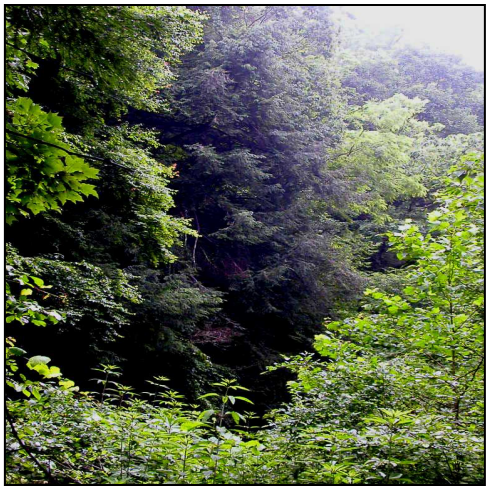
Biological Control Program
Report of Activities
July 1, 2008 – June 30, 2009

Fire Ants and Phorid Flies

Hemlock Woolly Adelgid



Summary of Quarantine Activities 2008/2009

A total of 5 shipments of foreign material were received by the NCDA &CS Insect Quarantine Facility during 2008/2009 and one shipment from previous years remained in the facility.

ID #	SPECIES	FAMILY	STAGE	#	ORIGIN	STATUS
Q02-1	***Lymantria dispar***[1]	Lymantriidae	Larvae	126	NC	Insects dissected with some held in incubator.
Q08-2	***Sasajiscymnus tsugae***[2]	Coccinellidae	Adults/ Eggs/ Larvae	330	Japan	Colony maintained in quarantine for research purposes.
Q08-3	***Striacosta albicosta***[3]	Noctuidae	Egg/larvae	4,059	IA	Insects maintained on artificial diet until pupal stage.
Q08/09 -4	***Cactoblastis cactorum***[3]	Pyralidae	Egg/larvae	9,341	FL	Insects maintained on artificial diet until pupal stage.
Q08-5	***Tetramesa romana***[3]	Eurytomidae	Egg/larvae	60	TX	Insects maintained on artificial diet until pupal stage.
Q09-1	***Adelges tsugae***[4]	Coccinellidae	Adults/ Eggs/larvae	200	OR, WA	Colony maintained in quarantine for research purposes.

[1]Gypsy moth cadavers which may contain resting spores of *Entomophaga maimaiga* are being kept for potential use in infecting populations of gypsy moth to slow their spread.

[2]*Sasajiscymnus tsugae* beetles shipped from Japan in 2008 were reared in quarantine for comparison and subsequent mating with the mass reared beetles to improve rearing stock. *S. tsugae* beetles are mass reared for release in the NC mountains to control the hemlock wooly adelgid (*Adelges tsugae*).

[3]Dr. Allen Cohen, Insect Diet & Rearing Research, LLC, is utilizing the NCDA&CS Beneficial Insects Quarantine Lab to develop artificial diets and rearing systems for *Cactoblastis cactorum* (prickly pear cactus moth), *Striacosta albicosta* (western bean cutworm), and *Tetramesa romana* (*Arundo* wasp).

[4]Kelly Felderhoff, graduate student at NCSU is comparing the western US population of hemlock wooly adelgid with the eastern population under the direction of Dr. Fred Hain.

Space in the NCDA&CS Quarantine Facility may be available for lease. Contact Rebecca Norris at (919) 233-8214 ext 22 for more information.

Cerceris fumipennis in North Carolina

The native ground-dwelling wasp, *Cerceris fumipennis,* provisions its nest with buprestids, including the invasive forest pest Emerald Ash Borer (EAB) (*Agrilus planipennis*) when present. The wasp is much more efficient than humans at finding EAB, and is proving to be a reliable way to monitor for this pest. It is a solitary, ground-nesting wasp that lives in diffuse colonies in sparsely vegetated, open spaces with hard-packed, sandy soil. Colonies are almost always found in full sunshine near wooded areas in places of human disturbance (fire-pits, campsites, road and trail edges, informal parking lots, playgrounds, and baseball diamonds). In 2008, the Beneficial Insects Laboratory of the NCDA initiated a project to locate nests of *C. fumipennis* for use in surveying for EAB and other pest buprestids..

