



Texas Imported Fire Ant Research and Management Project

Final Progress Report - October 2001

Introductions of South American Phorids to Texas: Improving Methods of Release, Monitoring Outcomes, and Assessing Impact of South American Phorids on Ant Community Interactions and Fire Ant Populations

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Funding Amount/2 Years: \$330,856

Summary of work to be done:

Subproject A. Experimental Field Introductions of *Pseudacteon* phorids in Texas with assessment of subsequent fire ant and native ant communities at each site.

Subproject B. Research aimed to develop improved methods for phorid introductions.

Subproject C. Evaluate impact of physical factors and phorids flies on the outcome of *S. invicta*'s interaction with dominant native ants, such as *Forelius*.

Subproject D. Assess phorid disruption of worker foraging as a factor reducing colony growth and fitness and in altering caste ratios in *Solenopsis invicta*.

Major accomplishments to date (Sept. 1, 1999 through Aug. 31, 2001):

We have:

- Detected long-term (4, 13, 21 and 24 months) phorid reproduction at 4 of 15 sites in Central and South Texas. (A)
- Detected field-bred phorids hundreds of meters away from our original introduction arenas at one site in Austin. (A)
- Begun releasing and monitoring of phorid flies at eleven (11) sites in addition to the four (4) previous sites begun in 1998/99. (A)
- Base-line community assessments were conducted at six (6) of the 2000/01 sites. (A)
- Detected fly reproduction at four of these new sites. (A)

- Completed dispersal studies to determine factors involved in movements of flies from release sites. Flies have been detected at 50-150 yards from initial sources in one hour periods. **(B)**
- Found the use of live ants and ant “trash piles”(midden) in white plastic trays to be highly effective in field detection and monitoring of phorids when mounds are rare. **(B)**
- Completed laboratory studies determining factors that influence fire ant risk aversion. Completed greenhouse study of bait presentations that influence fire ant foraging under risk of phorid attack. Showed that larger baits attracted a greater number of ants and on average, a proportionately greater number of larger ants (which produce female phorids). **(B)**
- Completed three studies examining fire ant burial of food in relation to worker size and soil particle size. **(C)**
- Collected data on *Forelius* activity around *Solenopsis* mounds, completed one study using caged and uncaged flies in relation to mound defense. **(C)**
- Completed a laboratory “task allocation” study that investigated the effects that phorids have on worker recruitment for several tasks. **(D)**
- Completed experimental study of colony-level impacts of phorids on *S. invicta* showing that one phorid per 200 workers reduces protein consumption by 50%. Manuscript prepared for submission. **(D)**.
- Continued long term field study of ant community interaction to quantify the comparative status of imported fire ant in Brazil vs. Texas and pre vs. post phorid establishment. **(C)**
- Completed 3 studies examining potential effects of fire ant midden on interspecific foraging interactions. **(C)**
- Examined patterns of meteorological conditions-that are likely to affect phorid survivorship under greenhouse situations. **(B)**
- Completed a) sex-ratio and fly number retention studies and b) risk aversion studies. **(B)**
- Completed two sets of surveys at our Texas study sites, using the protocol developed in Brazil for quantifying community interactions involving fire ants, native ants and phorid flies. **(A&C)**

Goals achieved:

- Obtained evidence for long-term establishment in, and dispersal of, *P. tricuspidis* from original release sites in Texas fire ant populations. **(A)**
- Obtained evidence of phorid establishment in the face of harsh drought conditions, high maximum daily temperatures and multi queen fire ants. **(A)** However, high population densities of this tropical phorid were not achieved under such conditions in 1999-2001.
- Developed methods to increase the probability that foraging worker fire ants are attacked by released phorids. **(B)**
- Improved methods for rapid assessment of phorid establishment. **(B)**
- Found in lab studies that fire ant risk aversion was influenced by starvation, fly presence, and bait quality. **(B)**
- Expanded understanding of how fire ant avoidance of phorid flies affects defense of the colony and its food supply against native ants. **(C)**
- Quantified, in laboratory experiments, the impact of phorid flies on factors directly related to the reproductive capacity of fire ant colonies. **(D)**
- Showed that 'protection of food' by burial is performed by all size classes of workers and that discovery and recruitment rates to baits diminish with amount of burial

