

RECENT RANGE EXPANSION OF BROWN MARMORATED STINK BUG IN EUROPE

¹TIM HAYE, ²DENISE WYNIGER, AND ³TARA GARIEPY

¹CABI, Rue des Grillons 1, 2800 Delémont, Switzerland

²Naturhistorisches Museum Basel, Abteilung Biowissenschaften,
Augustinergasse 2, 4001 Basel, Switzerland

³Southern Crop Protection and Food Research Centre, Agriculture and Agri-Food Canada,
1391 Sandford Street, London, Ontario, Canada, N5V 4T3

Abstract A public survey to determine the current distribution of the invasive brown marmorated stink bug, *Halyomorpha halys* in Switzerland showed that by the end of 2013, it was present in 11 Cantons, including six newly invaded Cantons (Basel-Landschaft, Aargau, Genève, Solothurn, Ticino, Thurgau, and Bern). In total, *H. halys* was found in 76 locations in 38 cities across Switzerland with large breeding populations being present in the cities Zurich, Basel, Bern, and Lugano. There is now evidence that *H. halys* was already present in 2004, three years before its first official detection in 2007. Although *H. halys* has been present in Switzerland for nearly 10 years, its natural spread can be considered slow. Large distribution gaps between Swiss cities Zurich, Basel and Bern indicate that founder populations from Zurich arrived in these locations through human activity and movement of goods along the main motorways connecting the cities. The new list of host plants in Europe contains 51 host plants in 32 families, including many exotic and native plants. High densities of nymphs and adults were observed on *Catalpa bignonioides*, *Sorbus aucuparia*, *Cornus sanguinea*, *Fraxinus excelsior*, and *Parthenocissus quinquefolia*. With growing populations in Switzerland, France and Italy *H. halys* may further extend its distribution and become a nuisance pest in many European cities.

Key words *Halyomorpha halys*, nuisance pest, host plants, European distribution.

INTRODUCTION

One of the most harmful invasive insect pests is the brown marmorated stink bug, *Halyomorpha halys* Stål (Heteroptera: Pentatomidae), which is native to eastern China, Japan, Korea and Taiwan (Zhu et al., 2012). In North America it was first reported in the mid-1990s (Hoebeke and Carter, 2003), whereas in Europe it was first recognized in Zurich, Switzerland, in 2007 (Wermelinger et al., 2008). Until recently, the distribution of *H. halys* in Europe was restricted to four cantons of Switzerland, but it is now also present in France and Italy (Wyniger and Kment, 2010; Callot and Brua, 2013; Pansa et al., 2013, EPPO 2013). In the north-eastern United States, *H. halys* developed into a severe agricultural and horticultural pest, but due to its behaviour to enter human houses in large numbers for overwintering, it is also considered a nuisance pest in 21 states (Inkley, 2012; Northeastern IPM Center, 2013a). Adults entering the houses are a nuisance mainly because of the unpleasant odor they emit when disturbed, the remains of their frass, and their abundance, which can exceed 25,000 individuals in a single house in a single year (Inkley, 2012). In Switzerland *H. halys* is not considered an agricultural pest, but Mueller et al. (2011) showed that reports of *H. halys* in private residences in Zurich have increased exponentially between 2007 and 2010. Due to this increased number of reports in private homes in Zurich and other Swiss cities, the objectives of our

study were to re-investigate the distribution of *H. halys* and their associated host plants to elucidate the current development of this nuisance pest in Switzerland.

MATERIALS AND METHODS

To determine the current distribution in Switzerland a public survey was conducted in 2012/13. Several articles were published in Swiss newspapers, public talks were given, and a webpage (www.halyomorphahalys.com) was launched, asking private homeowners to report findings of *H. halys* and infested host plants. Since *H. halys* adults are often confused with the native *Raphigaster nebulosa* Poda (Wyniger and Kment, 2010), only those records that were validated by the authors based on the submission of dead individuals or digital images were considered as positive finds. Areas where *H. halys* was never reported before were visited by the authors whenever possible in person to confirm the presence of the bug. In addition, highly infested cities in Switzerland (Zurich, Basel, Bern, Lugano) and France (Strasbourg, Schiltigheim) were visited several times to compile a new list of host plants of *H. halys* in Europe.

