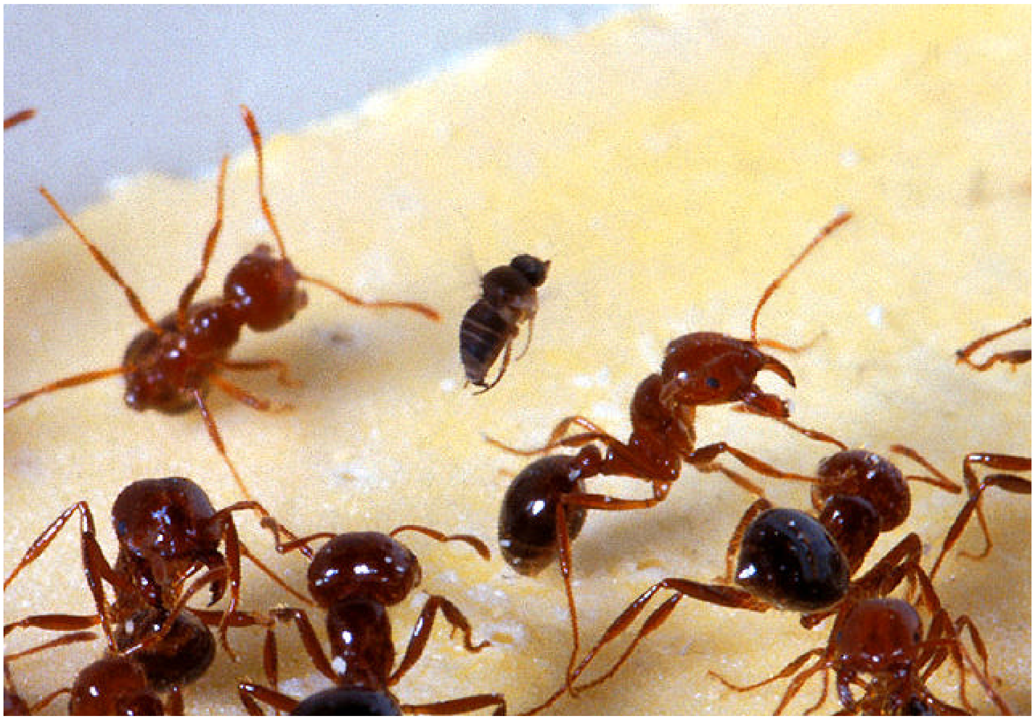
Beneficial Insects Laboratory
Annual Report of Activities
1999-2000



Phorid fly (*Pseudacteon tricuspis*) attacking Red Imported Fire Ants *(Solenopsis invicta)*. USDA Photo

Phorid fly-USDA Photo

North Carolina Department of Agriculture and Consumer Services

Meg Scott Phipps, Commissioner

1999-2000 REPORT OF ACTIVITIES

Beneficial Insects Laboratory

Plant Protection Section
North Carolina Department of Agriculture and Consumer Services
P.O. Box 27647
Raleigh, NC 27611

http://www.ncagr.com/plantind/index.htm

Introduction

This report is a summary of the projects undertaken by the Beneficial Insects Laboratory (BIL) of the Plant Industry Division of the North Carolina Department of Agriculture and Consumer Services during the years 1999 and 2000. The BIL addresses two programs, biological control and apiary inspection. The Biocontrol program implements classical biological control projects, in which the natural enemies of pest insects and weeds are released in the environment with the goal of stabilizing pest populations below their economic threshold. The Apiary Inspection program is designed to maintain a viable bee and honey industry in North Carolina through inspection for mites, diseases, and other hive pests.

The insect featured on our cover this year is *Pseudacteon tricuspis* Borgmeier, a minute parasitic fly that attacks fire ants. Native to South America, this fly is specific to the red imported fire ant, *Solenopsis invicta* Buren. We were able to obtain and release adults of this parasitoid in Beaufort Co. during spring 2000, and we hope it will prove to be a useful addition to our fire ant control programs. Although it will not eradicate the fire ant, it may provide a competitive edge for native arthropod fauna as well as humans. Details of the project may be found in this report.

The Cooperative Extension Service, faculty, and staff of North Carolina State University, USDA-APHIS and ARS all played roles in the implementation of our programs. We are grateful for the cooperation of other members of the NCDA Plant Protection Staff, including Support Services, the statewide field staff under the supervision of John Scott, Mike Massey, and Lloyd Garcia, and the identification service provided by NCDA taxonomist Kenneth Ahlstrom.

Implementation of our 1999-2000 programs included release of a total of 940 beneficial insects, an entomopathogenic fungus, and a microsporidian; some were redistributions within the state, others originated from out-of-state. Cooperative work with USDA-APHIS-ARS for cereal leaf beetle continued, as well as studies on the biology of the adventive predator *Harmonia axyridis*.

The Quarantine Facility housed at the laboratory has been used by our personnel, entomologists from NCSU, and by the Museum of Natural Sciences. Rebecca Fergus currently serves as the Quarantine Officer, and welcomes inquiries about the facility.

One paper was published by BIL personnel during 1999-2000:

Nalepa, C.A., K.A. Kidd and D.I. Hopkins. 2000. The multicolored Asian Lady Beetle (Coleoptera: Coccinellidae): Orientation to aggregation sites. Journal of Entomological Science 35(2): 150-157.