- covering. Related these results to interactions with phorids. (C)
- Obtained field evidence that midden has minimal effect on ant discovery and recruitment around baits or interspecific encroachment on *Dorymyrmex* mounds. (C)
- Overall, developed better insights into the region-specific challenges of using the species *P. tricuspis* for fire ant biocontrol in Texas. (A,B,C,D)

Relevance to the Texas Imported Fire Ant Research Ant Management Project:

The sustainable and self-perpetuating control of imported fire ant below pest status that biological control could provide is the most significant potential outcome of the State of Texas initiative. This project, through parallel sub-projects simultaneously carries out experimental field introductions of Brazilian phorid flies in a range of habitats using parallel and integrated lab, greenhouse and field studies designed to improve methods for introducing, as well as for assessing the consequences of introducing, these host-specialist fire ant parasitoids. (A ,B, C)

Additional projects examined the effects of the phorid fly parasitoid, *Pseudacteon tricuspis*, on colony fitness, worker caste ratios, and task allocation of imported fire ants. This species has been introduced into the U.S. for biological control of this invasive ant, yet its colony-level effects had not been assessed or quantified prior to this study. (D)

Publications submitted/published; presentations/posters presented at national technical meetings/conferences: (for all four projects of the grant combined)

Published

- Consoli, F., C. Wuellner, S. Vinson, L. Gilbert. 2001. Immature development of *Pseudacteon tricuspis* (Diptera: Phoridae), an endoparasitoid of the red imported fire ant, *Solenopsis invicta* (Hymenoptera: Formicidae). **Annals Ent. Soc. Am.** 94:97-109.
- Morrison, L.W., S.D. Porter, and L.E. Gilbert. 1999. Sex ratio variation as a function of host size in *Pseudacteon* (Diptera: Phoridae) parasitoid flies. **Biol. J. Linnean Soc.** 66:257-267.
- Morrison, L.W. 2000. Mechanisms of interspecific competition between an invasive and two native fire ant species. **Oikos** 90:238-252.
- Morrison, L.W. 2000. Mechanisms of parasitoid effects on exploitative and interference competition in host ant. **Annals Ent. Soc. Am.** 93:841-849.
- Morrison, L.W. 2000. Biology of *Pseudacteon* (Diptera: Phoridae) ant parasitoids and their potential to control imported *Solenopsis* fire ants (Hymenoptera: Formicidae). **Recent Res. Devel. Entomol.** 3:1-13.
- Morrison, L.W., E.A. Kawazoe, R. Guerra, and L.E. Gilbert. 1999. Phenology and dispersal in *Pseudacteon* flies (Diptera: Phoridae), parasitoids of *Solenopsis* fire ants (Hymenoptera, Formicidae). *Annals of the Entomological Society of America*. 92:198-207.
- Morrison, L.W., E.A. Kawazoe, R. Guerra, L.E. Gilbert. 2000. Ecological interactions of *Pseudacteon* parasitoids and *Solenopsis* ant hosts: environmental correlates of activity and effects on interspecific competition. **Ecological Entomol.** 25:433-444.
- Passera, L., S. Aron, E. L. Vargo and L. Keller. 2001. Queen control of sex ratio in fire ants. **Science** 293: 1308-1310.
- Shoemaker, D. D., K. G. Ross, L. Keller, E. L. Vargo and J. H. Werren. 2000. *Wolbachia* infections in native and introduced populations of fire ants (*Solenopsis* spp.). **Insect Molecular Biology** 9: 661-673.
- Vargo, E.L. 1999. Reproductive development and ontogeny of queen pheromone production in the fire ant *Solenopsis invicta*. **Physiol Entomol.** 24: 370-376.

