Characteristics of Home Invasion by the Brown Marmorated Stink Bug (Hemiptera: Pentatomidae)[1]

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Abstract The abundance and activity of brown marmorated stink bugs, *Halyomorpha halys* Stål, over-wintering inside a Maryland home were documented. Brown marmorated stink bugs, an invasive species, were collected daily, and their collection rate assessed with respect to outside temperature, location within the structure, and date. During the 181-day study period 26,205 adult brown marmorated stink bugs were collected inside the home. The exiting of stink bugs from hiding in the walls and other suitable areas into indoor living space was positively correlated with outside daily high temperature variation from the long-term daily high. Control measures to block exit from walls into living space reduced collection rate, but failed to halt it. This heavy infestation in a single home demonstrates the potential nuisance to millions of homes across the country if the range and population of the brown marmorated stink bug continues to expand.

Key Words brown marmorated stink bug, *Halyomorpha halys*, invasive species

The brown marmorated stink bug, *Halyomorpha halys* Stål (Hemiptera: Pentatomidae), was first reported near Allentown, PA in 2001, following introduction from East Asia probably in the middle 1990s (Nielsen and Hamilton 2009, Sargent et al. 2010). As of Nov 2011, the brown marmorated stink bug was extant in at least 36 states (Leskey and Hamilton 2011), including every state east of the Mississippi River, contiguous states on the Pacific coast, and several midwestern and western states (Hamilton 2011).

A threat to many agricultural crops (Leskey 2010, Welty et al. 2008), the pest risk potential for the brown marmorated stink bug has been rated as 'high' (Holtz and Kamminga 2010). Serious economic harm to crops has already been reported (USDA-ARS 2010) especially in midAtlantic states where $37 M in damage was reported for the apple crop, *Malus domestica* Borkh. (Rosales: Rosaceae), in 2010 alone (American/Western Fruit Grower 2011). On 24 June 2011 emergency action authorized the use of the insecticide dinotefuran on tree fruit (Environmental Protection Agency 2011) to help minimize damage. The serious risk to agriculture is further demonstrated by the formation of the Brown Marmorated Stink Bug IPM Working Group in 2010 for the purpose of researching methods for effective management (Leskey and Hamilton 2010) and the announcement in 2011 of $5.7 M in funding for research on control of brown marmorated stink bugs (Bartlett 2011, USDA-NIFA 2011).

In addition to an agricultural pest of growing significance, the adult brown marmorated stink bug's affinity for over-wintering in man-made structures, including homes,

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can be a nuisance to homeowners (Hamilton 2009, Hoebeke and Carter 2003, O'Brien 2009, Sargent et al. 2010). Although the brown marmorated stink bug invasion has attracted significant media attention (Northeastern IPM Center 2011), this is the first published study that quantitatively assesses an infestation in a residential structure.

Materials and Methods

During a 6-month period (1 January 2011 - 30 June 2011) the number of brown marmorated stink bugs found inside the author's home in southern Washington Co., MD (39°22'27.75" N, 77°40'53.90" W) was recorded daily. Brown marmorated stink bugs were individually counted as they were collected using household vacuum cleaners, and subsequently destroyed to preclude duplicate counting. Brown marmorated stink bugs were collected whenever sighted anywhere on the first and second floor levels. In contrast, collection in attic living space and crawlways was infrequent and only when deliberately sought and, therefore, excluded from quantitative analyses which assume consistent sampling effort.

Historic and current daily high temperatures used in analyses were obtained for Brunswick, MD located approx. 10 km SE of the study site.

Results and Discussion

Over 181 days, 26,205 adult brown marmorated stink bugs were found and collected from inside the home (Fig. 1). Unfinished crawlways in the attic contained the majority, where 13,153 (50.2%) were found in large congregations, although 10,584

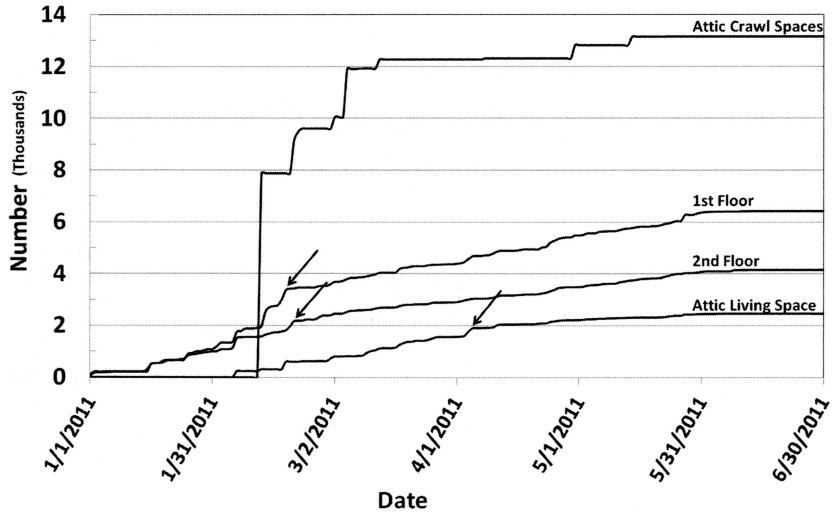

Fig. 1. Brown marmorated stink bugs collected in a Maryland home. A reduction in collection rate (arrows) was associated with the discovery and blockage on 18 February, 20 February and 05 April of major stink bug entryways into living space on the first floor, second floor and attic, respectively.

