* (Diptera: Phoridae). Biological Control.

Chen, L., Onagbola, E.O., and Fadamiro, H.Y. (in prep.). Aphid honeydew and floral nectar increase longevity and carbohydrate levels in the phorid fly *Pseudacteon tricuspis*. Entomologia Experimentalis et Applicata.

Drees, B. M. and K. L. Flanders. 2004. Managing fire ants in cattle production systems. Circular ANR-1248, Alabama Cooperative Extension System and

Fadamiro, H.Y., L. Chen, Onagbola, E.O., and Graham. L. (in review). Lifespan and Patterns of Accumulation and Mobilization of Nutrients in Sugar Fed Phorid Fly *Pseudacteon tricuspis*. Physiological Entomology.

Flanders, K. L. and B. M. Drees. 2004. Interstate collaborative efforts to develop educational programs for fire ant management in cattle production systems. *In* Drees, B. M. ed., Fire Ant Update: News from the Texas Applied Fire Ant Research and Education Program, April 2004.

Flanders, K. L. 2004. 2004 Fire ant control materials for homeowners.

Graham, L. C. "Fudd", S.D. Porter, and V.E. Bertagnolli. 2003. Phorid Flies in Alabama: A tale of two species. J. Agric. Urban Entomol. 20(3): 165-171.

Graham, L.C. 'Fudd', V.E. Bertagnolli, and R.K. Vander Meer. 2004. Distribution of Imported Fire Ant Populations in Alabama. pp. 131-134. *In* Proceedings of the 2004 Imported Fire Ant Conference, Baton Rouge, Louisiana.

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: 334-339.

Graham, L. C. 'Fudd'. 2004. Fire ants have a new enemy. Alabama Wildlife, 68:20-21.

Harvey, C.T. and M.D. Eubanks. 2004. Effect of habitat complexity on biological control by the red imported fire ant (Hymenoptera: Formicidae) in collards. Biological Control 29:348-358.

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

Kaplan, I. and M.D. Eubanks. In press. Aphids alter the community wide effect of fire ants. Ecology.

Liu, N. and L. Zhang. 2004. *CYP4AB1, CYP4AS1*, and *Gp-9* gene overexpression associated with workers of the red imported fire ant, *Solenopsis invicta* Buren. Gene 327: 81-87.

Shelton, T. G., J. T. Vogt, M. J. Tanley, and A. G. Appel. 2003. Monthly fluctuations of termite caste proportions (Isoptera) within fire ant mounds (Hymenoptera: Formicidae). Sociobiology 41: 571-581.

Zhang, L. and N. Liu. 2004. Vitellogenin gene, *Vg1*, expression and regulation in the red imported fire ant, *Solenopsis invicta*. Physiol. Genomics (In Review).

Presentations

Bertagnolli, V.E. and L.C. "Fudd" Graham. 2004. Diurnal patterns of ovipositional activity in two *Pseudacteon* parasitoids. Paper presented at the Annual Meeting of the Entomological Society of America, Salt Lake City, Utah.

Bertagnolli, V.E. and L.C. "Fudd" Graham. 2004. Diurnal patterns of ovipositional activity in two *Pseudacteon* parasitoids (Diptera: Phoridae) in Alabama. Paper presented at the Imported Fire Ant Conference, Baton Rouge, Louisiana.

Bertagnolli, V.E. and L.C. "Fudd" Graham. 2004. Diurnal patterns of ovipositional activity in two *Pseudacteon* parasitoids (Diptera: Phoridae) in Alabama. Poster presented at the 78th annual meeting of the Southeastern Branch of the Entomological Society of America, Charleston, South Carolina.

Cooper, L., J.F. Murphy, and M.D. Eubanks. 2004. Implications of a fire ant-aphid mutualism on the spread of aphid-vectored viruses. Southeastern Branch of the Entomological Society of America Meeting, Savannah, Georgia.

Cooper, L., J.F. Murphy, and M.D. Eubanks. 2004. Effects of ant-aphid mutualisms on herbivore populations and spread of aphid-vectored viruses. Ecological Society of America, Portland, Oregon.

Cooper, L., J.F. Murphy, and M.D. Eubanks. 2004. Implications of a fire ant-aphid mutualism on the spread of aphid-vectored viruses. Entomological Society of America Meeting, Salt Lake City, Utah.

Eubanks, M.D., J.D. Styrsky, L. Cooper, I. Kaplan, and C.T. Harvey. 2004. The importance of positive species interactions in structuring arthropod communities: applying the comparative method to community ecology. Entomological Society of America Meeting, Salt Lake City, Utah.

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

Flanders, K. L. and B. M. Drees. 2004. Interstate collaborative efforts to develop educational programs for fire ant management in cattle production systems. 2004 Imported Fire Ant Conference, Baton Rouge (poster).

Flanders, K. L. 2004. Stop chasing those fire ants around. Shelby County Fire Ant Meeting, Columbiana, AL.

Graham, L.C., V.E. Bertagnolli, and R.K. Vander Meer. 2004. Distributions of imported fire ant populations in Alabama. Poster presented at the Imported Fire Ant Conference, Baton Rouge, Louisiana.

Graham, L.C., V.E. Bertagnolli, and R.K. Vander Meer. 2004. Distributions of imported fire ant populations in Alabama. Poster presented at the 78th annual meeting of the Southeastern Branch of the Entomological Society of America, Charleston, South Carolina.

Graham, L.C. "Fudd" and V.E. Bertagnolli. 2004. Establishment and dispersal of phorid flies, *Pseudacteon* spp. (Diptera: Phoridae) in Alabama for control of imported fire ants, *Solenopsis* spp. (Hymenoptera: Formicidae). Poster presented at the International Congress of Entomology, Brisbane, Queensland, Australia.

