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# SURVEY OF *TIPHIA VERNALIS* (HYMENOPTERA: TIPHIIDAE), A PARASITOID WASP OF *POPILLIA JAPONICA* (COLEOPTERA: SCARABAEIDAE), IN CONNECTICUT

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The Japanese beetle, *Popillia japonica* (Newman) (Coleoptera: Scarabaeidae), was first encountered in the United States (US) in Riverton, New Jersey in 1916 (Clausen et al. 1927) and has since become the most economically damaging pest of turf and landscape plantings in the eastern United States (Potter & Held 2002). In response to the expansion of *P. japonica*, during the late 1920s and early 1930s, entomologists from the United States Department of Agriculture (USDA) imported several parasitoid wasp species that were natural enemies of *Popillia* in their native habitat (Clausen et al. 1927; King et al. 1951). Of these, *Tiphia vernalis* (Rohwer) (Hymenoptera: Tiphiidae) successfully established and widely distributed itself in the northeastern US, confirmed by surveys in the years subsequent to their release (King & Parker 1950; Ladd & McCabe 1965). In addition to being found in the northeast, today *T. vernalis* occurs in North Carolina, Ohio, Tennessee, Michigan, and Kentucky (Rogers & Potter 2004b; Reding & Klein 2001; Oliver et al. 2005).

In its native habitat (Korea, Japan, and China), *T. vernalis* has been reported to parasitize *P. quadriguttata* (Fabricius), *P. chinensis* (Frivaldsky), *P. formosana* (Arrow), and *P. japonica* (Clausen et al. 1927; Clausen et al. 1932; Clausen et al. 1933; Balock 1934; Fleming 1968; Reding & Klein 2001). *Tiphia vernalis* is univoltine and adults are active from mid-Apr through mid-Jun (Roger & Potter 2004a; King & Parker 1950). Adult female wasps locate soil dwelling larval hosts by using kairomones found in body odor trails and frass (Rogers & Potter 2002). Once a suitable host is found, it is stung ventrally in the mid-thoracic region paralyzing it temporarily (Rogers & Potter 2004a). An egg is then laid externally on the larva in the suture between the third thoracic and first abdominal segments on either side of the median ventral line with the anterior pole directed toward the lateral margin; the placement of the egg in this position is specific to *T. vernalis* (Clausen et al. 1927; Gardner & Parker 1940). *Tiphia vernalis* is an ectoparasitoid and by the fall the parasitoid becomes an adult and overwinters in this stage within the cocoon. Adult wasps emerge in the spring and have a short window of about 6 to 8 weeks in which to mate and parasitize a third instar Japanese beetle (Clausen et al. 1927). The availability of nearby food plants directly affects the efficacy of this wasp in realizing high parasitization rates (Clausen et al. 1932; Clausen 1956).

In 6 of Connecticut's 8 counties, from 1936-1949, the USDA released female wasps in groups of 100 (referred to by the USDA as a colony) at 151 separate locations. The number of colonies released in each county was as follows, 79 in Fairfield County, 33 in Hartford County, 2 in Middlesex County, 28 in New Haven County, 8 in New London County and 1 Windham County. Releases were not made in Tolland and Litchfield counties. A USDA study done in 1950, surveyed 5 sites near the original release points in 2 counties, Fairfield and New Haven, and confirmed the establishment of *T. vernalis* at these sites (King et al. 1951). The 1950 survey did not examine all counties where releases were made. The distribution of *T. vernalis* in Connecticut had not been monitored since the 1950 USDA survey and tiphiid wasp parasitoids of white grubs had been considered rare in Connecticut (Abbey 2001). Tashiro (1987) suggested that in the past 20-25 years *T. vernalis* has been scarce or unseen in many areas.