The personnel of the BIL during 1999-2000 were:

Ms. Kathleen Kidd, Biological Control Administrator
Dr. Christine Nalepa, Laboratory Research Specialist

Dr. Janet Shurtleff, Quarantine Officer (through March 2000)
Dr. Robin Goodson, Agricultural Research Technician (through March 1999)
Ms. Rebecca Fergus, Ag. Res. Tech II & Quarantine Officer (June 2000 – present)
Ms. Jamie Meadows, Office Assistant
Mr. Doug Huffman, Plant Pest Aide (1999)
Mr. Craig Hanemann, Plant Pest Aide (1999 - present)
Mr. Tim Smith, Summer Intern (2000)

Mr. Donald Hopkins, State Apiarist and Apiary Inspection Supervisor
Mr. Glenn Hackney, Agricultural Research Technician
Mr. Will Hicks, North Central Piedmont Area Apiary Inspector
Mr. Adolphus Leonard, Eastern Area Apiary Inspector
Mr. William Sheppard, Sandhills Area Apiary Inspector
Mr. Richard Lippard, Western Piedmont Area Apiary Inspector
Mr. Jack Hanel, Mountain Area Apiary Inspector

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C.A. Nalepa, R.R. Fergus and K.A. Kidd,
Editors
7 –III-01

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Records of Beneficials Released during 1999-2000

DATE	HOST	BENEFICIAL	#	SOURCE	CO./LOCATION
27IV00	Thistle	*Trichosirocalus horridus*	40	Nash Co. NC	Clay/Hyatt
27IV00	Thistle	*Rhinocyllus conicus*	900	Nash Co. NC	Clay/Hyatt
7III00	Gypsy moth	*Entomophaga maimaiga*	3 cad.[1]	Old Trap/Camden	Clay/Hyatt
27IV00	Gypsy moth	*Entomophaga maimaiga*	2 vials.	Old Trap/Camden	Clay/Hyatt
4X00	Fire Ant	*Thelohania solenopsae*	8 g [2]	USDA-ARS, FL	Sampson/Garland
5X00	Fire Ant	*Pseudacteon tricuspis*	3000	USDA-ARS, FL	Beaufort/Greenville

TOTAL: A total of 940 insects and 2 species of pathogen were released in North Carolina during 1999-2000.

[1] Cadavers infected with *E. maimaiga*
[2] Grams of fire ant brood infected with *T. solenopsae*

NCDA & CS Beneficial Insects Laboratory
Summary of Quarantine Activities 1999-2000

A total of 12 shipments of foreign material were received by the NCDA & CS Insect Quarantine Facility during 1999 and 2000, and several shipments in previous years remained in the facility.

ID #	SPECIES	FAMILY	STAGE	#	ORGIN	STATUS
Q97-1	***Blattella germanica***	Blattellidae	Adults/ nymphs	50	Japan	Insects received in this shipment are still being maintained in quarantine.
Q97-2	***Lymantria dispar***	Lymantriidae	Larvae	860	NC	Insects dissected and autoclaved
Q97-4	***Lemophagus curtus*** ***Diaparsis temporalis***	Ichneumonidae	Pupae	11 22	France	Emerged 4/00 Shipment has not emerged in quarantine.
Q97-5	***Trichogramma exiguum***	Trichogrammatidae	Larvae/ pupae	57,940,000	France	Released from quarantine. Insects originally from US, reared in France, and shipped back for release in NC.
Q98-2	***Aethina tumida***	Nitidulidae	Adults	50	NC	Colony being maintained in quarantine for research.
Q98-3	***Aethina tumida***	Nitidulidae	Adults	80	NC	Colony being maintained in quarantine for research.
Q99-1	***Calidiellum rufipenne***	Cerambycidae	Pupae/ larvae/ adults	Unknown 17 emerged to date	NC	Cedar logs being held in quarantine for maturation and emergence of adult beetles.

Ash Whitefly Monitoring

Craig Hanemann

The ash whitefly (AWF), (S*iphoninus phillyreae* Haliday)(Homoptera:Aleyrodidae), originated in Europe, North and Central Africa, and made its first American appearance in California in 1988. In 1993, the AWF was found in North Carolina on Bradford pear trees throughout Wake County. A parasitic wasp, *Encarsia inaron* (Walker) (Hymenoptera: Aphelinidae), that successfully controlled the AWF in California was released in Wake County during 1994-1995. The parasitoid became established and appears to have dispersed throughout the county. We continue to monitor Bradford pear trees throughout Wake County for AWF infestations and the presence of *E. inaron*.

Four infestations located in Garner, North Raleigh, downtown Raleigh (one of the original sites found) and Morrisville were monitored on a weekly basis from early summer through leaf drop during 1999 and 2000. An additional site, also in Morrisville, was added in 2000. The AWF population density was estimated visually, using a rating scale from 0-4 (0 = no apparent AWF population, 1 = 1-25%, 2 = 26-50%, 3 = 51-75%, and 4 = 76-100% of leaves with AWF present). Samples of 25 leaves/site were collected and returned to the laboratory to determine: 1) the number of leaves with AWF colonies, 2) an estimate of the leaf area (%) covered by colonies, and 3) life stages present (including adults).

During 1999, the populations at the Morrisville, N. Raleigh and Garner sites remained low (rating =1) throughout the season, but the population at the downtown Raleigh site was higher with ratings of 2-3. In the year 2000, infestations at monitored sites were very low until 22 August, two months later than in 1999. The outbreaks occurred after a weeklong rainy spell. Parasitism by *E. inaron* was first detected at all sites during the weeks of 20 September 1999 and the week of 25 September 2000, in the form of exit holes in AWF pupae. The AWF, which is native to dry Mediterranean regions, may be poorly adapted to North Carolina, and never develop into the pest problem that is did in California. Although AWF never appears to cause more than aesthetic damage to the Bradford pear trees at any site, new infestations are found each year. We will continue to monitor populations of both AWF and *E. inaron* to determine its pest status in this area.