Graham, L.C. "Fudd", R.K. Vander Meer, and V.E. Bertagnolli. 2004. Range expansion of two phorid flies (Diptera: Phoridae) in imported fire ant populations (Hymenoptera: Formicidae) in Alabama. Poster presented at the Annual Meeting of the Entomological Society of America, Salt Lake City, Utah.

Liu, N. and L. Zhang. 2004. Genes differentially expressed between queens and workers of the red imported fire ant, *Solenopsis invicta* Buren. Presentation in the National Red Imported Fire Ant Conference, Baton Rouge, Louisiana.

Styrsky, J.D. and M.D. Eubanks. Potential indirect interactions between soybean aphids and other canopy arthropods mediated by fire ants: an artificial honeydew experiment. Entomological Society of America Meeting, Salt Lake City, Utah, November 2004.

Outreach Presentations and Activities

Bertagnolli, V.E. Laboratory presentation for ENTM 6010-Entomology for Educators, Auburn University, Auburn, Alabama, 27 July 2004.

Flanders, K. L. 2004. Fire ant management: An introduction. In-Service County Agent Training Program, Alabama Cooperative Extension System, Auburn, AL.

Flanders, K. L. Management of Fire Ants, What Homeowners Should Know, Tuskegee University, September 2004.

Flanders, K. L. and H. Dorough. 2004. How to evaluate a fire ant management demonstration. In-Service County Agent Training Program, Alabama Cooperative Extension System, Auburn, AL.

Flanders, K.L. and L. Jackai. 2004. Fire ant labs for Tuskegee University IPM course.

Flanders, K. L. 2004. Getting the most out of your fire ant bait. In-Service County Agent Training Program, Alabama Cooperative Extension System, Auburn, AL.

Flanders, K. L., P. Carter, J. Jones, R. Hudson, and R. Vester. 2004. Wiregrass Fire Ant Management Workshop, Dothan, AL.

Flanders K. L. and M. Faver. 2004. Fire ants! Foley Intermediate School, Foley, AL. (six presentions).

Flanders, K. L. 2004. Fire ants and entomology. Bullock County Forestry for Youth Field Day and Tour, Union Springs, AL. (five presentations).

Graham, L.C. "Fudd". IPM in schools. Laboratory lecture for ENTM 4020-Economic Entomology, Auburn University, Auburn, Alabama, 19 November 2003.

Graham, L.C. "Fudd". Presentation on School IPM for Auburn High School Science Club, 20 November 2003.

Graham, L.C. "Fudd". Fire ant management in horse pastures. Alabama Horse Council Horse Fair, Montgomery, Alabama, 24 January 2004.

Graham, L.C. "Fudd". Laboratory presentation for Industrial Design class, Auburn University, Auburn, Alabama, February 2004.

Graham, L.C. "Fudd". 2004. Two training visits to Tuscaloosa Co. Phorid Release, Tuscaloosa, AL.

Graham, L.C. "Fudd". Alabama Association of Country Agricultural Agents Meeting, Huntsville, Alabama, 3 June 2004.

Graham, L.C. "Fudd". Household, school, and workplace IPM. Laboratory lecture for ENTM 5330/6330-Integrated Pest Management, Auburn University, Auburn, Alabama, 24 September 2004.

Graham, L.C. "Fudd". Restricted Use Pesticide Dealer meeting, Cullman, Alabama, 11 January 2005.

Graham, L.C. "Fudd". Restricted Use Pesticide Dealer meeting, Montgomery, Alabama, 12 January 2005.

Graham, L.C. "Fudd". Restricted Use Pesticide Dealer meeting, Headland, Alabama, 13 January 2005.

Graham, L.C. "Fudd". Biological control of fire ants. Alabama Horse Council Horse Fair, Montgomery, Alabama, 25 January 2005.

- Five visits to State House
- Alabama Turfgrass Meeting – presentation
- Extension in-service training presentation on fire ants and phorid flies

Media - Videotape

Flanders, K. L. and M. Lightfoote. 2004. How to Calibrate a Fire Ant Bait Spreader. Alabama Cooperative Extension System.

Media - CD

Ward, R., K. Ward, and K. Flanders. 2004. Fire ant Biology and Ant Identification CD (four PowerPoint® presentations).

Mass Media

- Two television spots on phorid release – Channel 7, Tuscaloosa; Channel 13, Birmingham
- Two newspaper articles on Tuscaloosa phorid release –Tuscaloosa News and Northport Gazette
- Television spot on School IPM – Channel 12, WTVM
- The Tallassee Tribune, July 8, 2004. "Research program seeks beneficial use of fire ants". Front page article.
- Extension Daily, Alabama Cooperative Extension Agency, June 22, 2004. "Fire ants a mixed bag for farmers".

Educational Displays

Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Getting Bugged?! insect program at the Frank Allen Turner Memorial Canopy, Louise Kreher Forest Ecology Preserve, Auburn University, Alabama , 24 July 2004.

Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Oxbow Meadows Insect Festival, Columbus State University, Columbus, Georgia, 11 July 2004.

Staffed educational exhibits, along with other members of Auburn University's F.S. Arant Entomology Club, for Callaway Gardens' Insect Encounters Weekend, Pine Mountain, Georgia, 12-13 June 2004.

Staffed educational exhibit, along with other members of Auburn University's F.S. Arant Entomology Club, for the Montgomery Zoo's Earth Day Safari, Montgomery, Alabama, 23 April 2004.

Prepared and staffed educational booth on The Alabama Fire Ant Management Program at the 24th annual CoAg Fall Roundup/Taste of Alabama Agriculture, Auburn University, Alabama, 1 November 2003.

