Monitoring Egg Parasitoids of the Brown Marmorated Stink Bug in Massachusetts

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The growth and spread of invasive pests like the brown marmorated stink bug (BMSB) is not usually encumbered by natural enemies (e.g., predators, parasites), which are not well-suited to interact with the invasive species (Venette & Hutchison, 2021). Instead, the responsibility to control the pest falls on growers, who often rely on chemical pesticides. However, the use of broad-spectrum insecticides can kill and deter beneficial insects that naturally control BMSB population levels (Leskey et al., 2012).

In a variety of cropping systems throughout the US, there are native species of parasitoids that attack stink bug eggs (Tillman, 2010). Over the decades, several uninvited biocontrol candidates have popped up on new continents. One example is the exotic samurai wasp (SW), a parasitoid that, though smaller than a tenth of an inch, is capable of killing up to 80% of BMSB populations in Northern China (Ogburn et al., 2021). This tiny wasp achieves such powerful control by laying its eggs inside BMSB eggs, effectively killing the developing stink bug nymphs as their offspring develop. The SW was first detected in Maryland in 2014 and, as of 2022, has been found in at least 13 states, including our neighboring New York State (Ogburn et al., 2021). We do not yet know if the SW is present in Massachusetts. If present, the SW could become a *biological control agent* critical to the suppression and control of BMSB.

Here, we report the results of field surveys aimed at assessing the presence of the SW in Massachusetts and identifying the complex of BMSB egg parasitoids that already exist in the state.

Materials and Methods

Sentinel Egg Preparation. We purchased BMSB eggs from the Phillip Alampi Beneficial Insect Laboratory (New Jersey Department of Agriculture, NJ). Upon arrival, egg shipments were frozen in -80 degrees Celsius (Tillman et al., 2020) for either 48 hours (May through mid-August) or 120 hours (three shipments in late August and September). After freezing, egg masses were individually attached to a piece of white paper using a small amount of superglue and left to dry for at least 30 minutes before deployment. In the field, prepared sentinel egg masses were stapled on the underside of leaves from trees in the orchard perimeter (Ogburn et al., 2021). Specifically, eggs were deployed on/near plant species known to be attractive to either the BMSB or wasp parasitoids.

Figure 1. Deployment of brown marmorated stink bug masses in the field.

Study Sites. For sentinel egg deployment, we selected ten fruit tree orchards located in the outskirts of either rural or suburban centers across the state of Massachusetts based on BMSB habitat suitability data (Figure 1). The ten orchards were visited at least once per month except for May, when only four of the orchards were visited.

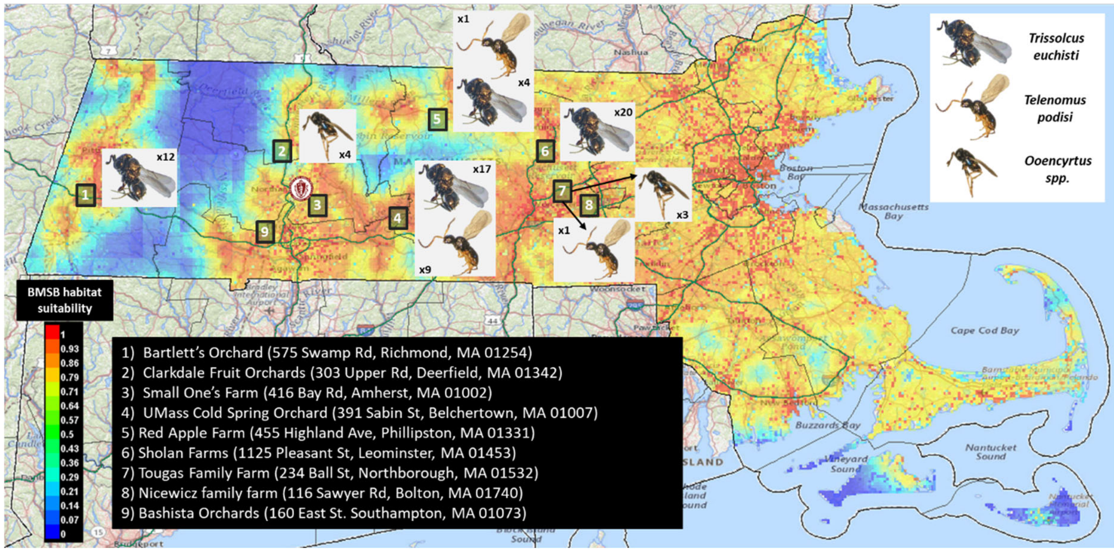

Figure 2. Brown marmorated stink bug (BMSB) sentinel egg deployment sites in Massachusetts. Incidence of wasp parasitoids is shown inside the pictures. Sites were chosen based on BMSB habitat suitability. In this heat map, redder colors mean higher habitat suitability for BMSB. The approximate location of the nine farms selected for this study is noted with numbers (1-9). Map credit: Dr. Javier Gutierrez Illan, Oregon State University.

Incubation and assessment of parasitism and predation. After 72 hours in the field, the sentinel egg masses were retrieved and counted, noting chewing predation damage (Tillman et al., 2020). Predated eggs were discarded, and the remaining were placed inside petri dishes unique for each orchard. The tops of the petri dishes were covered in four layers of insect netting (1 × 0.5 mm) before being incubated. Eggs were left inside the incubator until parasitoids emerged and died, at which point the petri dishes were removed, and the parasitoid wasps were transferred into 70% ethanol and refrigerated for preservation. After five weeks and no new parasitoid emergence, the remaining eggs were dissected to recover underdeveloped parasitoids that were not able to emerge.