RESULTS AND DISCUSSION

In total, the public survey resulted in 154 validated submissions. 51.9% of the submitted records were *H. halys*, followed by the native *R. nebulosa* (29.2%), and the invasive western conifer seedbug, *Leptoglossus occidentalis* Heidemann (16.2%). Other species reported were the native *Dolycoris baccarum* L. (1.3%) and the invasive *Nezara viridula* L. (1.3%). The most remarkable submission was a digital photograph taken May 5th, 2004 in Zurich-Seefeld by R. Burtscher, showing undoubtedly an adult *H. halys*. This proves that *H. halys* was already present in Switzerland long before the first official records in 2007 (Wermelinger et al. 2008). Wyniger and Kment (2010) reported that besides large populations in the Canton Zurich, single individuals had also occurred in the Cantons Basel-Stadt, Schaffhausen, and St. Gallen. The present survey showed that by the end of 2013 the bug had extended its range to 11 Cantons, including the newly invaded Cantons Basel-Landschaft, Aargau, Genève, Solothurn, Ticino, Thurgau, and Bern. In total, *H. halys* was found in 76 locations in 38 cities across Switzerland with large breeding populations being present in the cities Zurich, Basel, Bern, and Lugano (Figure 1).



Figure 1. Distribution of *H. halys* in Europe according to 2012/13 surveys and published records.

Although *H. halys* probably arrived in Zurich in the early 2000s, the majority of records were still submitted from an area of approximately 40 km around Zurich, suggesting that its natural spread was relatively slow. Large distribution gaps between populations in Zurich and other cities such as Basel and Bern indicate that founder populations from Zurich arrived in these locations through human activity and movement of goods along the main motorways connecting the cities, which was recently confirmed by Gariepy et al. (2013). The accidental movement of Swiss populations is likely also responsible for individuals discovered in Liechtenstein (Arnold, 2009), Germany (Heckmann, 2012), France (Callot and Brua, 2013), and Italy (EPPO, 2013; Pansa et al., 2013) (Figure 1).

Previously, the highly polyphagous *H. halys* was reported from eight plants in Switzerland (Wermelinger et al. 2008; Wyniger and Kment 2010), but with the present survey the list of host plants was extended to a total of 51 host plants in 32 families, including many exotic and native plants (Table. 1). In comparison, in the United States it was recorded from 166 plant species (Northeastern IPM Center 2013b), and in Asia a total of 106 host plants have been reported (Lee et al., 2013). High densities of sometimes more than 100 nymphs and adults per tree were particularly observed on *Catalpa bignonioides* Walter, *Sorbus aucuparia* L., *Cornus sanguinea* L., *Fraxinus excelsior* L., and *Parthenocissus quinquefolia* (L.) Planchon. Plants with large numbers of unripe fruits, buds and pods tended to host more individuals than plants without these parts, a phenomenon which was also observed in the US (Northeastern IPM Center, 2013b).

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CONCLUSIONS

The present survey demonstrated that *H. halys* is already far more widespread in Switzerland than previously assumed. With growing populations in Switzerland, France and Italy an expansion of the current distribution can be expected, and in the future *H. halys* may become a nuisance problem in many European cities. Areas of high risk are those cities that are connected by motorways with cities where large *H. halys* populations already exist. Remarkably, no breeding populations have been reported from Germany yet, but it is highly likely that *H. halys* will soon establish in German cities in the near vicinity of infested areas, e.g. Kehl, Weil am Rhein, and Konstanz. The reasons why *H. halys* populations seem to do best in larger cities remain unclear. Since *H. halys* develops better at warmer temperatures (Nielsen et al., 2008), one explanation could be the phenomenon of urban heat islands (UHI), which are metropolitan areas that are significantly warmer than their surrounding rural areas due to human activities (Oke, 1967).

Table 1. Host plants of *Halyomorpha halys* in Europe; n = native to Europe; e = exotic (^aWermelinger et al., 2008; ^bWyniger and Kment, 2010).