Cereal Leaf Beetle Parasitoid Insectary Program

K.A. Kidd

The cereal leaf beetle (*Oulema melanopus* (L.)) (CLB) (Coleoptera: Chrysomelidae) is native to the Palearctic region and a pest of small grains. This species was first detected in North Carolina in 1977 in 19 counties, primarily along the Virginia border, and is now found in all grain-growing regions of the state. CLB can cause severe damage to the leaves of wheat, oats, barley and other cereal crops, and when heavy feeding occurs, grain yields may be reduced.

Cereal leaf beetle was discovered in Michigan in the early 1960s, and efforts to quarantine and eradicate it were unsuccessful at that time. A biological control program was initiated in 1963 (Haynes and Gage 1981) and parasitoids were collected in Europe. Parasitoid nurseries (or field insectaries) were established in Michigan and other midwestern states by the late 1960s; field days were held to distribute parasitoids to regional extension personnel and farmers. USDA originally imported one species of egg parasitoid and three species of larval parasitoids from Europe. These became established in the United States, and all have been released in North Carolina. *Anaphes flavipes* (Foerster) (Hymenoptera: Mymaridae) (the egg parasitoid) was released as early as 1978. This species disperses well and is not reared in insectaries; it is released and allowed to spread on its own. Three larval parasitoids, *Tetrastichus julis* (Walker) (Hymenoptera: Eulophidae), *Diaparsis temporalis* Horstmann (Hymenoptera: Ichneumonidae) and *Lemophagus curtus* Townes (Hymenoptera: Ichneumonidae) have also been released.

In 1978, the first parasitoid releases were made in North Carolina, and a field insectary program, similar to the program in Michigan, was started in the fall of 1987; insectaries were seeded with parasitized larvae from an insectary in Virginia. Insectaries have been planted at the Tidewater Research Station near Plymouth, Oxford Research Station near Oxford, and the Piedmont Research Station near Salisbury, but the Piedmont insectary is the only one that has had perennial populations of CLB and *Tetrastichus julis.* Adults of *D. temporalis* (~420), reared from material collected in Europe, were released at the Piedmont insectary in 1996 and 1998. Approximately 400 adult *D. temporalis* adults were released at Tidewater in 1995, and CLB larvae parasitized by all 3 species were released there in 1994. *Tetrastichus julis* was recovered in low numbers at Tidewater in 1998, but neither of the ichneumonid species has been found. Cereal leaf beetle populations are low at Oxford, and low numbers of *T. julis* are typically recovered there. The egg parasitoid is prevalent at all insectaries, but does not appear until late in the season.

Materials and Methods

Descriptions of the parasitoid insectaries may be found in previous reports (Kidd and Bryan 1993, 1994). Although each insectary follows a different planting design, they all consist of two or four plots, each of which is divided into two or more subplots. All have fall wheat followed by a spring planting of oats. No-till planting methods are used in all plots. Three insectaries were planted in 1999; the insectary at The Tidewater station was not planted in 2000.

Beginning in late March or early April of 1999 and 2000, insectaries were monitored every 7-11 days. Presence of CLB adults in the early spring was determined using sweep net samples; after eggs and larvae were detected, the presence of adults was noted during visual inspection of the plants. To determine population densities of the eggs and larvae, three samples of one square foot each were taken in each subplot. Each sample consisted of counts of all eggs and larvae on 20.5 inches of small grain row, and the three counts were averaged for each subplot. After larvae were detected in the field, samples of larvae were removed and examined for the presence parasitoids. Larvae were dissected to determine the presence of parasitoid eggs or larvae at the Beneficial Insect Lab. and also by K.R. Ahlstrom, NCDA&CS, Plant Industry taxonomist.

CLB larvae were collected in France 13-21 May 1999. Laboratory dissections at the time of collection showed larvae were parasitized by *Diaparsis* sp. at a rate of 50%. Approximately 2000 larvae were collected and placed in vermicullite to pupate. Pupal cells were held in the NCDA&CS Quarantine Facility until adult parasitoids emerged in the spring of 2000.

Results and Discussion

During 1999, populations of cereal leaf beetle were low at the Oxford insectary, and the density of eggs never exceeded 1.0/ft^2. Larvae were found only on 13 April at a density of 0.2/ft^2. Populations were moderate at the Piedmont and Tidewater insectaries (Table 1). At the Piedmont insectary, both egg laying and hatching were protracted during the spring, with the highest egg density found on 23 April in all but the fall wheat. Highest larval populations occurred 23 April in the fall wheat and first oat plantings, and 13 May in the younger oat plantings. At the Tidewater insectary, highest egg populations occurred 16 April and larval populations peaked 10 days later on 26 April. In 2000, CLB populations were higher at the piedmont insectary, with relatively high egg counts continuing between 19 April and 8 May. Larval populations were also higher than in the previous year.

The larval parasitoid *T. julis* was recovered for the first time at the Tidewater insectary, on 14 May 1999, when most of the CLB had already pupated. This species persists at the Piedmont insectary (Table 2). Rates of parasitism at the Piedmont insectary were high at the end of the 1999 season, and parasitized larvae were sent to Alabama and Georgia for release in insectaries there. In 2000, ichneumonid parasitoids were recovered in the larval dissections. To allow these to increase in number, no larvae were removed from the insectary for redistribution.

Low numbers of insects emerged in quarantine, and instead of releasing them into the field, CLB larvae were placed on bouquets of oat foliage in cages in the lab and the adult parasitoids allowed to sting them. Pupal cells are being held in the lab until next spring.

Acknowledgements

Numerous individuals contributed to this project, and the list includes, but is not limited to Raymond Coltrain, Ray Horton, Bill Clements, and John Smith (Research Stations) and John VanDuyn, Stephen Bambara (NCSU).