Prepared educational booth on The Alabama Fire Ant Management Program for the 60th Annual National Peanut Festival, 31 October - 8 November 2003.

Prepared educational booth on The Alabama Fire Ant Management Program for the Walker County Fair.

Prepared educational booth on The Alabama Fire Ant Management Program for the Barbour County Fair.

Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Sunbelt Agricultural Exposition in Moultrie Georgia, 14-16 October 2003.

Prepared and staffed educational booth on The Alabama Fire Ant Management Program at Alabama National Fair, 3-12 October 2003.

Field Demonstrations and Experiments

- April 2004 *Pseudacteon. tricuspis* released in Tuscaloosa County, Alabama.
- Fire ant bait trials in conjunction with ongoing phorid fly projects in Talladega, Sylacauga and Notasulga.
- BASF product trial at Grouby Field Airport, Prattville, Alabama.

Additional Funding Leveraged by Fire Ant Program

Sikora, E., K. Flanders, R. Ebel, J. Kemble, W. Dozier, W. Bauske, M. Nesbitt, J. Novack, P. Mask, and D. Monks. Comprehensive risk management educational program for multiple specialty crops. Federal Crop Insurance Corp., USDA, 2002. $57, 475.

Eubanks, M.D. and J.F. Murphy. Breaking the Cycle: Development of a novel plant disease management strategy targeting pathogen vectors and reservoirs. Alabama Agricultural Experiment Station Foundation, August 2003 – July 2006, $108,060.

Kaplan, I. and M.D. Eubanks. Aphids as beneficial insects? Using a fire ant-aphid interaction for the sustainable management of insect pests in Southern cotton. 2003. $7,000.

Eubanks, M.D. Predicting the economic and ecological consequences of a fire ant - aphid mutualism. Auburn University BioGrants Program. May 2004 – April 2006. $44,100.

Flanders, K.L. Fire Ant Management. Alabama Cattlemen's Association, 2004, $6000.

Styrsky, J.D. Consequences of a fire ant – aphid mutualism on plant yield. Graduate Research Council. May 2004 – April 2005. $1,000.

Honors and Awards

The annual Beltwide Cotton Conferences were held in New Orleans January 4-7, 2005. Entomology's Ph.D. student, John Styrsky competed in the Ph.D. oral competition in the Cotton Insect Research and Control Conference and won the Gary A. Herzog Award for his talk entitled "Cotton aphids indirectly benefit yield by increasing fire ant suppression of caterpillar pests".

Fire Ant Education and Outreach

Kathy Flanders, Fudd Graham, 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 garden center personnel, cattlemen, and other teacher/trainers to develop a statewide base of fire ant "experts." Provide each stakeholder with fire ant educational materials
3) Conduct an in-service training on fire ant management and application of bait using the Herd spreader

Fire ant Educational Exhibit

An exhibit was prepared for the Alabama National Fair by Fudd Graham and Vicky Bertagnolli. The exhibit included informational posters, live fire ants, live decapitating flies, and plaster casts of fire ant tunnel systems. Most of the fair visitors were fascinated, rather than repelled, by the fire ants making this exhibit 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. This gave 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 and graduate students from our department.

The exhibit at the Southeastern Agricultural Exposition drew crowds of people to look at the two species of decapitating flies as they attacked fire ants. The exhibit was also on display at Ag Roundup, at the Louise Kreher Forest Ecology Preserve *Getting Bugged?!* insect program, at the Oxbow Meadows Insect Festival, at the Callaway Gardens Insect Encounters Weekend, at the Montgomery Zoo's Earth Day Safari, at the Baldwin County Fair's School Day, and at Dothan's Annual National Peanut Festival. The exhibit was also used by Master Gardeners and Extension agents in Houston, Henry, Walker, and Barbour counties. Publications on fire ants were distributed at the Alabama National Fair (approx. 8,000), and the Sunbelt Ag Expo (1,500), and the National Peanut Festival (5,000).

Fire ant education programs

In FY 2004, principal investigators and county Extension continued their fire ant education effort. Numerous educational programs were conducted for Master Gardeners, cattlemen, youth, future science teachers, civic clubs, and the general public youth. These programs featured fire ants and their management and were conducted in Bullock and Baldwin counties. Field demonstrations were conducted (Calhoun Co., Cleburne Co, Etowah Co., Houston Co. [2], Henry Co. [2], Lee Co. [2], Talladega Co., and Tallapoosa Co.) at sites such as nurseries, festival grounds, botanical gardens, pecan orchards, home lawns, and cattle ranches. All of these demonstrations used a sustainable, bait-based approach. Extension agents from Houston and Henry and Dale Counties conducted a fire ant demonstration, and placed a fire ant exhibit at the Alabama Peanut Festival. Thanks to the successful bait fire ant management program, 25,000 people were able to sit on the ground and listen to concerts and shows. Also, the Auburn City School System now serves as a model for fire ant control on school grounds and athletic fields. Pest management professionals serving the schools in Elmore County, Geneva County, Alexander City and Lee-Scott Academy are also implementing the recommendations for fire ant control.

A new fact sheet, *ANR-1248, Management of Imported Fire Ants in Cattle Production Systems*, was published as a joint publication of the Alabama Cooperative Extension System, the Texas Cooperative Extension Service, Alabama A&M and Auburn University. Results of a March 2004 survey of retail stores were published in April, *ANR-175-A, 2004 Fire Ant Control Materials for Homeowners*.

Fire ant educational materials, including current versions of all the circulars, are available at *www.aces.edu/dept/fireants*. Streaming video versions of fire ants videos produced in Alabama, as well as from other states, were added to the web site this year.

