

# Brown marmorated stink bug (Hemiptera: Pentatomidae) in Canada: recent establishment, occurrence, and pest status in southern Ontario

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**Abstract**—*Halyomorpha halys* Stål (Hemiptera: Pentatomidae), the brown marmorated stink bug (BMSB), has been intercepted numerous times in Canada, and overwintering BMSB adults have been reported by homeowners. However, established breeding populations were not detected before 2012. Here we report the occurrence of established populations of BMSB in southern Ontario, Canada and describe habitats, host plants, and collection efforts from 2012 to 2013. Tracking the phenology and spread of this pest in Ontario is critical for the development of integrated pest management strategies to prevent severe economic damage due to this pest.

**Résumé**—La punaise marbrée (*Halyomorpha halys* Stål) (Hemiptera: Pentatomidae) a été interceptée à plusieurs reprises au Canada, et des propriétaires ont signalé la présence de punaises marbrées adultes hivernant dans les maisons. Cependant, les populations reproductrices établies au Canada n'ont pas été détectées avant 2012. Nous ferons mention ici de l'apparition des populations de punaises marbrées établies dans le sud de l'Ontario, Canada, et nous ferons la description des habitats, des plantes hôtes, ainsi que les efforts de collecte des données pour la période 2012–2013. Faire le suivi de la phénologie ainsi que de la propagation de ce ravageur en Ontario est essentiel pour l'élaboration de stratégies de gestion intégrée des insectes nuisibles, et ce, pour éviter des dommages économiques graves dues à ce ravageur.

The brown marmorated stink bug (BMSB), *Halyomorpha halys* Stål (Hemiptera: Pentatomidae), is native to East Asia and is found in China, Japan, Korea, and Taiwan. This invasive species has become established in a number of areas, including United States of America and Switzerland, where it causes economic damage to a number of crops and has become a household nuisance pest due to its affinity for overwintering in structures (Hoebeke and Carter 2003; Wermelinger *et al.* 2008). Adult BMSB are often transported from Asia (or other areas where it occurs) to new locations on inanimate objects as a stowaway in cargo, packing crates, aircraft, machinery, vehicles, and personal luggage (Hoebeke and Carter 2003). Climate modelling suggests that favourable conditions

exist for the establishment and spread of this pest in Europe and North America (latitudes between 30° and 50°), as well as southern Australia and the North Island of New Zealand (Zhu *et al.* 2012). *Halyomorpha halys* has been detected in these areas over the last several years either as interceptions by border control authorities, single finds in private residences, or as recently established populations (Hoebeke and Carter 2003; Wermelinger *et al.* 2008; Walker 2009; Fogain and Graff 2011; Duthie 2012; Gariepy *et al.* 2013). This pest was first documented as established in North America in 2001 in Pennsylvania, United States of America (Hoebeke and Carter 2003). Pathway analysis and population genetic studies suggest that this established United States of America

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population is the likely source for the specimens detected in Ontario, Canada (Garipey *et al.* 2013). Although initially reported in Canada by Fogain and Graff (2011), these first records represented homeowner finds and/or interceptions in international shipments. However, evidence of established, breeding populations has been lacking and it remained unclear whether this pest could overwinter and establish breeding populations in Canada.

*Halyomorpha halys* can be distinguished from the other stink bugs species that occur in Ontario based on distinctive morphological characteristics (Paiero *et al.* 2013). Interception records and population genetic analysis suggest that *H. halys* in Ontario is mostly likely derived from movement and/or translocation of populations that have established in the northeastern United States of America (Garipey *et al.* 2013). To track the spread and occurrence of this pest in Ontario, members of the public were encouraged to report any suspect finds to the Ontario Ministry of Agriculture and Food and Ministry of Rural Affairs' Agriculture Information Contact Centre. High-resolution digital images and/or physical specimens were forwarded to the Ministry Entomology Program Lead – Horticulture (Hannah Fraser) for further evaluation and identification. First occurrences in a geographic region (city/town) were confirmed by submitting specimens to the Canadian Food Inspection Agency, the University of Guelph, or Agriculture and Agri-Food Canada. Identifications were based on morphological characteristics or DNA barcoding, or both. Homeowner finds were recorded and compiled from June 2011 to October 2013. Between June and December 2011 there were reports of homeowner finds in five locations in Hamilton, Ontario, as well as an interception of multiple adults from two successive shipments of building materials that arrived in Mississauga, Ontario via Pennsylvania, United States of America (November 2011). The majority of these findings occurred in late fall/early winter. By the fall of 2012, the number of locations where BMSB adults were found in homeowner residences or gardens increased to 74, with the majority of finds in Hamilton ( $n = 36$ ) and Burlington ( $n = 34$ ), along with finds in new locations including Toronto ( $n = 2$ ), Milton ( $n = 1$ ), and Newboro ( $n = 1$ ). In 2013, homeowner reports continued with the usual finds in

Hamilton and Burlington, and additional new locations including Windsor (single homeowner with multiple finds on different dates), Cedar Springs ( $n = 1$ ), Vaughn ( $n = 1$ ), Niagara on the Lake (single homeowner with multiple finds on different dates), and London (single homeowner with multiple finds on different dates). The higher incidence of reports in these areas is likely due to an increase and spread of established populations of BMSB as well as an increase in public awareness and reporting of this pest following media coverage.