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Table 1. Cereal Leaf Beetle Populations, 1999 and 2000

Plymouth, 1999	Eggs (Mean #/ft^2)		Larvae (Mean #/ft^2)	
Date	Wheat	Oats	Wheat	Oats
16 April	9.5	16.8	11.2	5.2
26 April	1.0	3.5	23.3	10.3
6 May	0.2	2.2	6.7	10.7
12 May	0.0	0.0	0.0	1.3
20 May	0.0	0.0	0.0	0.0

Salisbury, 1999	Eggs (Mean #/ft^2)				Larvae (Mean #/ft^2)			
Date	Wheat	Oats1	Oats2	Oats3	Wheat	Oats1	Oats2	Oats3
31 March	6.0	8.8	12.5	0.0	0.0	0.3	0.2	0.0
9 April	3.3	4.8	15.7	6.5	4.8	7.5	6.5	0.3
23 April	1.2	9.0	17.3	14.5	6.0	6.5	5.5	1.5
3 May	3.0	5.5	9.8	4.2	0.5	5.8	5.5	0.3
10 May	0.0	0.0	4.7	3.7	1.3	9.7	12.2	1.5
17 May	0.0	0.0	0.7	1.8	1.2	3.3	5.2	1.3
28 May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Salisbury, 2000	Eggs (Mean #/ft^2)					Larvae (Mean #/ft^2)				
Date	Wheat	Oats1	Oats2	Oats3	Oats4	Wheat	Oats1	Oats2	Oats3	Oats4
7 April	0.8	1.0	4.2	1.3	1.5	1.8	1.2	0.0	0.0	0.0
19 April	1.2	2.5	21.2	25.2	13.5	1.2	0.5	0.5	0.8	0.0
1 May	1.2	3.8	21.0	10.0	17.0	2.0	2.7	4.5	8.2	3.0
8 May	0.0	0.0	5.5	12.2	14.8	7.7	8.7	13.7	14.7	7.3
17 May	0.0	0.0	0.2	0.7	0.7	0.0	0.5	26.8	25.5	12.0
24 May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.3
31 May	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The multicolored Asian Lady Beetle *Harmonia axyidis*

C. A. Nalepa

In the fall of 1999, we collected the imported lady beetle *Harmonia axyridis* (Pallas) from three locations: Revis home, Reems Creek Rd., Buncombe Co. (15 October 1999), Upchurch home, Alleghany Co. (29 October 1999), and grounds of the Beneficial Insect Laboratory in Cary, Wake Co. (daily from 27 October – 1 November, and 6-7 November 1999). The insects were collected as they arrived at aggregation sites, then used in two series of studies. First, a subsample of the insects was dissected to determine parasitism levels by the tachinid *Strongygaster triangulifer*. Second, a number of studies examined the cues used by beetles when settling into overwintering quarters. The evidence suggests that pheromones may not play a large role in the aggregation behavior of *Harmonia*.

During October and November of 2000, experiments were conducted in Asheville, Pilot Mountain and Cary to determine the visual cues used by *Harmonia* when landing at aggregation sites. We were able to obtain data on more than 3000 beetles; the data are currently being analyzed. Beetles were also collected and shipped to cooperators at Virginia Polytechnic and State University, who are conducting physiological studies.

Immediately after *H. axyridis* was first detected in North Carolina (1993), we found it to be parasitized by the tachinid *Strongygaster triangulifer* (Loew) at levels of up to 31%. Yearly dissections of adults arriving at aggregation sites since that time (1994 – 1999), however, indicate an average 2 - 4% parasitism, with a maximum never exceeding 10%. Our results suggest that the tachinid is not a significant source of late season mortality in the coccinellid.

Gypsy Moth: *Entomophaga maimaiga*

Rebecca Romano Fergus

The gypsy moth *(Lymantria dispar* Linnaeus) was brought into the United States in 1869 in an attempt to start a silkworm industry. Soon after, gypsy moth escaped and has since become a major forest pest in portions of the U.S. North Carolina has battled the gypsy moth since the early 1970's. The first treatment of gypsy moth in NC took place in 1974 on about 350 acres in Winston-Salem. Since 1982, all of NC has been survey trapped and the first quarantine was imposed on eastern NC in 1988. Currently, the quarantine extends through all of Currituck County and those portions of Dare County located on the Outer Banks.

In 1989, an entomopathogenic fungus native to Japan, *Entomophaga maimaiga* caused considerable mortality of gypsy moth in the Northeast. Over the next few years, introductions of *E.maimaiga* into new areas resulted in successful epizootics. Therefore, in 1992 the NCDA&CS decided to introduce *E.maimaiga* into gypsy moth populations established in eastern North Carolina.

Soil containing *E.maimaiga* resting spores was collected in New Jersey and transported to NC. A site in Camden County was chosen for the first release and was a low-lying area with an ongoing gypsy moth infestation. The site had been treated twice with *B.t. (Bacillus thuringiensis)* without significant reduction in gypsy moth populations. Beginning in mid-May, larvae were collected at release sites and held for ten days in individual cups containing artificial diet. At the end of that period, any larvae remaining alive were autoclaved. Dead larvae were dissected and a sample of hemolymph was examined with a phase contrast microscope for the presence of resting spores and conidia.

In 1993, field-collected larvae were sampled and dissected with one being infected with *E.maimaiga*. In 1996, soil contaminated with resting spores was collected from Virginia and distributed at 11 gypsy moth sites in Dare, Currituck and Camden Counties. Larvae infected with the fungus rose significantly (Table 1) in the following years: 6% in 1997, 21% in 1998 and 30% in 1999. In 2000, the percentage increased to 51%, but did not include data collected at the newest site, Devil's Gut. Larvae were collected from eight total sites in eastern North Carolina in 2000 (Table 2). At some previously infested sites in Dare County, larvae were not found and soil samples were taken to determine if the fungus had spread. At the end of 2000, egg mass surveys at the previously infested sites in Dare County resulted in no findings of viable egg masses.