PowerPoint® presentations on fire ant biology and on ant identification were produced in cooperation with Alabama A&M University. These were distributed to all county Extension offices and to stakeholders at other southeastern universities. The presentations, along with those produced in previous years, are used by county Extension agents in fire ant education meetings.

Information packets, providing the latest updates of our fire ant fact sheets, were sent to 690 stakeholders who had attended our fire ant train-the-trainer meetings in FY02 and FY03. These stakeholders included master gardeners, certified crop advisers, cattlemen, and pesticide dealers.

Herd Seeder In-Service Training

On July 19-20, 2004, Alabama Cooperative Extension System agents and five other stakeholders attended an in-service training that emphasized a bait-based approach to fire ant management. The workshop provided updates on new fire ant control materials and information on how to set up a fire ant management demonstration. Most of the time was spent on "getting the most out of a fire ant bait" - application timing, choosing the right product and, most importantly, how to calibrate the bait spreader to deliver the correct amount of bait. David Herd, President, Herd Seeder Co. Inc., trained the attendees on how to set up and use a Herd Seeder to spread fire ant bait. Eighteen seeders are now available in Alabama for Extension agents and other stakeholders to use in applying fire ant bait.

Results, Impacts and Benefits to the Public

Our education efforts save Alabamians at least $1 million each year by teaching them sustainable fire ant management strategies. As a result of our educational programs, schools and nursing homes are less likely to be infested by fire ants. Our fire ant management advisers leave the training session knowing 29% more than when they started.

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

Lawrence Graham, Kathy Flanders, Henry Fadamiro, Vicky Bertagnolli

Danny Cain, David Daniel, Henry Dorough, Marla Faver, Rickey Hudson, Charlie Mason, Michelle Mobley, Charles Pinkston, Kevan Tucker, Alabama Cooperative Extension System

Objectives:

1) Continue to monitor fire ant bait trials at Talladega and Macon phorid fly sites and Sylacauga control site (est. 2003)
2) Release and evaluate the effectiveness of two species of phorid fly
3) Continue study to determine effect of *P. curvatus* activity on foraging fire ants
4) Determine habitat preferences of phorid flies
5) Continue survey of location of red, black and hybrid fire ants in Alabama

1) Baits were applied mid-summer and plots have been monitored monthly since at the Talladega and Sylacauga bait trial sites. The Sylacauga site has both species of phorids present at the site. We will continue monitoring the sites to document fire ant reinfestation rates. If fire ant reinfestation is delayed by phorids, baits will be applied at varying dates to determine best time to apply baits in areas with phorid flies. The Sylacauga site will now be used to document the effect of two species of phorid on fire ant populations.

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 eleven (one release in FY2004). This is the 9th year of this program. *P. tricuspis* is successfully established in Macon, Lowndes, Houston, Baldwin, Barbour, Marengo, and Tuscaloosa counties. *Pseudacteon curvatus* is successfully established in Talladega, Walker, Madison, and Cullman counties. In a cooperative effort with the USDA, Alabama A&M and Tennessee

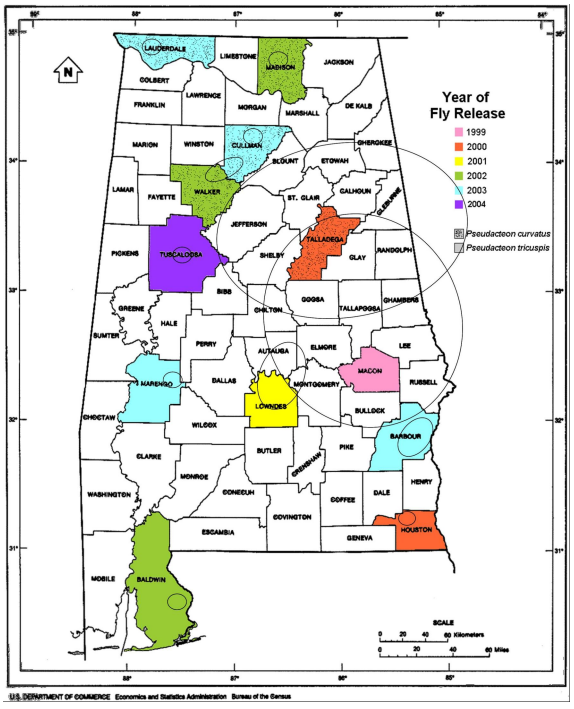


Figure 1. Map of Alabama showing locations and release years for *P. curvatus* and *P. tricuspis*. Circles indicate the flies' estimated ranges in Alabama.

State, population data are collected in Walker and Cullman counties using pitfall traps, baits and mound ratings. Fire ant abundance was monitored at the remaining sites in May and August in cooperation with USDA-CMAVE in Gainesville, FL and USDA-APHIS in Gulfport, MS.

Leading edges of all phorid populations were visited several times to track fly movement and fly dispersal was monitored. To date, phorid flies are estimated to cover about 35,000 square miles in Alabama (Fig. 1). A paper on the first successful release of *P. curvatus* in the United States is in the fall 2003 issue of the Florida Entomologist.

3) Sampling was conducted to determine the diurnal pattern of phorid activity at both the Macon Co. site (*P. tricuspis*) and the Talladega Co. site (*P. curvatus*). Data on other foraging activity were taken this summer, but data are yet to be analyzed. The effect of phorid flies on foraging fire ants in the field will be documented and quantified. Sampling for flies will be made easier once preferred habitat and attack times are documented and an efficient method of sampling is determined.

4) Sampling to determine habitat preference will be conducted in September, weather permitting.

5) A grid was established for the state of Alabama in order to map *Solenopsis invicta*, *Solenopsis richteri*, and *S. invicta* x *S. richteri* species boundaries (Fig. 2). Ants were collected on trips throughout the state, processed and sent to Bob Vander Meer at the USDA lab in Gainesville for species determination by analysis of cuticular hydrocarbons.