A total of 32 site visits were made between 9 April and 31August 2008; 21 of these were in Wake Co., 3 in Stanley Co., 2 in Alamance Co. and one each in Chowan, Granville, Randolph, Rockingham, Surry and Warren Co. *Cerceris fumipennis* was confirmed at two sites: A city park in Raleigh (Wake Co. – permission obtained from the Raleigh Parks and Recreation Department), and on private property in Snow Camp (Alamance Co.). In both cases, it was late in the season (mid-late August). Although a large number of potential nests were found in both sites it is uncertain how many of these were *C. fumipennis*. The nests of other burrowing insects were also present (different species of ground dwelling wasps, tiger beetle larvae). In the few *C. fumipennis* flights observed, no prey was being carried back to the nest.

Prior to 30 June 2009, 29 baseball diamonds in 16 sites in the North Carolina piedmont were surveyed for *C. fumipennis* nests. Six of these fields were positive for the wasp, but of these, four had just one or two nests. The wasps were monitored and their prey beetles collected in three sites in Raleigh. The work is ongoing.

***Cerceris fumipennis* nest with buprestid prey (circled), Gaston Co., NC 2009.**

Hemlock Woolly Adelgid Predator Rearing 2008-2009

The hemlock woolly adelgid occurs over multiple states, and is now distributed throughout the native range of the eastern and Carolina hemlock species. Hemlock is widespread in National and State Forests and Parks, and the loss of the hemlock would bring about a major change to the ecology of those areas. In addition to a loss of a unique ecosystem, dead and dying trees are a safety hazard in recreation areas, as well as aesthetically unattractive.

The primary objective for this project was for NCDA&CS to operate a large-scale central rearing facility to provide biological control agents for the management of hemlock woolly adelgid (HWA). *Sasajiscymnus tsugae* (St), native to Japan has been in mass production at the lab since December 2002. In May and July of 2008, newly collected *S. tsugae* from Japan were received in our quarantine facility to broaden the gene pool in the colony. Additionally, a small colony (25 adults) of a second species of predator, *Scymnus sinuanodulus* was obtained January 2007 from Mike Montgomery of the Forest Service in Connecticut for rearing on an experimental basis.

Figure 1. Hemlock woolly adelgid ovisacs.

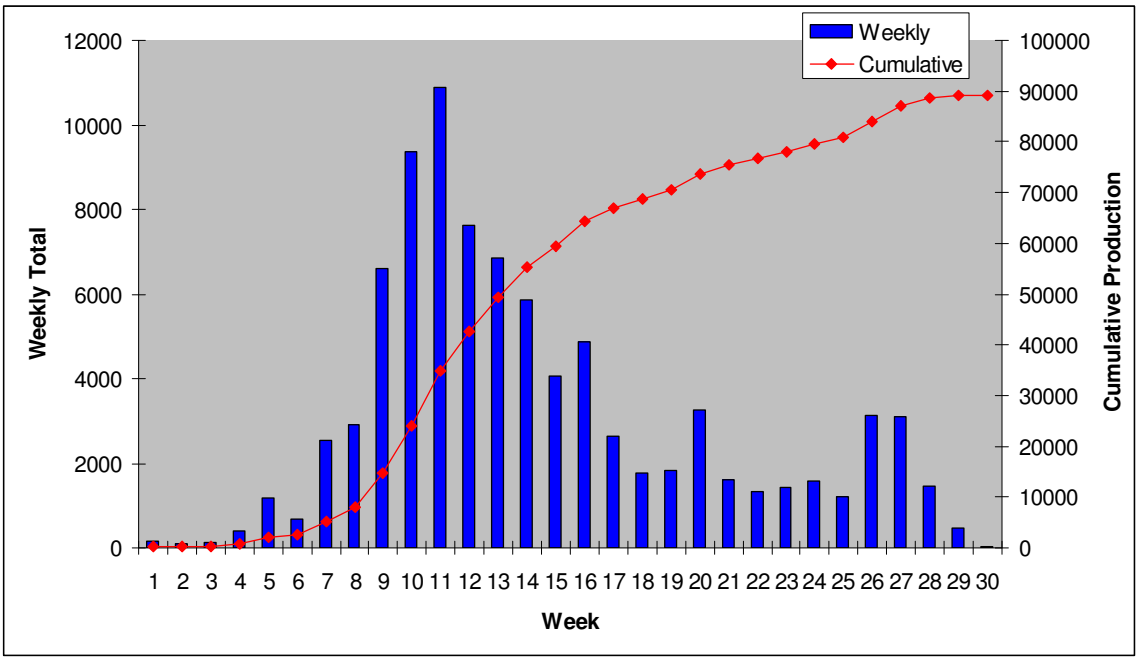
The predator beetles are well synchronized with the lifecycle of the adelgid. After a summer of aestivation, the adelgid begins to mature and prepare for oviposition. Once this maturation begins in the field, adelgid on hemlock boughs which are cut and stored in spring-like conditions begin laying eggs (Fig. 1). This stimulates reproduction in the St, and the mass rearing can proceed. Rearing continues until the adelgid completes two generations, usually by June, and aestivates as nymphs on new hemlock growth.