- Vargo, E. L. and C. D. Hulseay. 2000. Multiple glandular origins of queen pheromones in the fire ant *Solenopsis invicta*. **J. Insect Physiology** 46: 1151-1159.
- Wuellner, C.T. 2000. Male aggregation by *Solenopsis richteri* Forel (Hymenoptera: Formicidae) and associated mating behavior in Argentina. **J. Insect Behavior** 13: 751-756.

In Press or Accepted

- Folgarait, P.J., O.A. Bruzzone, and L.E. Gilbert. Development of *Pseudacteon cultellatus* (Diptera: Phoridae) on *Solenopsis invicta* and *Solenopsis richteri* fire ants. **Environmental Entomol.** Biological Control Section. In press.
- Morrison, L., W. Long-term effects of the *S. invicta* invasion on native ant fauna at Brackenridge Field Laboratories, Austin, TX. **Ecology** In Press.
- Wuellner, C.T., J.B. Saunders, and L.E. Gilbert. Circadian and circannual patterns of activity and territory shifts: comparing a native ant (*Solenopsis geminata*, Hymenoptera: Formicidae) with its exotic, invasive congener (*S. invicta*) and its parasitoids (*Pseudacteon* spp., Diptera: Phoridae) at a central Texas site. **Annals Ecol & Pop Bio.** Accepted.
- Wuellner, C.T., C.G. Dall'Aglio-Holvorcem, W.W. Benson, and L.E. Gilbert. Phorid fly (*Pseudacteon* spp) oviposition behavior and fire ant (*Solenopsis invicta*: Formicidae) reaction to attack differ according to phorid species. **Annals Ent. Soc. Am.** Accepted.

Submitted

- Folgarait, P.J., O.A. Bruzzone, and L.E. Gilbert. Seasonal patterns of activity among species of ant parasitoid flies in central Argentina explained by analysis of climatic variable (*Pseudacteon*: Phoridae). **Environmental Entomol.** Biological Control Section.
- Folgarait, P.J., Lawrence E. Gilbert, and Octavio A. Bruzzone. Studies of host ant acceptability and suitability for some Argentinean species of *Pseudacteon* (Diptera: Phoridae), parasitoids of worker fire ants, genus *Solenopsis* (Hymenoptera: Formicidae). **J. Econ. Entomol.**
- Morrison, L. Spatiotemporal variation in antlion density and impacts on ant and general arthropod foraging behavior. **Ecological Entomol.**
- Smith, C.R. and L.E. Gilbert. Differential attraction of a parasitoid to dead host ants. **Fla. Entomologist.**
- Wuellner, C.T. and C. Crusco. Phorid fly presence interferes with midden work in the fire ant, *Solenopsis invicta* (Hymenoptera: Formicidae). **J. Insect Behavior.**

In preparation

- Mehdiabadi, N.J., and L.E. Gilbert. Parasitism of a pest superorganism: Parasitoid flies vs. fire ants. for **PNAS**.
- Mehdiabadi, N.J., E.A. Kawazoe, and L.E. Gilbert. Interspecific interactions between an invasive ant and a native ant in the presence of an introduced parasitoid. **Oecologia.**
- Mehdiabadi, N.J., E.A. Kawazoe, and L.E. Gilbert. Effects of parasitism on task allocation and task prioritization in the red imported fire ant. **Animal Behaviour.**
- Mehdiabadi, N.J., E.A. Kawazoe, and L.E. Gilbert. A fully factorial analysis of the ecological impacts of parasitism and competition on foraging in an invasive ant. **Ecology.**
- Mehdiabadi, N.J., R.J. Patrock, and L.E. Gilbert. A field method for releasing adult phorid fly parasitoids in the genus *Pseudacteon* (Diptera: Phoridae) for their attack on the red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae).
- Patrock, R.J., L.E. Gilbert, and N.J. Mehdiabadi. Pitfall sampling of ants and other arthropods in the South Texas Plains.
- Wuellner, C.T., S.D. Porter, L.E. Gilbert. Eclosion, mating, and grooming behavior of the parasitoid fly *Pseudacteon curvatus* Borgmeier (Phoridae).