6) Six acres of fire ant bait trials were established in cooperation with Pursell Industries. Data are still collected monthly. A product study with BASF Corporation was started at Grouby Field Airport in Prattville, AL.

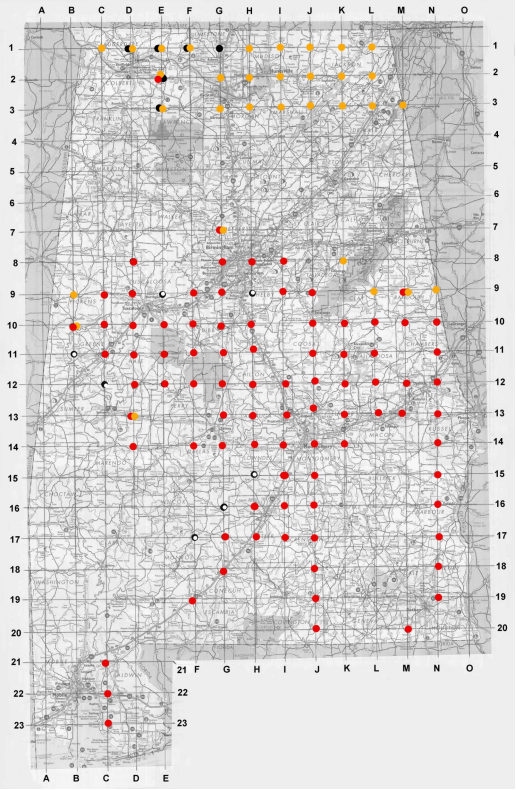


Figure 2. Grid map of Alabama showing imported fire ant species boundaries. Red circles denote red imported fire ants. Black circles denote black imported fire ants. Orange circles denote hybrid fire ants. Black circles with white dots inside denote that the species has yet to be determined by cuticular hydrocarbon testing.

Positive Effects of a Fire Ant – Cotton Aphid Mutualism on Cotton Yield

Micky D. Eubanks

In a previous series of greenhouse and field experiments we found that fire ants were strongly attracted to cotton aphids and fire ants were much more likely to forage in the canopy of cotton plants with aphids than cotton plants without aphids. This microhabitat shift resulted in more frequent encounters between fire ants and other arthropods associated with cotton. In greenhouse cage experiments the survival of herbivores (caterpillars) on cotton plants was dramatically lower in the presence of fire ants and aphids compared to fire ants alone. In a similar greenhouse experiment we found that plant bugs spent less time on plant foliage when cotton plants were infested with aphids and exposed to fire ants than when exposed to fire ants in the absence of aphids. These results suggest that cotton aphids indirectly increase the mortality and potentially the dispersal of serious cotton pests via their attraction to fire ants. Our results indicate that the interaction between fire ants and aphids results in the suppression of serious insect pests of cotton and that cotton aphids may be beneficial to cotton plants (i.e., increase yield) under some conditions.

We experimentally tested this hypothesis by embedding large field cages (6 ft x 6 ft x 6ft) that contain 5 cotton plants within cotton fields in which we manipulated the abundance of caterpillars (beat armyworms) and cotton aphids to simulate as wide a range of caterpillar-aphid densities as possible. We found a strong positive relationship between the number of fire ants per plant and the number of aphids per plant, indicating that fire ants are attracted to aphid-infested plants (Figure 1). We also found a strong negative relationship between the number of fire ants on cotton plants and caterpillar damage (Figure 2), strongly suggesting that fire ant

recruitment by aphids decreases herbivore damage. We also found a strong negative relationship between leaf damage caused by caterpillars and boll production in cotton (Figure 3). These results strongly support the hypothesis that aphid-tending by fire ants ultimately decreases cotton damage from caterpillars and increases cotton yield.

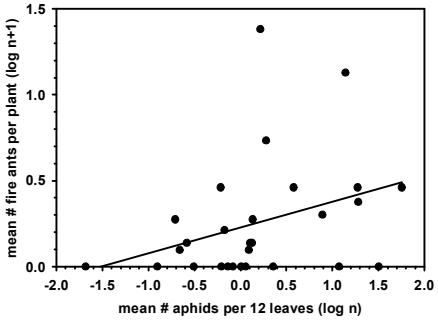


Figure 1

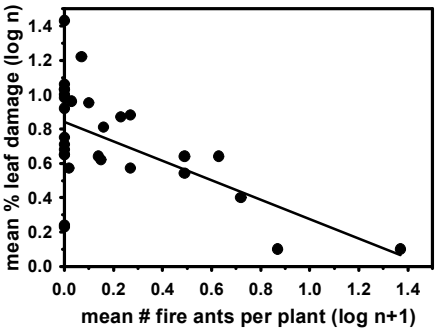


Figure 2

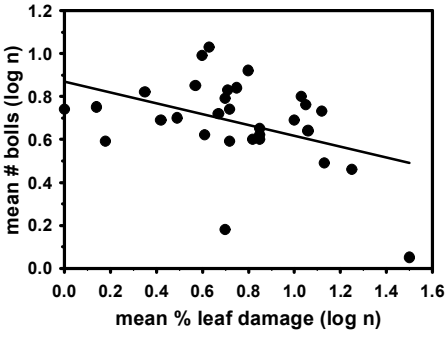


Figure 3

Energetics of Foraging and Load Carriage 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 size red imported fire ant, *Solenopsis invicta* Buren, workers were confined individually in custom designed 64 cm long running tube respirometers (Fig. 1). 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. The position of the ant within the running tube and the amount of CO_2 it produced were recorded every 0.5 sec for 1 hour using DATACAN software. 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. Average ant speed during sustained movements ranged from 26.6 to >110 cm/min and increased linearly with ant size (mass; mg) as seen in Fig. 2. Individual ants were, however, capable of brief (1-6 sec) bursts that reached speeds of >2,000 cm/min.