In 2012 and 2013, sites in Hamilton along the Niagara escarpment and near homeowner positives were scouted from June to August, in an effort to find established field populations. Detection and collection efforts were made by visual inspection of host plants and manual collection of specimens, beat sheet and sweep net sampling of host plants. The first occurrence of immature stages of BMSB in Ontario was on 14 July 2012 when several second instar nymphs were collected from a backyard garden. Identification of these immature specimens was based on their morphology, and confirmed using DNA barcoding (Garipey *et al.* 2013). As early instar BMSB nymphs may be difficult to distinguish from related species, and as this was a critical find, it was prudent to use molecular techniques to support the morphological identification. This provided the first evidence of the occurrence of breeding populations of BMSB in Canada. Additional field populations were later detected in mid-August in parks and urban areas in Hamilton, including Cootes' Paradise (decimal coordinates: 43.276455, -79.918084) where nymphs ( $n = 72$ ), adults ( $n = 39$ ), and several empty egg masses putatively belonging to BMSB were found on invasive buckthorn (*Rhamnus* Linnaeus (Rhamnaceae) species).

Continued scouting efforts in 2013 in the Hamilton area led to the discovery of the first overwintered BMSB adult on buckthorn on 18 June 2013 at Cootes' Paradise. In this same location, a male and a female adult *in copula* and second instar nymphs ( $n = 4$ ) were collected on buckthorn 11 July 2013. On 3 July 2013, adults ( $n = 4$ ) were found at Sam Lawrence Park (decimal coordinates: 43.244984, -79.865674). Since that date, collections at this location suggest increasing occurrence of BMSB. On 24 July

2013, a total of 257 individuals were collected in Sam Lawrence Park, including second ( $n = 73$ ), third ( $n = 97$ ), fourth ( $n = 39$ ), and fifth ( $n = 29$ ) instar nymphs, overwintered adults ( $n = 16$ ), and new generation adults ( $n = 3$ ). Several empty egg masses putatively belonging to BMSB were also found. A subsequent collection (using the same collection methods and collection time) from the Sam Lawrence Park location on 16 August 2013 yielded 585 specimens, including 38 adults and 547 nymphs (all instars present). These individuals were largely collected on buckthorn, but were also found in high numbers on ash [*Fraxinus* Linnaeus species (Oleaceae)], *Catalpa* Scopoli (Bignoniaceae), choke cherry (*Prunus virginiana* Linnaeus (Rosaceae)), crab apple [*Malus* Miller species (Rosaceae)], dogwood [*Cornus* Linnaeus species (Cornaceae)], American cranberrybush [*Viburnum opulus* var. *americanum* Aiton (Adoxaceae)], honeysuckle (*Lonicera* Linnaeus species (Caprifoliaceae)), lilac (*Syringa* Linnaeus species Oleaceae)), American basswood (*Tilia americana* Linnaeus (Tiliaceae)), Manitoba maple or box elder (*Acer negundo* Linnaeus (Sapindaceae)), mulberry (*Morus* Linnaeus species (Moraceae)), rose (*Rosa* Linnaeus species (Rosaceae)), tree of heaven (*Ailanthus altissima* (Miller) Swingle (Simaroubaceae)), walnut (*Juglans* Linnaeus species (Juglandaceae)), and wild grape (*Vitis* Linnaeus species (Vitaceae)). This is consistent with observed host plant use in the northeastern United States of America (Bernon 2004; Hamilton 2009; Nielsen and Hamilton 2009).

At present we can confirm that BMSB is officially established in southern Ontario, can complete at least one generation, and has become a minor nuisance pest in urban areas in the Greater Toronto and Hamilton areas (GTHA) in the Province of Ontario. Additional homeowner finds in other areas outside of the GTHA suggest the possibility that BMSB will become a nuisance pest in these areas in the near future. Although it has not yet been found in agricultural habitats, continued monitoring and surveillance are necessary to document population density and spread from the initial source population in Hamilton. This is of utmost importance given the close proximity to major fruit-growing regions (*e.g.* the Niagara Peninsula) and the ease with which BMSB both actively disperses and is passively transported between

locations based on human activity. With the occurrence of both overwintered and new generation adults in the field in mid-July (as observed in our 2013 collections), there is the potential for a partial second generation of BMSB in southwestern Ontario, which would present additional challenges for pest management efforts. A better understanding of the phenology, occurrence, and spread of BMSB in Ontario is necessary to develop an integrated pest management strategy to limit the impact and spread of this pest in economically important agricultural crops.

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