(40.4%) were removed from the first and second floors, which were the most-used areas by home occupants. Some 2468 (9.4%) were found in attic living space and none were found in the basement or ground level crawl space, both of which were unheated. Although infestation of homes with brown marmorated stink bugs is widespread throughout the area (Gibson 2011), this infestation appears to be among the most severe reported, but not unprecedented (M. Raupp, pers. commun.).

Brown marmorated stink bugs were most abundant in the structure from September 2010 through May 2011, after which diapause was over (Hoebeke and Carter 2003), contributing to very few remaining inside the home in June (Fig. 1). Due to the severe nature of the infestation, control efforts consisting of caulking possible interior exit points from walls into living space commenced in February and proceeded through May. Despite the obvious reduction in daily collection rate associated with the finding and blocking of major entrances, large numbers of brown marmorated stink bugs continued to infest the home (Fig. 1).

The integrity of construction of structures and their locations may be important factors affecting severity of infestations. In this two-story vinyl-sided house of 223 m^2 (2400 ft^2) with unfinished basement and partially-finished attic, both the original 93-yr-old house and the new 3-yr-old addition were heavily infested by adult brown marmorated stink bugs despite installation during the previous summer of extensive screening in attic crawlways to block potential brown marmorated stink bug entrances and hiding places. During the previous fall brown marmorated stink bugs probably found their way into walls from outside by crawling behind the vinyl siding at corner joints, and into the attic through several means, including shingle siding on one end of the attic. Subsequently, throughout the winter and spring, brown marmorated stink bugs exited house walls into interior living spaces through cracks around ceiling molding, baseboards, baseboard heaters, floor boards, windows and light fixtures.

The rural location with nearby deciduous forest and crops was probably conducive to the high brown marmorated stink bug population in this home, as well as widespread home infestations reported throughout the area (Gibson 2011). Common local crops that are known brown marmorated stink bug hosts include soybeans, *Glycine max* (L.) Merr. (Fabales: Fabaceae), (Bernon 2004, Hoebeke and Carter 2003) and corn, *Zea mays* L. (Poales: Poaceae) (Leskey 2010). Deciduous forest, abundant in the area, commonly harbors many brown marmorated stink bug host species (Bernon et al. 2004, Leskey 2010). The princess tree, *Paulownia tomentosa* (Thunb.) Sieb. & Zucc. ex Steud. (Lamiales: Paulowniaceae), a primary host (Bernon and Hoebeke 2010), is naturalized in the area from China where the brown marmorated stink bug is endemic (Zhu et al. 1986). During summer 2011 large numbers of immature brown marmorated stink bugs were observed (USDA-ARS 2011) on princess tree, as well as tree-of-heaven, *Ailanthus altissima* (Mill.) Swingle (Sapindales: Simaroubaceae), also native to China (USDA-NISIC 2011) and naturalized in the area.

The relationship between number of brown marmorated stink bugs collected and outside temperature was assessed for the first and second floors for 21 February 2011 through 31 May 2011. Data collected prior to 21 February 2011 were excluded because the rates of collection before and after the blockage of major entryways on 18 and 21 February 2011 were influenced by the blockage (Fig. 1). June data were excluded because diapause was complete and few stink bugs remained in the structure. Higher numbers of brown marmorated stink bugs tended to be collected on days with daily high temperatures exceeding the historic daily high average, whereas fewer brown marmorated stink bugs tended to be found on days with daily high temperatures

below the historic average (R^2=0.22, $P < 0.01$). This is consistent with reports of increased activity indoors during warm fall and winter days (Hamilton et al. 2008). Factors likely confounding the observed relationship were variation in cloud cover, as sunny days readily heated exterior walls and seemed to induce activity, as well as temperature variation inside the home associated with weekends (warmer) and weekdays (cooler).

The unpleasant odor emitted when brown marmorated stink bugs are disturbed, and for which they are named, was far less unpleasant than the perceived nuisance caused by their sheer numbers and daily presence. For the period 1 January 2011 through 31 May 2011, on 56% of days 25 or more stink bugs were collected on the first and second floors, and 100 or more were collected on 21% of days. Another contributing factor to nuisance was that brown marmorated stink bugs typically were found throughout the day, making them a nearly constant presence. Even when not present, their frass left obvious spotting on curtains and walls. From late December 2010 through May 2011, especially on warm days, their attraction to light in the dark evenings frequently disrupted home occupants. Given their increased activity and attraction to warmer temperatures, it is not surprising that brown marmorated stink bugs often collided with the bodies of occupants sleeping in cool bedrooms. They were also frequently found in areas with high moisture levels, such as sinks.

The large over-wintering brown marmorated stink bug population collected in a single home demonstrates one of many problems created by invasive species. The high likelihood that the brown marmorated stink bug will continue to spread throughout the United States (Holtz and Kamminga 2010), its widespread infestation of homes in the midAtlantic region (Gibson 2011), and the heavy infestation of one home reported here, indicate that in addition to its threat to agriculture, it could become an extraordinary nuisance to tens of millions of home owners.

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