SHORT PAPER

First evidence of *Halyomorpha halys* (Stål) (Hemiptera Heteroptera, Pentatomidae) feeding on rice (*Oryza sativa* L.)

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Abstract

The brown marmorated stink bug, *Halyomorpha halys* (Stål) is a pest of numerous annual and perennial crops. Additional distribution records for *H. halys* are provided from northern Italy where rice is cultivated, and the presence of adults feeding on panicles gives the first evidence of an association between this pest and rice (*Oryza sativa* L.), a crop not previously recorded as a host plant.

Introduction

Halyomorpha halys (Stål) (Hemiptera Heteroptera, Pentatomidae), commonly known as the brown marmorated stink bug (BMSB), is native to East Asia (China, Korea, and Japan) (Xu *et al.,* 2014). The invasion of other regions by BMSB began in the mid-1990s in the USA when *H. halys* was recorded in Pennsylvania and after few years it had spread to 40 states (Hoebeke & Carter, 2003). This species is now established in the United States of America (Northeastern IPM Center, 2014), in Canada and in Central and Southern America (Haye *et al.*, 2015). In Europe, it was first recorded from Switzerland in 2007 (Wermelinger *et al.*, 2008). In Italy it has been reported from various different regions since 2012 (Maistrello *et al*., 2013; 2014; Cesari *et al*., 2015; Limonta *et al*., 2016). It is continuing to extend its distribution in Switzerland, France, Germany, Greece, Hungary, Liechtenstein, Romania, Austria, Serbia (Haye *et al*., 2015), Russia (Mityushev, 2016) and Spain (Dioli *et al.*, 2016). *H. halys* has also been intercepted twice in Britain (Malumphy, 2014). As with other invasive pentatomids (Dioli & Grazioli, 2012), BMSB can rapidly spread to new areas through human transportation and the movement of goods, particularly agricultural commodities. The rapid spread of BMSB in Italy has also been facilitated by the climate, which provides excellent conditions for the survival and establishment of large populations of the pest (Zhu *et al.*, 2012).

H. halys, like most pentatomids, has a broad host range that allows it to feed and survive in fruit orchards and legume crops. Lee *et al.* (2013a) report more than 100 host plants in 45 families from 45 Asian publications. Due to its great host flexibility, *H. halys* has rapidly become a key pest of many annual and perennial crops in invaded countries (Lee, 2015). In the United States, the insect has caused economic losses valued at 21 billion dollars due to direct commodity damage, market loss, management costs, and rejection of exports (USDA-NIFA SCRI, 2013; Leskey *et al*., 2012). In Italy, economic damages has been observed close to harvest in peach and pear orchards and also in apricots, plums, apples, persimmons, and tomatoes (Pansa *et al.*, 2013; Bariselli *et al*., 2016).

Feeding injury by *H. halys* results in seed loss, punctures, fruit deformation, suberization, formation of spongy areas, fruit abortion, necrosis, and also destroyed pods (Lee, 2015). Adults and nymphs are extremely active and can readily move between different cultivated and ornamental host plants (Lee *et al.*, 2013b).

Recently BMSB was detected in many of the rice areas in the Po plain in Italy, but due to its polyphagy its role in the crop remained uncertain. As a consequence, its status in rice needs to be further evaluated, despite the fact that BMSB is widely distributed in other rice-producing countries and rice has not been identified as a host plant in the published literature. Rice production in Europe has been threatened by the exotic rice water weevil *Lissorhoptrus oryzophilus* Kuschel (Coleoptera: Curculionidae)

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which has compromised production in this economically important crop (Lupi *et al.,* 2009; 2013a; 2013b), and consequently concern has arisen about the possible association of *H. halys* with rice. Several species of Pentatomidae are known to attack rice and to cause economic losses in many rice-producing countries (Table 1). Damage is caused by adults and nymphs feeding on kernels in milk and dough stage of maturation, resulting in partially or totally unfilled grains (Lee *et al*., 1993; Pathak & Khan, 1994; Patel *et al.*, 2006, Kiritani, 2007). Trophic activity can also open an access to fungi and bacteria that are responsible for pecky rice, which leads to chalky discoloration around the feeding site (Hollay *et al*., 1987; Panizzi *et al.*, 2000).

This study provides the first direct observations of BMSB feeding on cultivated rice crops.