We will continue to monitor all sites in 2001, and cadavers containing resting spores will be placed in new locations. Soil from current and previous infested areas has been sampled and will be tested for resting spores.

Table 1. Establishment of *Entomophaga maimaiga* in NC 1997-2000.

Year	# Dissected	% w/ E.m.
1997	819	6%
1998	304	21%
1999	134	30%
2000	142	51%

Table 2. Gypsy moth larvae infected with *Entomophaga maimaiga* in NC during 2000.

Location	# Dissected	# w/ E.m.	% Infected
Old Trap	1	0	0
New Old Trap	60	38	63%
Devil's Gut	51	0	0
Riviera	14	4	29%
Rest Stop	1	0	0
New Riviera	1	0	0
Bertha	13	3	23%
X-rd Bertha	1	1	100%

Red Imported Fire Ants:
Release of *Pseudacteon tricuspis* (Diptera: Tachnidae)

Rebecca Romano Fergus

The red imported fire ant (*Solenopsis invicta* Buren) (RIFA) inhabits over one third of North Carolina and almost the entire Southeastern United States (Callcott and Collins 1996). The RIFA is native to South America, where RIFA populations are one fifth of those normally found in North America (Porter et al 1997). These population differences are attributed in part to the RIFA escaping natural enemies in their native habitat. One such enemy is the phorid fly *(Pseudacteon tricuspis* Borgmeier), a parasitic insect that preys upon only the fire ant. Using their hypodermic shaped ovipositor, female phorids inject a single egg into the neck of a foraging RIFA. Just after hatching, the larva move into the RIFA's head where for two to three weeks it will develop (Porter et al 1995). Just before pupation, the larva releases an enzyme that dissolves the membranes that hold the exoskeleton together. The parasitoid consumes the contents of the ant's head, resulting in decapitation of the ant. Pupation occurs in the head and two to three weeks are required until the adult fly emerges. About six hours after emergence, phorids mate and begin oviposition.

The goal of this release program is not to eradicate the RIFA, but to reduce their populations and allow the native ants to better compete with them. When flies emerge, the RIFA becomes aware of their presence and they decrease their foraging. This can result in smaller mounds per acre because of a smaller food supply. Consequently, this allows the native ants to acquire more food than before the RIFAs were threatened.

In May 2000, the NCDA&CS became partners with USDA-ARS to release phorid flies at a site in Beaufort County. To quantify the ant population and species composition and monitor the efficacy of the phorid fly release, the field was sampled prior to release and again in the fall using protein baits and pitfall traps. A control site similar to the release site was also sampled. All ants collected were sent to Sanford Porter of the USDA-ARS, CMAVE lab in Gainesville, Florida for identification.

RIFA heads containing phorid pupae were held in the laboratory until adult emergence. Each day emerged flies were transferred by aspirator to plastic vials and transported to the release site. A total of approximately 3000 phorid flies were released over a two-week period, or about 300 per day. Individual RIFA mounds were excavated by shovel, deep enough to sample plenty of ants and brood and placed them into plastic buckets. The buckets were emptied into large covered, plastic trays. Fluon coated the sides to prevent the ants' escape. The soil inside the trays was moistened with water and a moistened plaster of paris shelter was placed in the tray. Screened lids were placed on the tops of the trays and closed. Next, 40-50 phorids were released into the plastic trays from holes on the tops of the lids. Once all of the phorids flew out of the vials and into the tray, the holes in the lids were closed with rubber corks and the trays remained covered. After two to three minutes, the trays were uncovered and agitated periodically for two hours to keep them active during the period. The plaster of paris shelter functioned as protection for the ants and their larvae. For the two-hour period, the flies would oviposit causing a lot of the ants to retreat under the shelter. The shelter was moved periodically, leaving once safe ants out in the open for the phorids to use as their hosts. After exposure time, ants and soil were returned to their original mounds. To minimize colony damage, mounds were moistened with water.

On days when the number of flies exceeded the capacity of the trays, mounds were treated directly. For this treatment, the mound was disturbed over a two-hour period to keep ants actively moving, and then the mound was watered.

Table 1. Phorid fly monitoring data for 2000 in Beaufort County, NC.

Date	# Mounds	# w/ Flies	Soil	Air Temp	Wind Speed
6/14/00	26	0	Dry	94/96	2 mph
6/16/00	27	0	Some Moist	90	8-10 mph
6/19/00	28	3	Some Moist	88/90	5-10 mph
6/21/00	24	3	Moist	90/92	5-10 mph
7/12/00	22	0	Very Moist	80	5-10 mph
7/17/00	30	0	Moist	84/88	5-10 mph
7/19/00	24	0	Dry	89/94	10-15 mph
7/26/00	29	4	Wet	80/79	5-10 mph
8/29/00	5	2	Wet	77/82	0-5 mph
9/1/00	8	0	Wet	86/88	5-10 mph
9/7/00	11	1	Moist	77/80	0-5 mph
10/6/00	19	0	Moist	82/78	0-5 mph
10/9/00	7	0	Moist	56	10-15 mph
10/11/00	18	1	Dry	65/72	0-5 mph
10/20/00	11	3	Dry	70	0-5 mph

Monitoring for the phorids began 36 days after the initial release date. Mounds located in the release area were disturbed and observed for phorid activity for 20 minutes each. Each day, two and a half-to three hours were spent observing RIFA mounds watching for the presence of phorids. The first generation of phorids was recovered from two mounds 41 days after the first release date, and from three mounds at 43 days. A total of five generations were recovered before temperatures dropped too low (< 70°) for flies to be observed.

Monitoring will resume in spring 2001 as temperatures rise. We will broaden our search for phorids a short distance away from the original release site to see if they have expanded their range. Currently, a second release site in North Carolina is being sought.