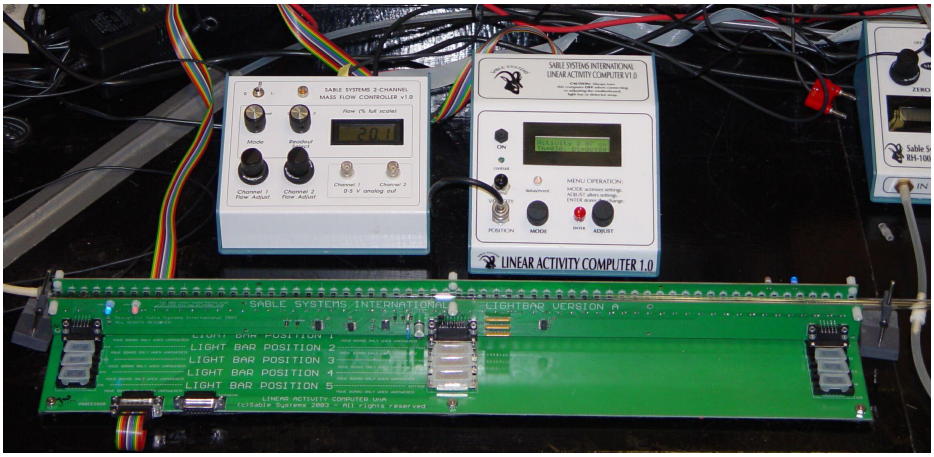


Figure 1. Custom designed running tube respirometer.

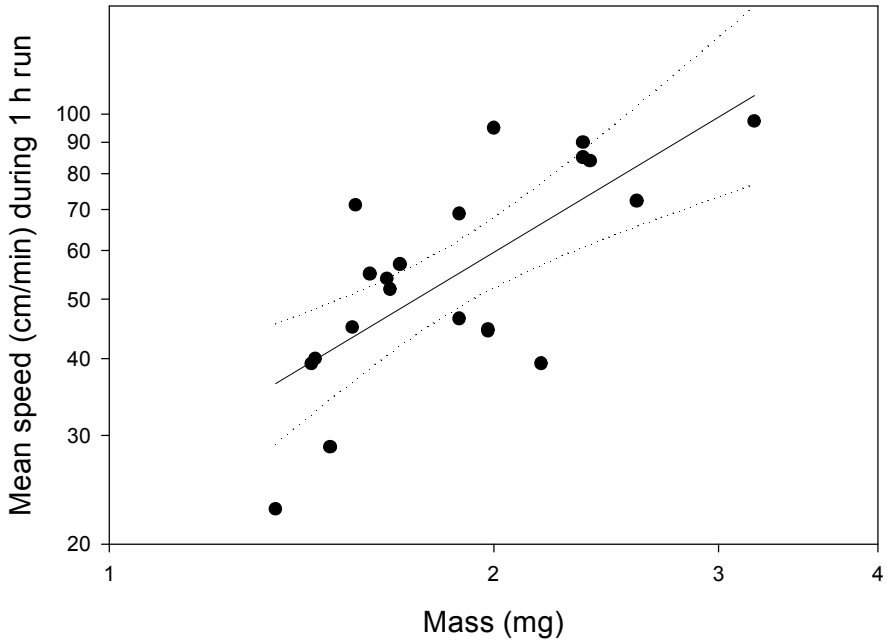


Figure 2. Effects of red imported fire ant worker size (mass; mg) on average running speed.

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. 3). Ants that moved produced significantly more CO_2 than resting ants. CO_2 production rates increased linearly with increasing ant speed (Fig. 2).

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 ant 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 energetic value of food, select, 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 ant incur when they are attacked by phorid flies.

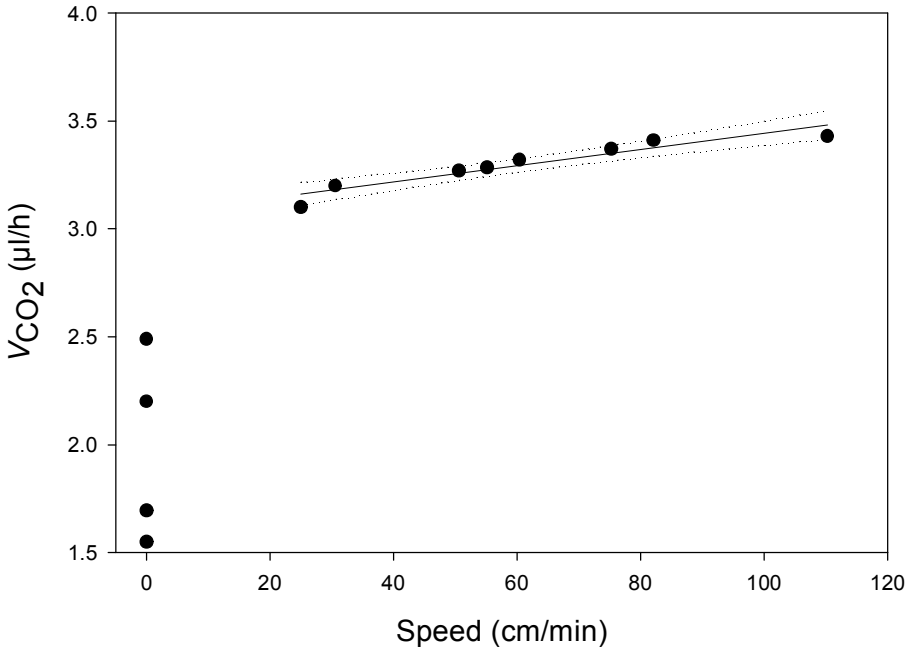


Figure 3. Comparison of CO_2 production rates by moving and resting worker red imported fire ants.

