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STINK BUG HUNTER

(Sand wasp; *Bicyrtes quadrifasciatus*)



The native sand wasp, *Bicyrtes quadrifasciatus*, specializes in preying on nymphs of stink bugs, including the brown marmorated stink bug (*Halyomorpha halys*), an introduced pest first found in North America in Allentown, Pennsylvania, in 1996.

Figure 26.1 Logan Circle, where stink bug hunters (*Bicyrtes quadrifasciatus*) dig nests in sand between granite pavers.

In 2001 Karen M. Bernhard, a Pennsylvania State University entomologist, collected two specimens of a strange species of stink bug in Allentown, 79 kilometers northwest of Philadelphia. She submitted them to Cornell University's Insect Diagnostic Lab, where E. Richard Hoebeke identified them as the brown marmorated stink bug (*Halyomorpha halys*; family Pentatomidae), an agricultural and domestic pest in China, Korea, Taiwan, and Japan. Published records had never before documented the species in North America, although Hoebeke and Maureen E. Carter later determined the species had been found in Allentown as early as 1996.¹

Two days after Hoebeke identified the insect, he went to Allentown:

On that unseasonably warm day, adults of *H. halys* were extremely numerous on the foundations, outer wall surfaces, eaves, and window and door frames of homes and sidewalks.²

Spread of the brown marmorated stink bug to downtown Philadelphia

By the time Hoebeke's observations were published in 2003, the outbreak had spread to five counties in Pennsylvania.³ By 2007, the *Philadelphia Inquirer* reported the stink bug invading people's homes in suburban Philadelphia.⁴ By January 2012, the stink bug had been reported in thirty-seven counties in Pennsylvania and in thirty-six states, including California and Oregon.⁵ The insect has since turned up in Switzerland⁶ and New Zealand.⁷ I first noted adults of the insect attracted to my black light on the rear wall of our house on Pine Street in Center City on July 4, 2010. The nymphs (immature stages) arrived twelve days later.



Figure 26.2 Nymph (immature stage) of brown marmorated stink bug (*Halyomorpha halys*) climbing up the outside doorframe of our house in July 2010.



Figure 26.3 Head of adult brown marmorated stink bug crawling up stucco rear wall of our house, February 2011.

Agricultural pest

A trade organization for apple growers in the mid-Atlantic region estimated that in 2010 the pest caused crop losses valued at \$37 million.⁸ The insect attacks peaches as well, and many kinds of garden vegetables and ornamentals.⁹

To control infestations, apple growers in Maryland quadrupled the number of applications of insecticides and reduced intervals between applications.¹⁰ In Japan pyrethroid and neonicotinoid insecticides administered together, plus three additional insecticides, reduced fruit injury to one-fifth the level achieved with conventional insecticidal regimens;¹¹ however, neonicotinoid insecticides used against pests have unintentionally harmed bees.¹² Several species of fungi pathogenic against this stink bug¹³ have not been shown effective as weapons against outbreaks. Parasitoids of the stink bug's eggs in China and Japan¹⁴ have yet to be released as biological control agents in the United States, and whether they will succeed in establishing populations here and safely controlling outbreaks of the stink bug is unknown.

Native wasps (*Trissolcus* sp.) parasitize eggs of this stink bug but have not substantially increased its mortality rate.¹⁵ Feather-legged flies (*Trichopoda pennipes*), native to North America, were found parasitizing brown marmorated stink bugs in Allentown, Pennsylvania.¹⁶ Although used for biological control of other stink bugs,¹⁷ feather-legged flies have not controlled infestations of brown marmorated stink bugs.