Materials and Methods

The research was carried out in the rice growing areas of the Po Valley in the Lombardy region of Italy. The two main rice producing provinces (Milan and Pavia) are contiguous, and they are characterized by a fragmented landscape in which rice is the main crop and rice paddies are interspersed with populated areas. Due to the distinctive characteristics of the different instars of the insect (Hoebeke & Carter, 2003), visual observations were made directly in paddy fields and in nearby areas from late August to the end of October 2016.

Observations are discussed comparing previous records of BMSB (author's communication, published records and the internet).

Results and discussion

Earlier records exist of *Halyomorpha halys* from different rice areas in Northern Italy and also from Milan and Pavia provinces, however the insect was has not previously been directly associated with rice crops. Even though rice is cultivated in 129 Piedmont and 216 Lombardy Municipalities (data courtesy of Italian National Rice Research Institute, 2016), only 14 records of this species have previously been reported from the rice area, mainly in 2016 (Table 2).

The observations carried out in rice crops in the Lombardy Region resulted in two records of BMSB on rice in Pavia Province: the first detection of the species on panicles was on the 24th September 2016 in Linarolo (45°9'47"88 N 09°16'15"60 E) and a

Table 1. List of the major species of Hemiptera Pentatomidae associated to rice according to geographic distribution.

Distribution	Species	Literature
North America	*Oebalus pugnax* (F.)	Naresh & Smith, 1984; Foster *et al.*, 1989; Espino *et al*., 2008
	Scotinophara coarctata (F.)	Heinrichs *et al.,* 1987
	Nezara viridula L.	Viator *et al*., 1993
Central America (Cuba)	*Oebalus ornatus* (Sailer)	Pantoja *et al*., 1993
South America	*Oebalus peoecilus* (Dallas)	Albuquerque, 1993; Pathak & Khan,1994
	Oebalus ypsilon-griseus (De Geer)	Pathak & Khan,1994
	Oebalus grisescens (Sailer)	Pathak & Khan,1994
	Tantia antiguensis (Westwood)	Litsinger *et al*. 1986
	Tantia perditor (Fabricius)	Litsinger *et al*. 1986
	Tibraca limbativentris Stal.	Alves *et al*., 2016
Europe	*Aelia rostrata* Boheman	Süss *et al*., 2008
	Carpocoris pudicus (Pd.)	Süss *et al*., 2008
	Eurigaster Laporte	Süss *et al*., 2008
	Nezara viridula L.	Süss *et al*., 2008
Asia	*Dolycoris indicus* Stal.	Litsinger *et al*. 1986
	Eysarcoris ventralis (Westwood)	Litsinger *et al*. 1986
	Pygomenida varipennis (Westwood)	Pathak & Khan,1994
	Pygomenida bengalensis (Westwood)	Pathak & Khan,1994
	Scotinophara scotti Hovarth	Litsinger *et al.* 1986
	Nezara viridula L.	Pathak & Khan, 1994
Asia (Southeast)	*Scotinophara coarctata* (F.)	Barrion *et al.*, 1982
	Scotinophara cinerea (Le Guillou)	Mochida, 1988
	Scotinophara latiuscola Bredding	Mochida, 1988
	Scotinophara lurida (Burmeister)	Mochida, 1988
	Scotinophara. serrata (Vollenhoven)	Mochida, 1988
Asia (Philippines)	*Scotinopara tarsalis* (Vollenhoven)	Litsinger *et al.*, 1986
Asia (Japan)	*Lagynotomus elongatus* (Dallas)	Takeuchi *et al*., 2004
Africa	*Aspavia armigera* F.	Ewete & Olagbaju, 1990
	Macrina iuvenca Burmeister	Litsinger *et al.*, 1986
	Nezara viridula L.	Pathak & Khan,1994
	Tantia gelii Schout	Litsinger *et al.*, 1986
Australia	*Anaxilaus vesiculosus* (Herrich-Schaeffer)	Stevens *et al.* 2008
	Eysarcoris trimaculatus (Distant)	Stevens *et al.* 2008
	Nezara viridula (L.)	Stevens *et al.* 2008

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second record was obtained a month later on 20th October 2016, in Zeme (45°11'74 N;8°38'25 E) nearly 60 km away. The probing activity on rice grain shown in Figure 1 provides evidence that the insect is attracted to rice for feeding.

