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First occurrence of *Halyomorpha halys* in Bordeaux vineyards

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ABSTRACT

Here we report the first detection of *Halyomorpha halys* (Stål, 1855) in Bordeaux vineyards. The species is native to Eastern Asia and was introduced to France in 2012. *Halyomorpha halys* is highly polyphagous and causes significant damage to various crops, including grapevines. From 2018 to 2020, Pentatomidae species were collected in vineyards in the Bordeaux region. In 2020, the first nymphs and adults of *H. halys* were identified in the plot centres. The study emphasizes the need for field population monitoring in risk assessment and, consequently, risk management.

KEYWORDS: vineyards, grapevine, exotic pest, Pentatomidae, monitoring, BMSB

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INTRODUCTION

The number of invasive species continuously increases worldwide (Simberloff *et al*., 2013) and this is primarily attributed to human trade and transport. As their numbers increase, these species can have ecological and/or economic implications; but eradicative or corrective measures can be implemented in response (Renault *et al*., 2021; Simberloff, 2003; Simberloff *et al*., 2013). In Europe, the trade of fruits presents an entry channel for exotic pests (Suffert *et al*., 2018) and thus poses a particular risk. During phytosanitary import inspections over the past twenty years, many invasive insects have been detected or intercepted from different regions of the world in France (Balmès and Mouttet, 2019; Mouttet *et al*., 2020; Touroult *et al*., 2016). Among these, some were not detected or intercepted, as was the case for the dramatic introduction of the Asian yellow-legged hornet (Monceau *et al*., 2014) or of *Drosophila suzukii* Matsumara.

Another example of an invasive species affecting grapes is the brown marmorated stink bug, *Halyomorpha halys* (Stål, 1855) (Hemiptera, Pentatomidae). Native to East Asia (Hoebeke and Carter, 2003; Lee *et al*., 2013), this highly polyphagous species causes significant damage to many crops, including grapevines (*Vitis vinifera* L.) (McPherson, 2018). *H. halys* was detected for the first time in Europe in 2004 in Liechtenstein and the first outbreaks were declared in 2007 in Zurich, Switzerland (Wermelinger *et al*., 2008). In France, the first record dates back to 2012 in the Alsace region (Callot and Brua, 2013; Streito *et al*., 2014). Since then, this insect has spread through the country and its presence was reported in 2013 in Paris (Garrouste *et al*., 2014), in 2015 in Toulouse and the Landes region (located in the south of Bordeaux) (Labatut and Géry, 2019) and in 2018 in urban areas near Bordeaux (Maurel *et al*., 2016; Streito *et al*., 2020).

Grapevines are some of the most important crops cultivated in the Bordeaux region and are also one of the host plants of *H. halys*. Indeed, in North American vineyards, all development stages can be found on the plants, from eggs to adults (Basnet *et al*., 2015). Nymphs and adults feed on and damage the grapes (Smith *et al*., 2014). Damage can be observed in the vineyard and/or in derived products (Nielsen *et al*., 2016). By feeding on the fruit with its mouthparts, injecting saliva and sucking up the plant fluid, the insect causes declines in the quality and yields of grapes, especially post-veraison (Basnet *et al*., 2015; Smith *et al*., 2014). Moreover, damages to the berries may lead to aromatic deviations in the wine. If bugs are collected along with clusters and transported in bins to wineries, which is possible for nymphs, they can impact the odour or flavour of the product when crushed along with the berries. The presence of released defensive odours can change the flavour of the wine and is detectable by humans (Kehrli *et al*., 2021; Mohekar *et al*., 2017; Pfeiffer *et al*., 2012).

For the Bordeaux region, at this time, no Pentatomidae was referenced as a clear pest to grapevines (Boudon-Padieu *et al*., 2000). However, populations of *H. halys* are constantly increasing in the south of France (Hamidi *et al*., 2019; Streito *et al*., 2020) and are becoming a major concern for French winegrowers. Monitoring is required to deploy anticipatory control strategies against the pest. The study aimed to collect individuals from the stink bug community in vineyards and surrounding hedges in the Bordeaux region to detect the presence of *H. halys*.

MATERIALS AND METHODS

1. Study sites

The experiment was conducted in conventional Merlot grapevines for wine production. Plots were located in the Bordeaux region, within a 5 km radius from the city of Libourne, France and were designated as follows: Pomerol 1 (44°55'47.2"N 0°12'31.1"W, 11 m a.s.l.), Pomerol 2 (44°55'37.8"N 0°11'29.2"W, 39 m a.s.l.) and Fronsac (44°55'22.4"N 0°16'38.5"W, 84 m a.s.l.). The mean distance between plots was 4.6 ± 2.3 km. The hedges and centres of the vines were monitored. In Pomerol 2, only the centre of the plot was monitored. Between May and August, all plots were treated against fungal diseases. Mating disruption was used against grape berry moths and natural or synthetic pyrethrins against leafhoppers. Hedges were composed of various species surrounding the grapevines: bushes (*Rubus fruticosus* L. aggr. and wild *Vitis* sp.), trees (*Quercus robur* L., *Pinus pinaster* Aiton, *Robinia pseudoacacia* L. and *Acer campestre* L.) and shrubs (*Corylus avellana* L., *Prunus spinosa* L., *Crataegus monogyna* Jacq. and *Sambucus nigra* L.). All species were controlled at least one time during the monitoring period.

2. Monitoring and identification of Pentatomidae species

From 2018 to 2020, adults and nymphs were collected in spring (mid-May), summer (mid-July) and before the harvest (end of August). At each sampling date, insects were collected by beating techniques in the morning at cooler temperatures when insects were relatively motionless (Muneret *et al*., 2019). In grapevine plots, two transects of ten vines each were sampled. On each transect, sampling was carried out on one side by sampling five vines on one row, then completed by sampling the same number of vines on the opposite row. Only one transect was carried out over an equivalent length of 20 vines on one side only and this was performed in the border exposed on the vineyard side.