For mass production of the colony, mating groups of beetles were placed in 3.8 l jars supplied with a bouquet of hemlock twigs (Fig. 2). Eggs (on the twigs) were removed weekly and put in rearing cages supplied with infested hemlock. Infested twigs and water were supplied and after 4 weeks, adult beetles collected and moved into storage cages. Oviposition jars for the 2008-2009 season were set up beginning November 20, with numbers increasing as egg laying increased. Beetles produced in this way are packed into paper buckets and turned over to USDA – FS personnel on a bi-weekly basis, for release at selected field sites.

Figure 2. *Sasajiscymnus tsugae* oviposition jars and rearing cages.

A total of 74,055 predator beetles were produced by the "old" colony (Fig. 3). Of these, 70,000 were distributed to the Forest Service for release. The remainder was kept for the summer and will be used to restart the colony in the fall.

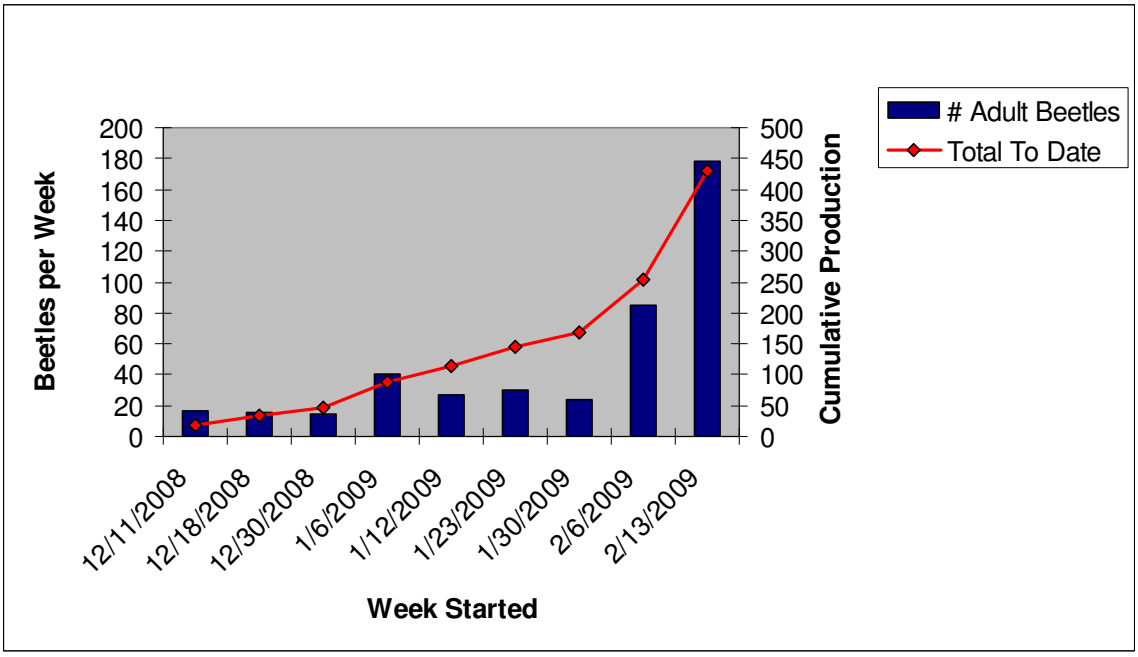
Figure 3. Production of *Sasajiscymnus tsugae* (old and new beetles) 2008-2009. Production started 20 November, 2008, last week of oviposition was 8 June, 2009.