Whilst the presence of *H. halys* in the Piedmont and Lombardy rice areas has been well documented, the nature and extent of the feeding damage that could be inflicted to rice by BMSB requires further investigation. The majority of municipalities in which *H. halys* has been detected so far are, have only low levels of rice production. The findings from 2014 in Novara and in 2016 in Pavia, the major rice areas in Piedmont and in Lombardy respectively, demonstrates that the insect is still spreading in the rice area and highlights the need for further work on the association between BMSB and rice.

As rice cultivars differ in susceptibility to invasive species attack (Lupi *et al*., 2009; 2013b) and also to the development of pecky rice in response to pentatomid feeding (Lorenz & Hardke, 2013), particular attention should be paid to the association of *H. halys* with specific cultivars and to the level of damage inflicted. The timing of feeding relative to the developmental stage of the crop should be assessed, as the amount and the type of rice stink bug damage depends upon the stage of rice kernel development.

Figure 1. Adult of *Halyomorpha halys* feeding on rice grain in the field (photo Roberto Scherini).

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References

ALBUQUERQUE G.S., 1993 - Planting time as a tactic to manage the small rice stink bug, *Oebalus poecilus* (Hemiptera, Pentatomidae), in Rio Grande do Sul, Brazil. - Crop Prot. 12 (8): 627-630.

ALVES T.M., MAIA A.H., BARRIGOSSI J.A., 2016 - Spatial distribution and coexisting patterns of adults and nymphs of *Tibraca limbativentris* (Hemiptera: Pentatomidae) in paddy rice fields. - Env. Ent. 45 (6): 1505-1514.

BARISELLI M., BUGIANI R., MAISTRELLO L., 2016 - Distribution and damage caused by *Halyomorpha halys* in Italy. - EPPO Bull. 46 (2): 332-334.

BARRION A.T., JOSHI R.C., SEBASTIAN L.S., 2008 - Occurrence and distribution of the invasive rice black bugs *Scotinophara* spp. (Hemiptera: Pentatomidae) in the Philippines. - International Rice Research Institute. Available from: www.scribd.com/.../occurence-and-distributionof-the-invasive-rice-black bug.

BARRION A.T., MOCHIDA O., LITSINGER J.A., DELA CRUZ N., 1982 - The Malayan black bug *Scotinophara coarctata* (F.) (Hemiptera: Pentatomidae): a new rice pest in the Philippines. - Int. Rice Res. New. 7 (6): 6-7.

CESARI M., MAISTRELLO L., GANZERLI F., DIOLI P., REBECCHI L., GUIDETTI R., 2015 - A pest alien invasion in progress: potential pathways of origin of the brown marmorated stink bug *Halyomorpha halys* populations in Italy. - J. Pest Sc. 88 (1): 1-7.

COLDIRETTI, 2016 - Assalto della cimice asiatica nel Mantovano, pere a rischio. - Available fromhttp://www.italiafruit.net/DettaglioNews/35868/mercati-e-imprese/assalto-della-cimice-asiatica-nel-mantovano-pere-a-rischio [Accessed 24.02.2017]

DIOLI P., GRAZIOLI L., 2012 - Prime segnalazioni di Lygaeus creticus Lucas, 1854 per il Veneto e altre regioni dell'Italia peninsulare (Insecta, Heteroptera, Lygaeidae). - Boll. Museo St. Nat. Venezia 63:19-25.

DIOLI P., LEO P., MAISTRELLO L., 2016 - Primera cita para España y Cerdeña de la especie invasora *Halyomorpha halys* (Stål, 1855), con apuntes sobre su distribución en Europa (Hemiptera, Pentatomidae). - Rev. Gadit. Entomol. 7 (1): 539-548.

ESPINO L., WAY M.O., WILSON L.T., 2008 - Determination of *Oebalus pugnax* (Hemiptera: Pentatomidae) spatial pattern in

Table 2. Municipality in Piedmont and Lombardy rice areas where *Halyomorpha halys* (Stål) was detected.