Stink bugs were collected and stored in 70 % alcohol and identified under a stereomicroscope in the laboratory. Insects were counted and their phenological stages were determined according to the identification key of French Pentatomidae (Lupoli and Dusoulier, 2015).

RESULTS

In the vineyard centre, 18 Pentatomidae specimens were collected (Table 1). Among them were: 38.9 % of *H. halys*, 22.2 % of *Dolycoris baccarum* L., 16.7 % of

TABLE 1. Total number of *Halyomorpha halys* and other species of Pentatomidae recorded inside the vineyard plots and in the edges of these plots in 2018, 2019 and 2020.

Year	Plot	Species	Centre of the vine plot	Hedge of the vine plot
2018	Pomerol 1	*Halyomorpha halys*	0	0
		Other Pentatomidae	3 (0)	23 (9)
2019	Fronsac	*Halyomorpha halys*	0	0
		Other Pentatomidae	8 (2)	15 (1)
2020	Pomerol 1	*Halyomorpha halys*	3 (3)	5 (2)
		Other Pentatomidae	0	8 (0)
	Fronsac	*Halyomorpha halys*	2 (2)	0
		Other Pentatomidae	0	10 (4)
	Pomerol 2	*Halyomorpha halys*	2 (1)	N/A
		Other Pentatomidae	0	N/A

N/A: data not collected; number of nymphs in brackets.

Aelia acuminata L., 5.6 % of *Nezara viridula* L., 5.6 % of *Palomena prasina* L. and 11.1 % of undetermined species.

In the hedges, 61 Pentatomidae specimens were collected (table 1). Among them were: 23.0 % of undetermined species, 18.0 % of *N. viridula*, 18.0 % of *P. prasina*, 8.2 % of *A. acuminata*, 8.2 % of *H. halys*, 8.2 % of *Neottiglossa leporina* L., 6.6 % of *Rhaphigaster nebulosa* Poda., 3.3 % of *D. baccarum*, 1.6 % of *Acrosternum heegeri* Fieber, 1.6 % of *Carpocoris purpureipennis* (De Geer), 1.6 % of *Eysarcoris aeneus* Scopoli and 1.6 % of *Eurydema oleracea* L.

Almost all *H. halys* specimens collected in the fields were nymphs. *Halyomorpha halys* specimens were collected in 2020, while none were observed in 2018 and 2019 (Table 1). Field observations showed that eggs of *H. halys* were present under grapevine leaves (personal observations, Rouzes) (Figure 1). Therefore, all stages were found in the vineyards analysed. Additionally, adults and nymphs were observed on grapevines close to vineyards close to harvest in 2020.

DISCUSSION

The present study highlights the establishment of the exotic pest species *H. halys* in the Bordeaux vineyard area. However, according to observations, the population is currently relatively low. The pest was recently introduced in France and its population is quickly increasing across the country (Streito *et al*., 2021), raising concerns to farmers.

Our observations indicate that *H. halys* arrived in the Bordeaux vineyards in 2020. The presence of nymphs in the centres of all three sampled plots shows that the insect is well-established. It is well-known that *H. halys* needs to feed on different host species to complete its life cycles (Acebes-Doria *et al*., 2016), leading to the movement of adults and nymphs throughout the landscape (Acebes-Doria *et al*., 2017; Blaauw *et al*., 2019; Nielsen and Hamilton, 2009). Hedges and crops surrounding the vineyards include several alternative host plant species, such as tree of heaven, kiwis, apples, maples, plums and hazel trees, particularly conducive to the establishment of this pest (Haye *et al*., 2014; Hedstrom *et al*., 2014; McPherson, 2018). A rise in edge populations is expected and should therefore be monitored. The phenomenon is known as the border effect (Basnet *et al*., 2015) or spillover (Tscharntke *et al*., 2005). Nonetheless, the low number of individuals and the limited diversity recorded of bugs in the plots allow the vineyard plot to be deemed an ecological zone not well adapted to most of these species. These pentatomids are otherwise only observed as adults.

Palomena prasina was cited as a very occasional pest in southeastern France and around the Mediterranean (Galet, 1982); the species is currently an emerging pest in southern France but mainly affects apples and hazelnuts (Hamidi *et al*., 2022; Streito and Bout, 2019). *Nezara viridula* is an exotic pest species currently on the rise in France (Streito and Bout, 2019) but not referenced as a serious pest of grapevines (McPherson, 2018). *Eurydema oleracea* was also captured, but only in the edge samples, and the species is known to feed on mainly cruciferous plants species (Piersanti *et al*., 2020). *Rhaphigaster nebulosa*, *D. baccarum*, *C. purpureipennis* and *N. viridula* are common hedge species of surrounding vineyards and not mentioned

FIGURE 1. Nymphs as well as an egg clutch of *Halyomorpha halys* on grapevine plants (Photo credit: R. Rouzes).

as pests of grapevines (Franin *et al*., 2021). Until the present study, and according to previous knowledge, no Pentatomidae species was referenced as a clear pest to grapevines (Boudon-Padieu *et al*., 2000).

CONCLUSION

Our monitoring is the first report of *Halyomorpha halys* in the French vineyard. This species has joined the community of Pentatomidae bugs present in these agroecosystems, at least in the Bordeaux wine production areas. The presence of nymphs in the centres of the plots show that the pest can develop in vineyard agroecosystems and pose a growing threat to wine production. Therefore, monitoring *H. halys* in French vineyards is important for risk assessment and, consequently, in risk management.

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