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Red Imported Fire Ants: Effect on Native Ants in Wake County

Tim Smith

Abstract The activity of the red imported fire ant, *Solenopsis invicta*, was examined to determine the exotic ant's effect on the native ant fauna in Wake County, NC. Fire ant infested, pesticide-controlled, and uninfested sites were sampled using both pitfall traps and bait stations. The infested sites showed reductions in both native ant abundance and species diversity compared to sites where fire ants were not present.

The red imported fire ant (RIFA) was introduced to the United States near Mobile, Alabama, between 1933 and 1945 (Porter and Savignano 1990), and has since spread quickly across the southeastern United States. Currently it may be found as far west as Texas and as far north as North Carolina (Porter and Savignano 1990). This success of this exotic species is partly due to the lack of its natural enemies in the US (Porter et. al. 1997). Other traits such as its rapid reproductive rate, ability to survive in a variety of environments, and preference for disturbed habitats also make this species a successful invader (Stoker et al. 1995).

Ants usually experience most of their competitive interactions with other ants (Howard and Oliver 1979). It is difficult to examine the effects of competition between different species under natural conditions. When a new species is introduced to an area, however, the resulting competitive interactions are easier to recognize (Porter et al. 1988). Previous studies suggest that the RIFA decrease the diversity and abundance of other ant species (Urbani and Kannowski 1974, Howard and Oliver 1979, Porter et al. 1990, Cherry and Nuessly 1992, Stoker et al. 1995). However, these experiments were conducted in Louisiana, Texas, and Florida, where the RIFA has been established in for over 40 years, and where the environment approximates their native habitat in Brazil (Porter 1997). The objective of this study was to determine the effect of a RIFA invasion on the native ant fauna in Wake County, NC, at the edge of its established range.

Materials and Methods

Three site types were examined using pitfall traps and bait stations during this experiment: 1) sites currently infested by RIFA, 2) previously infested by RIFA, or 3) uninfested by RIFA. All sites were located in Wake County, NC. One infested site was located at the corner of Dillard Rd. and Columbus Ave. in Cary. It was a landscaped roadside with clay soil and 10-15 cm vegetation. The plot measured 8 x 90 m and contained 11 mounds. The average area of the mounds was 562.1 cm^2. The second RIFA infested site was located at the First Citizens bank in Garner. It was a lawn next to the roadside with clay soil and 6-8 cm vegetation. There were 16 mounds in the 14 x 90m plot, and the average mound area was 351.7 cm^2. The two previously infested sites used in this study had been treated with AMDRO® insecticide by either the State of North Carolina or by Parker Landscaping Company on a mound-to-mound basis for at least one year prior to experimentation. Fire ants apparently had been eradicated at these sites. One site located at Crabtree Lake Park in Raleigh was a mowed field between a wooded area and a lake. The other, located at the corner of Caitboo Ave. and Columbus Ave. in Cary, was a landscaped roadside similar to the infested site in Cary. The uninfested sites were located at the Beneficial Insect Lab (BIL) in Cary and Carter Finley Stadium in Raleigh. The (BIL) site was frequently mown lawn between a lab building and a weedy field. The stadium site was located on the roadside and had 4-6 cm vegetation. Each site was inspected for the presence of RIFA prior to experimentation.

Pitfalls- Pitfall traps were set out at each site between 13 and 25 June 2000. Each trap consisted of a 25mm diam., 25ml plastic vial containing approximately 10ml propylene glycol. Each vial was inserted into a hole bored into the ground, with the upper edge of the vial level with the surface of the ground. The 10 traps at each site were set in a line 9 m apart, and remained in the field for 3 days before they were collected, capped, and transported back to the lab for identification.

Baits- Each site was sampled using baits. Baits consisted of a 15x45mm-shell vial with a slice of Vienna sausage weighing roughly 0.7 g inserted 1 cm inside the open end. The vials were placed flat on the ground so that the meat was easily accessible to ants and other surface-active arthropods. They were set out in the same manner as were the pitfalls (10 per site and 9 m apart), but were left out for 30 minutes at each site. At the end of the 30-minute period, the vials were collected, corked, and transported back to the lab for identification of the contents. Baiting was done 13 to 22 June 2000 between 7:00 and 10:00 AM. Ants were counted and identified to species, while other arthropods were counted and identified to order or family.

Data were analyzed using the general linear model procedure of SAS (Proc GLM, SAS Institute 1996)

Results

Red imported fire ants affected abundance and diversity of other ant species in the sites tested (Table 1). Pitfall traps contained a mean of 270.5 ± 3.5 (mean ± SE) native ants in the non-infested sites, 15.5 ± 6.5 native ants in the eradicated sites, and only 0.5 ± 0.5 native ants in the uninfested sites (Fig. 1). The mean number of species collected in the pitfalls was 10.5 ± 1.5 species for the uninfested sites, 6.0 ± 0 species in the eradicated sites, and 1.5 ± 0.5 species for the RIFA-infested sites (Fig. 2). Many species that were present in the uninfested sites were not found at the eradicated or infested sites (Table 2). The difference in total number of ants collected among the three sites was not significantly different (F=1.06; df= 2,3; P › 0.05). No obvious trend was found in the abundance of surface-active arthropods from uninfested to infested sites (Table 2).

A mean of 1296.5 ± 580.5 non-RIFA formicids were collected on baits at the uninfested site, 141.5 ± 73.5 non-RIFA in the eradicated site, and 0 in the RIFA infested site (Table 3). Little change was found in total ant diversity for the three different populations; a mean of 2 different species was collected in the never-infested sites, 2.5 in the eradicated site, and 1 ± 0 in the infested site. As with the pitfalls, the total number of ants collected was not significantly different for each site (F=6.93; DF=2,3; P › 0.05).