Characterize the Functional Genomics of the Red Imported Fire Ant, *Solenopsis invicta* Buren

Drs. Nannan Liu and Lee Zhang

Introduction

A number of genes differentially expressed in fire ant queens and workers have been uncovered using subtractive hybridization and cDNA array approaches (Liu and Zhang 2004). Although several partial cDNAs identified in queens and workers showed homologues to known genes, the functions of these genes in the fire ant have not been well reported. Among these genes, *Gp-9*, *Vg1*, and two cytochrome P450 genes, *CYP4AB1* and *CYP4AB*, have been cloned, sequenced, and characterized from the red imported fire ant (Liu and Zhang 2004). While *CYP4AB1*, *CYP4AB2*, and *Gp-9* are overexpressed in workers, *Vg1* is overexpressed in queens (Zhang and Liu 2004). Differential expression of these genes among castes and developmental stages suggests their functional importance in development and caste differentiation. These pioneer studies have provided important information on the differential expression of genes present in workers and queens, confirming that substantial physiological differences between queen and worker fire ants reflect the differential expression of genes present in both castes.

Current Study and Results

Our previous studies have focused on the genes that are differentially expressed between fire ant workers and queens using subtractive PCR hybridization. In the age of genomics, the subtractive PCR hybridization technique is limited. It fails to provide global examination of genome function. Our goal is to identify genes involved in the caste differentiation, development, reproduction, response to pathogens, and social behavior of the red imported fire ant. We have initiated the first comprehensive state-of-the-art EST database and microarray system of the red imported fire ant to determine the function of these genes. The EST library database represents an entire genomic population of mRNAs of the fire ants. Using this knowledge, we can characterize the functional genomics of the red imported fire ant. This will allow us to study many interesting aspects of the biology of fire ants by simultaneously monitoring the expression of many genes. It will also accelerate the discovery of new and possibly full-length cDNAs. We have constructed a normalized cDNA library from poly(A)$^+$RNA isolated from fire ant queen

using a TRIMMER cDNA normalization kit (Evrogen JCS) as described by the manufacturer to remove abundant transcripts. A total of 4257 plasmid DNA partial sequences were cloned and sequenced from the normalized fire ant library, resulting in 3916 high quality EST sequences with an average length of 750 bp. EST sequences were analyzed (Table 1).

Table 1. Summary of fire ant queen ESTs generated from the normalized library

# of total sequences	4257
# of high quality sequences	3916 (92%)
# of contigs	270
# of ESTs in contigs	900 (of the mRNA mass)
# of singletons	3016 (77% of the mRNA mass)
# of total unique sequences	3286
Redundancy	9% (3286/3916)
Genes in contigs containing >10 ESTs	
	NADH dehydrogenase subunit
	Elongation factor-1 alpha F2
	Vitellogenin
	Hexamerin
	An unknown gene

From these, 900 ESTs were assembled into 270 contigs and the remaining 3016 ESTs as singletons. The combination of contigs and singletons totaled 3286 in the normalized library. These represented unique transcripts. Four contig sequences contained more than 10 ESTs. This represents an unknown gene, identified in the non-normalized queen library assembled into the largest contig. BLASTx similarity searches revealed that 65% fire ant queen ESTs exhibited significant protein homologies with entries in the GenBank database and 35% had no database match to genes with a known function. Putative genes have been functionally annotated (using the Gene Ontology classification system, *http://www.geneontology.org*) based on matching gene sequences. Five genes - NADH dehydrogenase subunit, elongation factor-1 alpha F2, vitellogenin, hexamerin, and an unknown gene - represent the highest redundancy in the genome of the fire ant queen, indicating the functional importance of these genes in the queen cast

(Zhang and Liu 2004). Further characterization of gene function in queens may provide information for management of the fire ant.

Significance

We have established the first fire ant EST database. To date, 3286 unique EST sequences have been established and will soon be made publicly available. Our research comprises the first comprehensive effort to characterize the genome, as well as the genes, involved in the development, reproduction, and behavior of the red imported fire ant. Additionally, it provides the first information on how the components work together to maintain the complexity and order of fire ant social life. This research is the first step towards gaining an understanding of molecular processes associated with the organization of social insects' societies. It may be useful in developing new fire ant management strategies.

The Ants (Hymenoptera: Formicidae) of Alabama

Michael L. Williams and Jason A. Forster

This is an ongoing project to determine the presence and distribution of species of native and exotic ants in the state of Alabama. This survey is being done to increase the basic understanding of the ant fauna of Alabama and the impact of imported ants on ant diversity of this state. The information obtained will provide a stepping stone in understanding the effects Red Imported Fire Ants (RIFA) have had on other possibly beneficial or ecologically important species of ants. As part of this project, a guide to identifying ants will be produced and this should greatly benefit researchers, state pest control operators and extension agents.

Data collection for this project involves extensive travel throughout Alabama. Travel expenses were kept to a minimum by camping at primitive camp sites or staying with friends/relatives while collecting. The materials required to collect ants are also fairly inexpensive and they include: vials with ethanol, various food items as baits, cups for pit fall traps and small shovels and axes for excavating soil samples and splitting logs.

The methods used to collect ants involve: searching areas and collecting by hand, opening logs and other possible nest sites, the laying of index cards with a food bait, the use of pitfall traps (plastic cups with antifreeze in the bottom), the use of lights to collect reproductives and the use of Berlese funnels to collect soil dwelling ants.