Wuellner, C.T., C.R. Smith, C.G. Dall'Aglio Holvorcem, R.J. Patrock, and L.E. Gilbert.
Disturbed mound recovery time of the red imported fire ant, *Solenopsis invicta*
(Hymenoptera: Formicidae), is decreased in the presence of phorid flies (*Pseudacteon*
spp).

Proceedings Articles:

Gilbert, L.E. and R.J.W. Patrock. Phorid flies for the biological suppression of imported fire ants in Texas: Region specific challenges, recent advances and future prospects. **Southwestern Entomologist**. Submitted.

Presentations:

Consoli, F.L., C.T. Wuellner, S.B. Vinson, and L.E. Gilbert 1999. Immature development of *Pseudacteon tricuspis*, a parasitoid of the red imported fire ant. XII International Entomophagous Insects Workshop, Berkeley, California. (Posters).

Cônsoli, F.L., C.T. Wuellner, S.B. Vinson, and L.E. Gilbert. 2000. Imported Fire Ant Research Conference, Chattanooga Tennessee. Life history of *Pseudacteon tricuspis* (Dip.: Phoridae), an endoparasitoid of the red imported fire ants, *Solenopsis invicta* (Hym.: Formicidae).

Folgarait P. J., O. A. Bruzzone, S. D. Porter, M. A. Pesquero, & L. E. Gilbert. 2000. Geographical ranges and patterns of diversity for *Pseudacteon* flies, parasitoids of *Solenopsis* ants, from Argentina and Brazil. XXI International Congress of Entomology. Iguazú Falls, Brazil. (Poster)

Folgarait, P.J., O. A., Bruzzone, & L. E. Gilbert. 2000. Phenological patterns for parasitoids specialized in attacking *Solenopsis* fire ants, at the Reserva Ecológica Costanera Sur, Argentina. XXI International Congress of Entomology, Iguazú Falls, Brazil. (Poster)

Gilbert, L.E. and R.J.W. Patrock. 1999 Ecology of fire ant invasions in the Rio Grande Plains: Opportunities for biocontrol and lessons for management. The Wildlife Society (Invited Talk)

Gilbert, L.E. 2000 Ecology of fire ants and phorid flies suggests novel biological control strategy. La Selva Biological Station, Organization for Tropical Studies, Costa Rica. July.

Gilbert L. E., and R.J.W. Patrock. 2000. Phorid Flies for the Biological Suppression of Imported Fire Ants in Texas: Region Specific Challenges, Recent Advances and Future prospects. Imported Fire Ant Conference, Annual Meeting, San Antonio, TX.

Gilbert, L.E. 1999-2000 "Fire ants and their dipteran parasitoids: Ecological interactions and biocontrol dreams". (Invited Lectures)

99 Oct. 1 Division of Life Sciences, University of Texas at San Antonio.

99 Nov. 19 Connecticut Entomological Society, Hamden, CN.

00 Apr. 10 Dept. of Environmental, Population, and Organismic Biology, Univ. of Colorado, Boulder.

00 Apr. 21 Department of Entomology, Univ. of Arizona, Tucson.

Gilbert, L.E. 2001. Behavioral and community ecology of phorid flies and fire ants.

23 May 01 Centro de Estudios e Investig., Universidad Nacional de Quilmes, Buenos Aires, Argentina

01 July 18 Am. Behav. Soc., Corvallis, OR

Gilbert, L.E. 2001 Feb 28 Progress in screening phorid fly parasites for release in Texas and Assessments of experimental releases of *Pseudacteon tricuspis*. Texas Fire Ant Project Symposium, SW Branch of ESA and Annual Imported Fire Ant Research Conference. San Antonio, TX.

Horn, K. and N. Mehdiabadi. 2000 Effects of a phorid fly parasitoid (*Pseudacteon tricuspis*) on task allocation in the red imported fire ant (*Solenopsis invicta*) College of Natural Sciences Undergraduate Poster Session, Univ. of Texas. (Poster).