In 2004, a survey was conducted on 10 golf course fairways, at least 1 in each county, to determine if *T. vernalis* was established in all of Connecticut's 8 counties. In 2005, populations of adult wasps were monitored to determine seasonal activity in the south, central, and northern regions of the state. In 2005, activity was monitored on 1 golf course in the south region, 1 in the central region and 2 in northern region. The technique described by Rogers & Potter (2004b) for attracting the species was utilized during both years. These methods required the application of 20% sugar water to leaves paralleling golf course fairways on sunny mornings from a height of 0-2 m. In 2004, sugar water was applied to the foliage of plants along golf course fairways for a length of 25 m and this was repeated every 30 min for 2 h. All the wasps attracted to this area, during the time interval, were counted. In 2005 this procedure was repeated for 60 m, reapplying sugar water every 60 min for 2 h. In 2004 and 2005 wasp voucher specimens were collected and these are currently

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stored in the laboratory of Dr. Ana Legrand at University of Connecticut. Authentication of *T. vernalis* was determined morphologically by Dr. Ken Ahlstrom of the North Carolina Department of Agriculture and Consumer Services.

The survey indicated that *T. vernalis* wasps are presently distributed throughout all of Connecticut's 8 counties, even in counties where they were not released (Fig. 1). The 2005 survey results indicate that *T. vernalis* adults are active from the first week in May to the beginning of Jun. Peak numbers were observed during the fourth week of May (Table 1). In Kentucky, where extensive sampling of *T. vernalis* has been conducted, adults were found to be active from mid-Apr to mid-Jun (Roger & Potter 2004a). There was substantial variation in the numbers of wasps observed at each site. For example, at Hunter Memorial Park (New Haven County) the peak number observed was 563 adults, while only 28 were seen at Skunkgamaug Golf Course (Tolland County). The results of this survey show that the wasps are not rare in Connecticut and that they should be integrated with other measures for Japanese beetle management. For example, the public is generally unaware of these wasps and integrated pest management guidelines could suggest methods to conserve and enhance their population; e.g., planting floral nectar sources to attract and sustain the wasps (Rogers & Potter 2004b) and avoiding insecticide treatments to turf during the adult flight period (Rogers & Potter 2003; Oliver et al. 2005). While adult wasps were readily observed in this study, parasitized larvae were not found in the limited search conducted. Additional work needs to address the current rates of parasitism by *T. vernalis*. In Kentucky, *Tiphia* spp. have been found to parasitize up to 58% of potential host grubs (Rogers & Potter 2004a) and King & Parker (1950) found an average of 57% of Japanese beetle grubs parasitized over a 13-year study.

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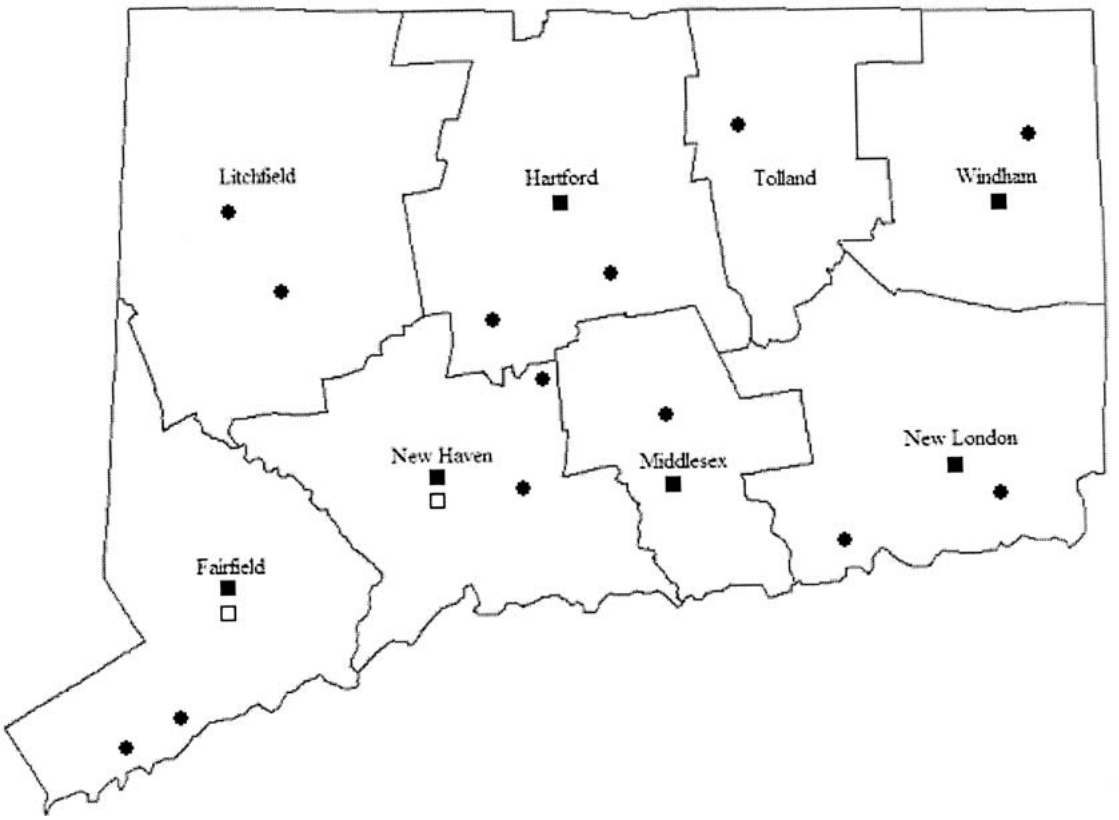