Discussion

Red imported fire ants had a negative effect on ant populations in the infested sites examined. Species richness and total number of ants collected decreased considerably when RIFAs were present. However, in contrast to Porter et al. (1990), the total number of ants at each site remained consistent for each experimental group.

There are several factors that may explain RIFA's dominance over native ants. The RIFA is a highly aggressive species (Stoker 1995), it has less regulation by natural enemies (Porter 1997), and it exploits resources needed by native ants (Porter 1990). When RIFA colonize an area, these advantages allow them to outcompete native ants. As a result of the declining food resources available for native ants, their colonies become exhausted and worker numbers decrease. Consequently, the RIFA gains even more dominance in the area as they are subjected to less competition from the weakened native ant population. This trend results in a homogeneous environment containing many RIFA and few native ants.

In a similar study conducted in Texas, Porter (1990) found that the total number of ants collected in RIFA infested sites was 10-30 times the number of ants found in uninfested sites. He hypothesized that the imported fire ants were able to survive in such great numbers because they either exploited food resources from other scavenging arthropods, or found new resources that were previously unused by the community. He observed a significant decrease in the number of surface-active arthropods in infested sites when compared to the numbers collected from uninfested sites, which suggests that the RIFA was also competing with them for food, or using them as food.

In this experiment, a 10-30-fold ant increase at infested sites was not observed; the difference in total number of ants collected from the various plots was not statistically significant. This suggests that the RIFA did not overload the environment's carrying capacity for ants, but merely replaced the native ant population. There are two possible explanations for why the results reported here differ from the Porter study. One is that variances in temperature, rainfall, food supply, and other environmental factors could allow the imported pests to prosper more in Texas than in North Carolina. If the environment in Texas more closely resembles the RIFA's native Brazil, the ants theoretically would be better adapted to Texas conditions, thus allowing them to dominate. Secondly, the RIFA has not existed in Wake County as long as it has in Austin. The first record of any RIFA infestation in Wake County was only reported in 1990 (Rebecca Fergus, pers. comm.). In contrast, fire ants were first reported in Texas in 1950 (Drees et al. 1996). This 40-year difference could contribute to the difference in results between the two studies. An additional factor is that the sites treated with insecticide resulted in intermediate levels of native ant abundance and diversity (Figs. 1 and 2). The AMDRO® insecticide used to control the RIFA is not species-specific, but it was selectively applied to fire ant mounds. The insecticide may have killed many native ants, causing their abundance and diversity to decrease. Alternatively, native ant population levels may be on the rise as a result of the eradication of the RIFA in the area. Restoration of native ant diversity would take many years to complete. Sampling these same areas in the future while keeping the pesticide treatments constant would indicate whether the pesticide treatments were beneficial or detrimental to the native ant population. The imported fire ant infestation in Wake County, NC, has had an impact on native ant abundance and total ant diversity; however, a number of unanswered questions regarding the ecological impact of this invasion on the native ant fauna of North Carolina still remain.

Acknowledgements

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Table 1. Mean numbers of ants collected at sites with different levels of RIFA infestation. Mean (standard error)

Pitfall Traps	**n**	**#RIFA**	**#others**	**total ants**	**# species**	**Total # traps w/ ants**	**# traps w/ RIFA**
infested	2	407(293)	0.5(0.5)	407.5(293.5)	1.5(0.5)	8.5(1.5)	8.5(1.5)
eradicated	2	1(0)	15.5(6.5)	16.5(6.5)	6(0)	7.5(1.5)	1(0)
uninfested	2	0	270.5(3.5)	270.5(3.5)	10.5(1.5)	10(0)	0(0)
Bait Traps							
infested	2	1546(707)	0(0)	1546(707)	0	7.5(1.5)	7.5(1.5)
eradicated	2	0(0)	141.5(73.5)	141.5(73.5)	2.5(0.5)	3.5(0.5)	0(00
uninfested	2	0(0)	1296.5(580.5)	1296.5(580.5)	2(1)	9(1)	0(0)

Table 2. Arthropods (non-Formicidae) collected from each population type.

	Arthropods		
	uninfested	**eradicated**	**infested**
order Acarina	18	47	33
order Araneae	72	16	12
order Coleoptera	15	13	4
order Diptera	6	8	1
order Isopoda	27	81	0
order Hymenoptera	1	2	0
family Culicidae	1	12	1
family Gryllidae	2	0	2
family Ixodidae	7	0	1
family Limacidae	5	0	0
family Locustidae	0	1	0

Table 3. Ant species collected from bait and pitfall traps.

	Pitfalls (# individuals)			**Baits (# individuals)**		
	uninfested	**eradicated**	**infested**	**uninfested**	**Eradicated**	**infested**
Aphaenogaster lamellidens	1	0	0	0	0	0
Acanthomyops latipes	5	0	0	0	0	0
Crematogaster lineolata	0	15	0	0	36	0
Iridomyrmex humilis	28	1	0	12	2	0
Lasius alienus	0	1	0	0	0	0
Monomorium minimum	128	0	1	2495	1	0
Paratrechina longicornis	21	0	0	0	0	0
Phidole sp.	163	8	0	106	244	0
Phildole sp.	21	0	0	0	0	0
Ponera pennsylvania	0	2	0	0	0	0
Solenopsis invicta	0	2	814	0	0	3092
Solenopsis molesta	58	0	0	0	0	0
Tapinoma sessile	30	0	0	0	0	0
Tetramorium caespitum	30	0	0	0	0	0

Fig. 1 Number of native ants by population type.