Family	Common name	Scientific name	origin	High densities observed
Apocynaceae	oleander	<i>Nerium oleander</i> L.	n	
Aquifoliaceae	European holly	<i>Ilex aquifolius</i> L.	n	+
Araliaceae	Japanese angelica tree	<i>Aralia elata</i> (Miq.) Seem. ^a	e	+
	common ivy	<i>Hedera helix</i> L.	n	
Arecaceae	Chinese windmill palm	<i>Trachycarpus fortune</i>	e	
Asparagaceae	sicklethorn	<i>Asparagus falcatus</i> (L.) Druce	e	
Asteraceae	sunflower	<i>Helianthus annuus</i> L.	e	
Betulaceae	hornbeam	<i>Carpinus betulus</i> L.	n	+
	common hazel	<i>Corylus avellana</i> L.	n	
Bignoniaceae	Chinese trumpet vine	<i>Campsis grandiflora</i> (Thunb.) K.Schum. ^b	e	+
	cigar tree	<i>Catalpa bignonioides</i> Walter	e	+
Convolvulaceae	morning glory	<i>Ipomoea</i> sp.	(?)	
Cornaceae	common dogwood	<i>Cornus sanguinea</i> L.	n	+
Fabaceae	-	<i>Caragana brevispina</i> Royle ex Benth.	e	
	Judas tree	<i>Cercis siliquastrum</i> L.	n	
	lupine	<i>Lupinus</i> sp.	(?)	
	runner bean	<i>Phaseolus coccineus</i> L.	e	
Fagaceae	holm oak	<i>Quercus ilex</i> L.	n	
	English oak	<i>Quercus robur</i> L.	n	
Hydrangeaceae	hortensia	<i>Hydrangea</i> sp.	e	
Lamiaceae	harlequin glorybower	<i>Clerodendrum trichotomum</i> Thunb.	e	
Lauraceae	bay laurel	<i>Laurus nobilis</i> L.	n	
Lardizabalaceae	dead man's fingers	<i>Decaisnea fargesii</i> Franch. J. Bot. (Morot) ^a	e	+
Malvaceae	Hibiscus	<i>Hibiscus</i> sp.	e	
Magnoliaceae	Magnolia	<i>Magnolia</i> sp.	e	
Meliaceae	Chinese Toon	<i>Toona sinensis</i> (A.Juss.) M.Roem.	e	
Moraceae	common fig	<i>Ficus carica</i> L.	e	
	white mulberry	<i>Morus alba</i> L.	e	
Oleaceae	European ash	<i>Fraxinus excelsior</i> L.	n	+
Plantaginaceae	figwort	<i>Asarina scandens</i> (Cav.) Pennell	n	
Rosaceae	juneberry	<i>Amelanchier lamarckii</i> F.G.Schroed. ^a	e	
	black chokeberry	<i>Aronia melanocarpa</i> (Michx.) Ell.	e	
	cotoneaster	<i>Cotoneaster cochleatus</i> (Franch.) G.Klotz	e	
	common hawthorn	<i>Crataegus monogyna</i> Jacq.	n	
	apricot	<i>Prunus armeniaca</i> L.	e	
	sweet cherry	<i>Prunus avium</i> L.	n	
	almond	<i>Prunus dulcis</i> Batsch	n	
	peach	<i>Prunus persica</i> (L.) Stokes	e	
	nectarine	<i>Prunus persica</i> var. <i>nucipersica</i>	e	
	blackthorn	<i>Prunus spinosa</i> L.	n	
	firethorn	<i>Pyracantha coccinea</i> M.Roem.	n	

	garden roses	<i>Rosa</i> spp.	e	
	blackberry	<i>Rubus fruticosus</i> L.	n	+
	raspberry	<i>Rubus ideaeus</i> L.	n	+
	mountain-ash	<i>Sorbus aucuparia</i> L.	n	+
Sapindaceae	box elder	<i>Acer negundo</i> L.	e	
	Japanese maple	<i>Acer palmatum</i> Thunb.	e	
	Norway maple	<i>Acer platanoides</i> L.	n	
	sycamore maple	<i>Acer pseudoplatanus</i> L. ^a	n	
	bottlebrush buckeye	<i>Aesculus parviflora</i> Walter	e	
Scrophulariaceae	summer lilac	<i>Buddleja davidii</i> Franch. ^a	e	
	mullein	<i>Verbascum</i> sp.	(?)	
Sequoioideae	giant redwood	<i>Sequoia sempervirens</i> (D. Don) Endl.	e	
Simaroubaceae	tree of heaven	<i>Ailanthus altissima</i> (Mill.) Swingle	e	
Solanaceae	sweet pepper	<i>Capsicum annuum</i> L.	e	
	eggplant	<i>Solanum melongena</i> L.	e	
Theaceae	Japanese Stewartia	<i>Stewartia pseudocamellia</i> Maxim. ^a	e	+
Tropaeolaceae	Indian cress	<i>Tropaeolum majus</i> L. ^a	e	+
Ulmaceae	elm	<i>Ulmus</i> sp.	(?)	
Vitaceae	Virginia creeper	<i>Parthenocissus quinquefolia</i> (L.) Planch.	e	+
	common grape vine	<i>Vitis vinifera</i> L.	n	

The list of host plants for *H. halys* will undoubtedly grow as the pest spreads to new areas in Europe. The wide variety of exotic and native plants planted in parks and private gardens in cities provides a nearly unlimited food source for *H. halys* throughout the season and could be another reason why *H. halys* is mainly a nuisance problem in urban environments and less in the countryside. To avoid an increase of *H. halys* populations within cities, municipal nurseries and private home owners should consider less suitable host plants when planting streets, public parks or private gardens.

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