Mehdiabadi, N.J. and Gilbert, L.E. October 5 – 8, 2000. Parasitism to a superorganism: effects of a parasitic fly on red imported fire ant colonies. International Union for the Study of

- Social Insects - North American Section, Huntsville, Arkansas (oral presentation).
- Mehdiabadi, N.J. November 6, 2000. Parasitism to a superorganism: effects of a phorid fly parasitoid on red imported fire ant colonies. Population Biology Seminar, Section of Integrative Biology, University of Texas, Austin, TX. (oral presentation).
- Mehdiabadi, N. 2001. Keynote Speaker at Howard Hughes Medical Institute Undergraduate Research Symposium, Texas Tech University.
- Patrock, R. 2000 "Off with their Heads": Phorid Flies Harass Fire Ants, Austin Science Fun Day, Mar. 4, 2000. Attended by 4,000 Austin area school children and their parents (Demonstration and lecture).
- Patrock, R., C. Wuellner, and L.E. Gilbert. 2000. Classical biological control of the red imported fire ant using phorid flies: A Texas perspective.. Entomological Society of America, Montreal, Quebec. (Talk).
- Patrock, R.J.W. 2001. Ant distribution patterns in Texas. Texas Academy of Sciences, Annual Meeting, San Marcos, TX. (Talk)
- Patrock, R.J.W., C. Wuellner, and L.E. Gilbert. 1999 No mistaking the phorids for the trees: *Pseudacteon spatulatus* attacks *Solenopsis geminata* in tree canopies. Entomological Society of America, Atlanta, Georgia (Poster).
- Patrock, R.J.W., C. Wuellner and L.E. Gilbert. 2000. Classical biological control of the red imported fire ant using phorid flies: A Texas perspective. Entomological Society of America, Montreal, Quebec. (Talk).
- Patrock, R.J.W. 2001. Digging behavior of *Pseudacteon tricuspis*. 2001 Annual Fire Ant Research Conference, San Antonio.
- Plowes, N. and R. Patrock. 2000. Generalized key to the ants of Brackenridge Field Laboratories. <http://www.utexas.edu/research/bfl/collections/antkey.pdf>
- Smith, C. 2001 Mar 5 RIFA Bait Preference and Risk Aversion Experiment in the tropical greenhouse at BFL, with data on RIFA foraging dynamics. U. Wisc., Madison
- Smith, C., C. Wuellner, R. Patrock. 2000. A logical synthesis of the environment of the red imported fire ant, *Solenopsis invicta* Buren (<http://uts.cc.utexas.edu/%7Egilbert/research/fireants/faenviron/>).
- Vargo, E. Fire ant queen pheromones: functions, glandular sources, ontogeny. Poster presented at Imported Fire Ant Conference, Chattanooga, TN April 5-7, 2000
- Wuellner, C.T. 1999. Behavioral response of the red imported fire ant depends on the species of phorid fly attacking. USDA-ARS, CMAVE, Gainesville, FL. (Invited Lecture)
- Wuellner, C. 1999. Everything you wanted to know about the red imported fire ant, but were afraid to ask. North Austin, TX Rotary Club. (Invited Lecture).
- Wuellner, C., C. D-A Holvorcem, C. Smith, R.J.W. Patrock, and L.E. Gilbert 1999 How to keep a bad ant down: Disturbed fire ant mounds return to an unagitated state more quickly when phorids are present. Entomological Society of America, Atlanta Georgia (Poster).
- Wuellner, C. 2000. Taming man's pest friend: choosing the most promising species of phorid flies for biocontrol of the red imported fire ant, *Solenopsis invicta* Buren. USDA-ARS, Southern Insect Management Research Unit, Stoneville, MS. (Invited Lecture)

Ant workshops held at BFL: <http://www.utexas.edu/research/bfl/antworkshops/>
 The site provides teaching resources such as keys and lists in down-loadable form:
 for example, <http://www.utexas.edu/research/bfl/collections/ants.html>