Results

All results are summarized in Table 1. In May, we recovered 1,224 eggs from 4 orchards, out of which 6 (0.5%) had signs of chewing predation, and none hatched wasp parasitoids. In June, we doubled the number of eggs deployed to 2,556 and recorded 28 eggs (1.1%) with chewing damages, while no parasitism was recorded. July was the first and only month when we recovered parasitized eggs (84), constituting a 2.5% parasitism rate out of the 3,405 eggs deployed in that same month. The adult parasitoids that actually emerged were *Trissolcus euchisti* (n= 53), *Telenomus podisi* (n= 10), and *Ooencyrtus* sp. (n= 7), as well as two underdeveloped parasitoids from the subfamily *Telenominae* (Figure 2).

We also recorded the highest levels of predation in July, when 328 eggs (9.6%) showed signs of chewing. Out of 1,888 eggs recovered in August, 71 of these (3.8%) showed signs of predation. No parasitoid wasps emerged in August. Only two orchards were visited in September and 738 eggs were deployed. Out of these, 16 (2.2%) showed signs of chewing and we recorded no parasitoid emergence (Table 1).

Table 1. Summary of predation and parasitism on Brown Marmorated Stink Bug sentinel eggs. Recovered egg masses were assessed to identify chewing predation damage. Parasitism was noted as parasitoids that either, emerged or were dissected out from the eggs if underdeveloped. Highest rates of predation and parasitism were observed in July.

Month	Eggs recovered	Eggs chewed	% Eggs chewed	Eggs parasitized
May	1224	6	0.5	0
June	2556	28	1.1	0
July	3405	328	9.6	84 = **(2.5%)**
Aug	1888	71	3.8	0
Sep	738	16	2.2	0

Conclusion

While we did not find evidence of SW presence in the Massachusetts orchards that were surveyed, across five out of the nine participating orchards we observed 2.5% parasitism of sentinel eggs and recovered 72 parasitoid wasp specimens. While parasitism rates were not substantial, few orchards in MA currently report BMSB infestation problems, which could indicate low BMSB population levels. With few BMSB eggs around, native wasps may preferentially parasitize well-established host populations. According to our data, BMSB egg predators currently seem to exert more powerful control than parasitoid wasps, as we report chewing predation rates as high as 9.6% mid-summer. Our surveillance efforts will continue in 2023.

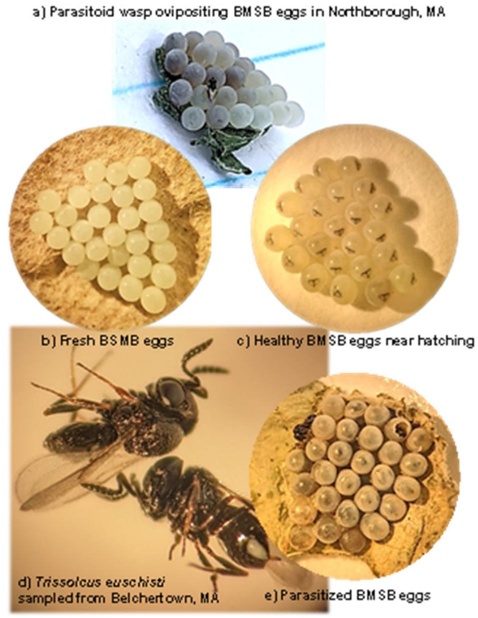

Figure 3. Brown Marmorated Stink Bug (BMSB) egg development and parasitism**.** Chemical cues from BMSB eggs lure parasitoid wasps to the egg mass, where females lay their own eggs (a) into freshly laid BMSB eggs (b). Unparasitized eggs will hatch healthy nymphs within a few days, developing characteristic burster marks (c). However, when parasitized, the eggs will adopt a darker, brown color, and hatch wasp adults (d). Adult wasps usually emerge 2-4 weeks after oviposition, leaving behind emergence holes on top of the eggs (e) from which they emerged from.

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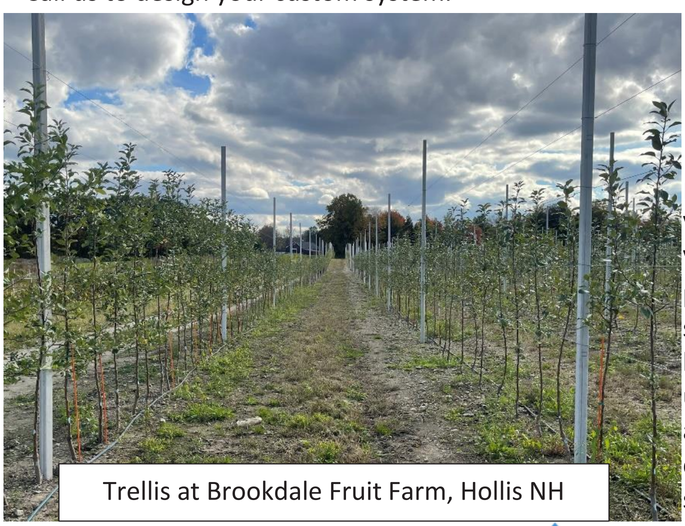

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