Outbreaks of this agricultural pest in peach and apple orchards have challenged entomologists in Pennsylvania. The insect is wary and feeds on fruit at night, so visual counts in an orchard during the day may underestimate the potential for damage. Monitoring populations with traps based on pheromones, bait, or light has proved disappointing. Stink bugs that attack fruit in orchards spend most of their reproductive time outside orchards, so targeting them in orchards may fail to destroy them where they propagate. The few classes of insecticides effective against stink bugs are also toxic to beneficial species useful in pest management.¹⁸

Comparison with other outbreaks

The outbreak of the brown marmorated stink bug in Pennsylvania is reminiscent of nineteenth-century outbreaks of pests of shade trees in Philadelphia. Parasitoids then had not had sufficient time to establish themselves within the city, so even native species like bagworms proliferated out of control, causing epidemics of defoliation. The city responded by importing house sparrows (*Passer domesticus*), with dubious benefit.¹⁹ Broad-spectrum insecticides such as arsenic were manufactured in the city and sprayed on trees.²⁰ Eventually parasites dispersed into the city, and massive defoliation of shade trees abated. David J. Biddinger and his colleagues from Pennsylvania State University have noted that the use of broad-spectrum insecticides against the brown marmorated stink bug in Pennsylvania threatens to turn back the clock on integrated pest management, which attempts to minimize use of such agents.²¹

Theoretical ideal agent for control of stink bugs

The best insect for biological control of the brown marmorated stink bug might not be a parasitoid; insecticides that kill the host also kill parasitoids inside the host, and parasites like the feather-legged fly allow their stink bug victims to reproduce before succumbing.²² The optimal insect for biocontrol might be a predator that carries the stink bug away—distancing itself from insecticides targeting its prey’s habitat—and kills or incapacitates its victims before they have a chance to reproduce. Such a predator ideally would be locally native, obviating the risks associated with importation of foreign agents for biocontrol. It would also be adaptable—capable of living in disturbed habitats, including cities and farms—and its geographic distribution would be broad.



Figure 26.4 Feather-legged fly (*Trichopoda pennipes*) in Fairmount Park just outside Center City. Although native to North America, it lays its eggs on the brown marmorated stink bug (in addition to native stink bugs), which its larvae eat.²³

Discovery of *Bicyrtes quadrifasciatus*

In 1823, John C. Calhoun, Secretary of War under James Monroe, ordered Major Stephen H. Long to lead an expedition to the headwaters of the St. Peters River, now known as the Minnesota River. He appointed Thomas Say of Philadelphia to serve as official naturalist. Among Say’s accomplishments on this trip were discoveries of many new species of insects, including a wasp with four conspicuous cream-colored abdominal stripes. Say described its morphology and documented its location in Pennsylvania, but he offered no clues about its habits or habitat.²⁴ It is *Bicyrtes quadrifasciatus*, named in reference to the four abdominal stripes. It has no specific common name.²⁵

The life history of this wasp was not examined until the twentieth century. In 1966 Howard E. Evans reviewed all that had been learned about it in the chapter “*Bicyrtes*: A genus of stink bug hunters.”²⁶ The best-known member of this genus is the species Say discovered. It is found throughout temperate North America east of the Rockies. Females prey exclusively on nymphs (immature stages) of true bugs (Heteroptera), predominantly stink bugs (Pentatomidae) and leaf-footed bugs (Coreidae). A female seizes a nymph, paralyzes it with her stinger, and clasping it beneath her, flies to her nest, a chamber she has excavated underground in sand. She uncovers a hidden entrance hole leading to a tunnel connecting to the chamber, and, clutching her prey, disappears down the hole to her nest. She lays an egg on the first nymph she brings to her nest, and then returns to stock the nest with additional prey. Her offspring feed on her prey, while she feeds on nectar at flowers. All other members of the genus *Bicyrtes* are sand wasps that specialize in hunting true bugs.²⁷ Biddinger et al. reported that prey of *Bicyrtes* wasps include brown marmorated stink bugs.²⁸

Bicyrtes quadrifasciatus at work in Logan Circle

I observed Say’s stink bug hunter at work in sand between granite pavers in Logan Circle. Jon Gelhaus, entomologist at the Academy of Natural Sciences of Drexel University, called my attention to the sand wasp during Bug Fest, an occasion when entomologists at the Academy guide visitors on tours of Logan Circle. Male sand wasps flew around close to the ground while females landed with prey or emerged from their holes. At any one moment, two or three males would be cruising over the pavers. They generally ignored me, except for avoiding me when I blocked their way. I photographed a female carrying into her hole a nymph of a leaf-footed bug, probably the western conifer seed bug, *Leptoglossus occidentalis*, another home invader recently introduced into Pennsylvania. It feeds on seeds of cones of conifers.²⁹



Figure 26.5 Sand wasp (*Bicyrtes quadrifasciatus*) emerging from her hole in sand at Logan Circle.