Japanese collection. *Sasajiscymnus tsugae* that were collected in Nara and Osaka Prefectures, Japan, were received from Ashley Lamb of Virginia Tech in May and July 2008. Single pair matings with 60 of the adults were conducted in the quarantine facility to obtain F1 beetles. Adults used in these matings and samples of their offspring were examined by Leellen Solter, Illinois Natural History Survey to determine the presence of microsporidia or other pathogens. Only one beetle was positive, and all of its offspring were destroyed. A sample of the beetles that developed on the shipped material was also examined and found negative for pathogens. The remaining beetles were held in the quarantine facility of NCDA&CS, and studies on their life history in the lab were initiated in December. Before mixing them with the general colony population, single pair matings were conducted, and comparisons of factors such as development time, fecundity, longevity, and host seeking behavior were made to beetles from the existing colony. Data are being analyzed at this time. Additionally, mating groups were set up in oviposition jars to increase the colony of "new" St beetles. Approximately 15,500 beetles were produced, with 7500 released and 8000 kept to maintain the colony and distribute to other state rearing labs.

Other predators. Efforts to rear *Scymnus sinuanodulus* resulted in about 200 new adults at the end of the 2007-08 season. Some mortality occurred over the summer, but new mating groups were established in the early winter. All adults produced (431) were sent to the University of Georgia to add to their colony (Fig. 4). This work was undertaken to learn more about this beetle and its behavior in a small scale rearing experiment.

Figure 4. Production of *Scymnus sinuanodulus* 2008-2009.



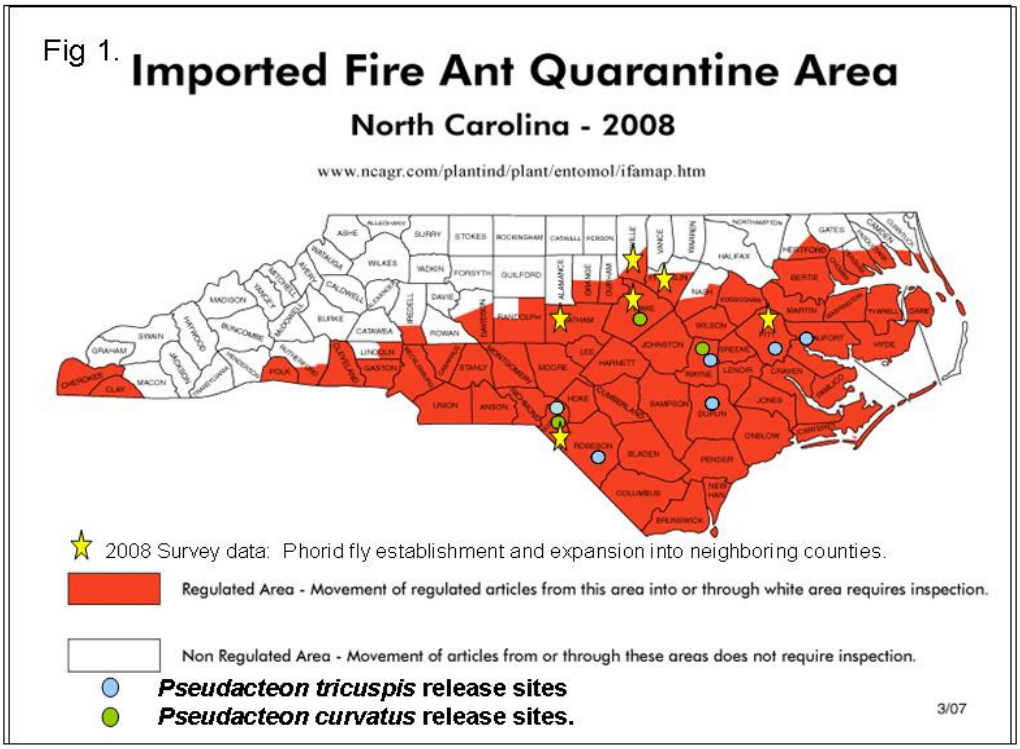
Status of the field release and monitoring of phorid flies *Pseudacteon* spp (Diptera: Phoridae) for imported fire ant control