Fig. 1. Specific locations in Connecticut counties where *T. vernalis* wasps were released and where they were found by subsequent surveys. ■ Counties where the USDA released *Tiphia vernalis* adults during 1936-1949. □ Counties where the USDA reported viable *Tiphia vernalis* colonies as a result of releases made during 1936-1949 (from USDA surveys conducted in the 1950s). ● Locations within each county in Connecticut where *Tiphia vernalis* wasps were found during 2004 study.

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TABLE 1. THE SEASONAL TIMING OF *TIPHIA VERNALIS* COLLECTIONS IN CONNECTICUT DURING 2005 DETERMINED BY THE NUMBER FOUND AT EACH LOCATION FOR EACH WEEK.

| Date sampled | BA | HMP | WCC | SGC |
|---|---|---|---|---|
| May 2 | 2 | 9 | 0 | 0 |
| May 9 | 28 | 15 | 4 | 0 |
| May 17 | 28 | 430 | 6 | 52 |
| May 23 | 35 | 563 | 28 | 84 |
| May 30 | 10 | 387 | 4 | 27 |
| Jun 6 | 0 | 60 | 0 | 0 |
| Jun 11 | 0 | 0 | 0 | 0 |

BA—Bartlett Aboretum, Fairfield County, southern location; HMP—Hunter Memorial Park, New Haven County, central location; WCC—Willimantic County Club, Windham County, northern location; SCG—Skungamaug Golf Course, Tolland County, northern location.

participation with the Bartlett Arboretum. We thank the Connecticut Association of Golf Course Superintendents and all the golf courses that participated in this study. These include Longshore Golf Course, Hunter Memorial Park, Farms Country Club, Black Hall Country Club, Norwich Golf Course, Tunxis Plantation, Indian Hill Country Club, Torrington Country Club, Crestbrook Park Golf Course, Indian Springs Country Club, Skungamaug Golf Course, and Willimantic Country Club. This project was funded by the Connecticut Cooperative Extension System.

## SUMMARY

This study determined the distribution and seasonal timing of *Tiphia vernalis* (Rohwer) (Hymenoptera, Tiphiidae) in Connecticut. *Tiphia vernalis*, an imported parasitoid of the Japanese beetle, was considered rare in the state before this study. The survey results indicated that *T. vernalis* is present in every county of the state including Tolland and Litchfield counties, where the wasps were not originally released. The widespread existence of the species in the state is significant because it aids in the control of the Japanese beetle, a serious pest of turf and landscape plantings.

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