Currently, 144 species of ants have been recorded in Alabama belonging to 36 genera. Out of 144 species, 24 are known only from past records and have not been collected during this survey. At least two native species of ants (*Solenopsis xyloni* and *Solenopsis geminata*) have gone extinct within this state or been reduced to small isolated populations. These changes in the ant fauna are most likely due to the introduction of the RIFA, since these species are known to compete directly with each other.

In August 2003, Jason Forster traveled to Arizona and participated in an ant studies workshop taught by the leading experts in the field. In October 2003 a poster with the results of

this project was presented at the annual Entomological Society of America meeting in Cincinnati, OH. In March 2004, Mr. Forster presented a poster with updated results at the annual Red Imported Fire Ant meeting in Baton Rouge, LA.

A presentation on this project will be given at the Entomological Society of America national meeting in Salt Lake City, UT in November 2004.

A publication on the ants of Alabama is currently planned for Fall 2004. This will be a collaboration effort with Joe MacGown from the Mississippi State University Museum who has also been collecting in Alabama and assisting in the identification of the samples collected.

Foraging and Host Location Behavior of Pseudacteon Phorid Flies that Attack Solenopsis Fire Ants

Henry Y. Fadamiro and Lawrence Graham

1) Effect of adult feeding on the lifespan of *P. tricuspis*. One major objective of the FY03 funded project was to demonstrate adult feeding and its impact on longevity of phorid flies. We investigated the effect of sugar feeding on the survival of adult phorid fly *Pseudacteon tricuspis* Borgmeier (Diptera: Phoridae). Flies fed 25% sucrose continuously throughout their lifespan had higher longevity than completely starved (no water, no sugar) flies, flies provided water only, or flies fed only on their first day of life (Table 1). Completely starved flies rarely lived beyond one day. Provision of water increased longevity by 2 days, and one full day of sugar meal further increased longevity by an additional 1-2 days. Female and male flies fed 25% sucrose had similar survivorship as those fed 50% sucrose. The increase in lifespan that resulted from adult feeding should enhance the efficacy of phorid fly as a biological control agent by allowing the parasitoid more time to locate suitable fire ant hosts.

Diet	Females	**Males**
Starved (no water)	1.2 ± 0.1 c	1.3 ± 0.1 d
Water only	3.0 ± 0.2 b	3.3 ± 0.2 c
Sugar fed day 1 only	4.2 ± 0.3 b	5.0 ± 0.3 b
Sugar fed throughout lifespan	7.9 ± 0.8 a	8.9 ± 0.9 a
P	< 0.0001	< 0.0001

Table 1. Mean longevity (days ± SEM) of *P. tricuspis* subjected to different feeding regimes. Means within the same column having different letters are significant ($P < 0.05$).

2) Patterns of Accumulation and Mobilization of Nutrients in Sugar Fed Phorid Fly *Pseudacteon tricuspis*. Using a series of biochemical tests we compared the temporal patterns of nutrient accumulation and utilization in *P. tricuspis* fed different diets: starved, sucrose fed on the first day of life only, and sucrose fed continuously. Adult *P. tricuspis* emerged with virtually no gut sugars, and only minimal amounts of body sugars and glycogen. While the levels of body sugars and glycogen declined gradually in starved flies, a single day of sugar feeding resulted in

the accumulation of maximum amounts of gut sugars, body sugars, and glycogen. High levels of these nutrients were maintained in female and male phorid flies fed sucrose continuously over the observation period, whereas nutrient levels declined in flies fed only on the first day of life, beginning 1 d postfeeding. Female and male *P. tricuspis* emerged with an estimated 12.3 μg and 7.2 μg lipid reserves, respectively. These teneral amounts represented the highest lipid levels detected in adult flies, irrespective of their diet and were maintained over the life times of sucrose fed female and male flies, but declined steadily in starved females. These results suggest that adult *P. tricuspis* are capable of converting dietary sucrose to body sugars and glycogen but not lipids, and that moderate levels of body sugar is necessary to maintain life. The data also showed a positive effect of winglength on the amounts of gut and body sugars, and glycogen in sugar fed flies suggesting that larger flies may have a higher rate of sugar intake than small flies.

3) Effect of temperature and mating on survival of adult *P. tricuspis*. We conducted another study to test the effect of mating and temperature on lifespan of adult female and male phorid fly. Treatments included mated versus unmated starved or sugar-fed (female and male) flies placed at four different temperatures: 20°C, 25°C, 28°C, and 33°C. Preliminary analysis of the data suggests that mating has no effect on the lifespan of adult flies of both sexes. However, temperature appears to have a significant effect with adult flies living significantly longer at the lower temperatures (20°C, 25°C). These results indicate that phorid fly lifespan may be limited during hot summer days in Alabama, and may suggest the potential effect of microclimate and microhabitat on phorid fly lifespan and biological control efficacy.

4) Utilization of floral nectar and aphid honeydew by adult *P. tricuspis*. In an ongoing study, we are evaluating whether on not phorid flies can feed on floral nectar or aphid honeydew and the potential effect of both food sources on phorid fly lifespan. Treatments included buckwheat nectar, cotton leaf containing honeydew produced by cotton aphid, cotton leaf without honeydew, and control (water only). Preliminary data suggest that adult *P. tricuspis* may indeed utilize cotton aphid honeydew as a food source.

5) Attraction of phorid flies to imported fire ant. We have commenced a preliminary study to determine the cues used by phorid flies in locating fire ant hosts. Our preliminary olfactometer bioassays have demonstrated possible attraction of *P. tricuspis* to fire ant hosts. We plan to evaluate potential physiological and environmental factors that may affect response of *P. tricuspis* to fire ant hosts or host-related compounds.