Figure 26.6 Preparing to plug her hole and take off in search of prey, which she will paralyze with her stinger.



Figure 26.7 Dragging prey down the hole leading to her nest. The hole is too small.



Figure 26.8 Backing out of the hole and positioning herself for a change in strategy.



Figure 26.9 Shoving prey down the hole. The fit is still too tight.



Figure 26.10 Enlarging the hole.



Figure 26.11 Portrait of her prey on a granite paver. While she was distracted enlarging her hole, I seized the opportunity to snatch her prey and place it on a paver for this diagnostic photo. Her prey is a nymph (immature stage) of a leaf-footed bug (family Coreidae), in the same suborder as stink bugs (family Pentatomidae)



Figure 26.12 The hole after her descent into her nest. While I was photographing her prey a couple of pavers away, she discovered my theft and in an instant snatched it back and disappeared with it down this hole. At this moment she may be laying an egg on it in her nest.



Figure 26.13 Stink bug hunter feeding on late boneset (*Eupatorium serotinum*) along the Schuylkill River Trail in Grays Ferry Crescent immediately south of Center City. Stink bug hunters do not eat their prey; they dedicate their prey exclusively to their offspring, which as larvae consume their parents' victims.

Use of specialized predators for biocontrol

To what extent this wasp might succeed as a biological control agent against brown marmorated stink bugs has not been studied. The impact of specialized predators on populations of their prey may be less than one might suppose. Cicadas can be heard singing throughout residential areas of Center City despite the presence of cicada killers (*Sphecius speciosus*), large wasps that prey exclusively on them. Cicada killers have not eradicated cicadas in Center City, but they may suppress their populations sufficiently to prevent destruction of the trees upon which immature cicadas feed. Biddinger et al. suggest that goals for biological control agents need to be scaled back. They recommend that a biological control agent be introduced not as a single solution, but as an incremental step, one of many safeguards that, in combination, provide protection against outbreaks.³⁰



Figure 26.14 Annual cicada (*Tibicen tibicen*) attracted to light behind the screen door in our backyard. It can be heard singing in summer in parks and residential areas throughout Center City, despite the presence of cicada killers.



Figure 26.15 Cicada killer (*Sphecius speciosus*) found dead in Fidler Square. I have posed it for scale. Cicada killers are the largest wasps in North America. Females grab and paralyze cicadas and drag them into their burrows, where their larvae consume them.

Controlled trials of *Bicyrtes* wasps deployed against the brown marmorated stink bug would be technically challenging. Methods to cultivate or attract the wasps have yet to be investigated. The wasps' enemies, particularly flies (*Senotainia trilineata* and *S. rubriventris* [Miltogramminae]), may suppress populations of the wasps. These flies have been described hovering around *Bicyrtes* and depositing their larvae on *Bicyrtes*' prey as the wasps carry their prey into their holes or after the wasps have deposited their prey inside their nests.³¹ I saw no such flies around the colony of wasps at Logan Circle.

The *Bicyrtes* colony at Logan Circle suggests how an empiric trial using *Bicyrtes* wasps for biocontrol might proceed: Construct a spacious sunny patio or broad promenade with pavers embedded in sand, and add beds of flowers that bloom all summer long. Evans noted that the wasps visit many kinds of flowers, especially white sweet clover (*Melilotus alba*) and Queen Anne's lace (*Daucus carota*).³²

The question of how to control infestations of the brown marmorated stink bug may become moot if its enemies like *Bicyrtes* wasps and feather-legged flies achieve this control independent of human intervention. Farmers selling apples in Rittenhouse Square told me that stink bugs were less numerous in 2012. Until longer periods of observation confirm such improvement, the plague of brown marmorated stink bugs is likely to continue.



Figure 26.16 Frecon Farms' stand in Rittenhouse Square's farmer's market, September 2012. Brown marmorated stink bugs, which attack apple orchards, were less numerous this year, according to farmers at this stand.