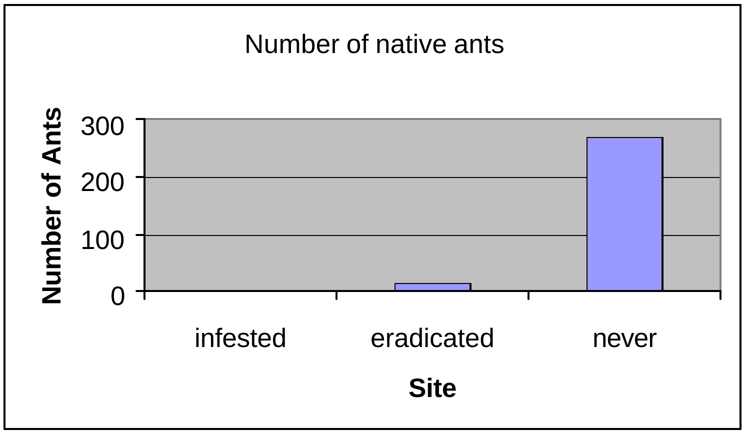
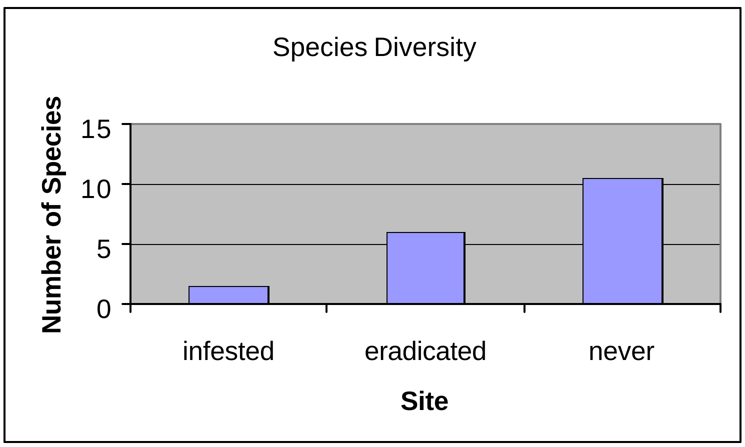


Fig. 2 Species diversity by population type.



Red Imported Fire Ants:
Release of the Microsporidian *Thelohania solenopsae*

C. A. Nalepa

The monitoring of two plots (one treatment, one control) in Garland (Sampson Co.) where the microsporidian disease (*Thelohania solenopsae*) of imported fire ant was released in 1998 (in cooperation with the USDA) was continued in 1999. The plots were visited 5 times in 1999 (12 January, 15 April, 24 June, 27 August and 12 November). During each visit all mounds in each plot were mapped and sampled for workers; brood samples were taken from mounds in which the disease was released. The population of ants in each mound was estimated. On two dates (15 April, 27 August) a grid of bait dishes was set out to identify and quantify all ant species present in the plots. Analysis of the samples (from 15 April) found preliminary evidence of infection in two fire ant colonies in the treatment plot.

In 1999 North Carolina was accepted as a cooperator in a Southern Regional IPM Grant administered by the University of Tennessee (Knoxville) to continue studies of *Thelohania solenopsae.*

Monitoring of the release site continued in 2000. Three surveys were conducted, on 7 February, 15 March and 20 June; no infected ants were detected. Two grams of infected fire ant brood was re-released into each of four mounds in the same site (Garland, Sampson Co.) in October; monitoring will continue.

Apiary Inspection Program

Donald I. Hopkins

The apiary inspection service monitors bee pests and regulates the movement of bees and equipment to protect the bee and honey industry of North Carolina. Using funds provided in an expansion budget, a laboratory was established in 1998 to perform quality assurance testing for the program. This laboratory is used to confirm mite and disease diagnoses and test equipment that has been fumigated in ethylene oxide chambers. The same expansion funds provided an additional inspector who currently serves the north central piedmont.

A new pest of honey bees and hive products was detected in NC in the fall of 1998. The small hive beetle *Aethina tumida*, of South African origin, was found in Scotland County in November. Earlier in 1998, the pest was found in Florida, Georgia, and South Carolina. The source of the infestation has not been determined. Delimiting surveys have shown that initially (1999) the beetle was limited to Scotland and adjoining counties, but by the end of November 2000, inspectors confirmed that the small hive beetle was established in 15 counties. Beetles have been found in four additional counties, but inspections following the implementation of control measures revealed no apparent beetle establishment. In seven of the counties where beetles are established in bee colonies, the sites are limited thus far to single yard locations. In-hive treatments with Chek-Mite™ strips and ground treatments with Guard Star™ have been used to control the beetles in these yards, but eradication of the beetle has not occurred. Counties with established beetle populations include Cherokee, Davidson, Guilford, Halifax, Johnston, Mecklenburg and Mitchell. Hive and ground treatments were also used in counties where more than one site was infested and where damage by the beetle has been curtailed but not eliminated. These counties are Cumberland, Edgecombe, Hoke, Nash, Richmond, Robeson, Scotland, and Wilson.

To better determine the natural migratory behavior of the beetle, the Apiary Inspection Service has purchased 50 nuc boxes (miniature hives) to be used as bait monitoring stations. The boxes will be set and ready to be installed next spring (2001) in presumably clean areas surrounding counties with the widest distribution of the beetles.

In an effort to protect the beekeeping industry in NC, NCDA & CS in May 2000 issued an emergency quarantine of the small hive beetle; areas under quarantine change as surveys indicate the extent to which the beetle has spread. The results of this quarantine and other control measures have been variable across the state. Work continues in monitoring and limiting the spread of this pest.

Other pests, including mites and diseases, continue to be of concern to NC beekeepers; apiary inspectors assist beekeepers through inspection, treatment, and education. With continued cooperation of the beekeepers and the NCDA & CS Apiary Inspection Service, the industry will remain strong and a valuable part of NC agriculture.