The release of phorid flies in North Carolina for biocontrol of imported fire ant (IFA) was initiated in 2000 as a cooperative effort between NCDA & CS and USDA-ARS. Since then two phorid fly species *Pseudacteon tricuspis* and *P. curvatus* have been released in this state (Fig 1).

The species of phorid flies released at each locality are based on the most prevalent ant colonies present: monogyne colonies with one queen or polygyne colonies with multiple queens. *P. tricuspis* flies typically attack larger workers found in the monogyne colonies whereas *P. curvatus* shows a preference for smaller workers common to polygyne colonies.

***Pseudacteon curvatus**:* *P. curvatus* is showing more potential for establishment in NC than *P. tricuspis*. Less than three years after their initial release in Wake County, the phorid flies have spread to Chatham, Franklin and Granville counties. The flies appear to be following the northern movement of the imported fire ant infestation. Phorid flies were found one year after their 2007 release in Scotland County and found in Wayne Co in the fall after their release in late April and early May. Delimiting surveys to monitor establishment and spread are planned for the fall.

***Pseudacteon tricuspis**:* In 2008, the only sustained *P. tricuspis* populations were found at the 2006 Pitt County release site. At this site phorid flies were observed at 18 of the 22 mounds surveyed. A survey to determine dispersal from the release site is planned for the fall of 2009.



Kudzu Natural Enemy Host Testing

Kudzu (*Pueraria montana* (Lour.) Merr. var. *lobata* (Willd.) Maesen & Almeida) is a common weed in the southeastern United States. Native to Asia, this plant is widely used for food and fiber. Kudzu was introduced to the US in 1876, and planted first as an ornamental then as a forage crop and to prevent soil erosion along roadsides and railroad embankments. Kudzu is now widely acknowledged as a major weed of forests and rights of way in the Southeast, and many herbicides are labeled for kudzu control on such sites. Because infestations may be extensive, remote, on marginal lands, or in environmentally sensitive areas where herbicide applications are not feasible, classical biological control of kudzu is being explored.

Several insects have been identified in China feeding on leaves, stems and roots of kudzu. Some agents have been tested in the country of origin, but shipments to quarantine facilities in the US for host plant testing have been problematic. In order to better target vulnerable stages and parts of the kudzu plants, a test of simulated wounding is proposed.

Kudzu is a widespread problem across the southeast, affecting nursery plantations of forest species. The weed is also thriving outside of the southeast with infestations found in the eastern US as far north as Massachusetts, and in parts of the Pacific Northwest. Much of the kudzu currently found in the southeast was planted at the encouragement and with the assistance of the US Department of Agriculture. The assistance of the federal government is needed for exploration to discover natural enemies in the native range of kudzu, and to establish a systematic program of testing these natural enemies to determine their suitability for a biological control program.

Kudzu plants were grown from stem cuttings and transplanted to a field near Butner, NC. In addition, crowns of undetermined age were isolated, measured and their vines were subjected to a regular schedule of artificial wounding to simulate insect herbivory on foliage, stems and crowns over 1 or 2 growing seasons.

Matthew Frye, a graduate student at the University of Delaware working under the direction of Judith Hough-Goldstein, planned these studies as a supplement to his own work conducted in Delaware. A temporary technician was hired to perform daily tasks for the duration of the project. Data were collected from the plants that were already established, and include crown size, leaf and stem biomass, and number of nodes. Data will be compiled and analyzed by Matt Frye. A final season of field data is currently being collected.

Kudzu plot at Butner, NC, 2008, established crowns.