Region	Municipalities (Province)	Rice area, Ha	Geographic coordinates	Sources
Piedmont	Savigliano (Cuneo)	28.88	44°38′53″ N - 7°39′24″ E	Pansa *et al.*, 2013
	Casale Monferrato (Alessandria)	1777.21	45°08′00″ N - 8°27′09″ E	Pansa *et al.*, 2013
	S.Giuliano Nuovo (Alessandria)	88.42	44°54′33″ N - 8°36′36″ E	Forum Ent. Ital., 2015
	Roasio (Vercelli)	13.99	45°36′16″ N - 8°17′05″ E	Forum Nat. Med., 2016
	Novara	4387.97	45°26′48″ N - 8°37′16″ E	Forum Nat. Med., 2014
Lombardy	Settimo Milanese (Milano)	6	45°28'10"N - 9°42'64" E	Forum Nat. Med.,.2013
	San Donato Milanese (Milano)	36	45°23′38″ N - 9°17′27″ E	Forum Nat. Med., 2013
	Rice Park (Milano)	650	45°27′55″ N - 9°11′11″ E	Forum Nat. Med., 2015
	Lodi	91.82	45°18′35″ N - 9°30′03″ E	Coldiretti 2016
	San Martino Siccomario (Pavia)	481	45°09′48″ N - 9°08′26″ E	Authors record 2016
	Pavia	1318.35	45°11'7"44 N - 9°9'45" E	La provincia pavese 2016
	Voghera (Pavia)	22.46	44°59′29″ N - 9°00′42″ E	Voghera news 2016
	Mantova	6.27	45°09′37″ N - 10°47′52″ E	Gazzetta di Mantova 2016
	Ostiglia (Mantova)	80.27	45°04′11″ N - 11°08′05″ E	Gazzetta di Mantova 2016

rice and development of visual sampling methods and population sampling plans. - J. Econ. Entomol. 101 (1): 216-225.
EWETE F.K., OLAGBAJU R.A., 1990 - The development of *Aspavia armigera* F. (Hemiptera: Pentatomidae) and its status as a pest of cowpea and rice. - Insect Sci. Applic. 11 (2): 171-177.
FORUM ENT. ITAL., 2015 - Richiesta di segnalazioni su *Halyomorpha halys*. Available from: http://www.entomologi-italiani.net/public/forum/phpBB3/viewtopic.php?f=28&t=65192 [Accessed 24.02.2017].
FORUM NAT. MED., 2013. - Pentatomidae: *Halyomorpha halys* - nuova per l'Italia. Available from: http://www.naturamediterraneo.com/forum [Accessed 24.02.2017].
FORUM NAT. MED., 2015 - Forum animali. Insetti:. *Halyomorpha halys*. Available from: http://www.naturamediterraneo.com/forum/ [Accessed 24.02.2017].
FORUM NAT. MED., 2016. - Forum animali. Insetti: *Halyomorpha halys*. Available from: http://www.naturamediterraneo.com/forum/ [Accessed 24.02.2017].
FOSTER R.E., CHERRY R.H., JONES D.B., 1989 - Spatial distribution of the rice stink bug (Heteroptera: Pentatomidae) in Florida rice. - J. Econ. Entomol. 82 (2): 507-509.
GAZZETTA DI MANTOVA, 2016 - L'invasione delle cimici: danni nei campi e in città. Available frm: http://gazzettadimantova.gelocal.it/instant-articles/2016/10/19/news/mantova-l-invasione-delle-cimici-danni-nei-campi-e-in-citta-1.14275266 [Accessed 24.02.2017]
HAYE T., GARIEPY T., HOELMER K., ROSSI J.P., STREITO J.P., TASSUS X., DESNEUX N., 2015 - Range expansion of the invasive brown marmorated stinkbug, *Halyomorpha halys*: an increasing threat to field, fruit and vegetable crops worldwide. - J. Pest Sci. 88 (4): 665-673.
HEINRICHS E.A., DOMINGO I.T., CASTILLO E.H., 1987 - Resistance and yield responses of rice cultivars to the black bug *Scotinophara coarctata* (F.)(Hemiptera: Pentatomidae). - J. Plant Prot. 4 (1): 55-64.
HOEBEKE E.R., CARTER M.E., 2003 - *Halyomorpha halys* (Stål) (Heteroptera: *Pentatomidae*): a polyphagous plant pest from Asia newly detected in North America. - Proc. Entomol. Soc. Washington 105: 225-237.
HOLLAY M.E., SMITH C.M., ROBINSON J.F., 1987 - Structure and formation of feeding sheaths of rice stink bug (Heteroptera: Pentatomidae) on rice grains and their association with fungi. - Ann. Entomol. Soc. Am. 80 (2): 212-216.
KIRITANI K., 2007 - The impact of global warming and land□use change on the pest status of rice and fruit bugs (Heteroptera) in Japan. - Glob. Change Biol. 13 (8): 1586-1595.
LA PROVINCIA PAVESE, 2016 - Il caldo riporta le cimici in carrozza. - Available from: http://ricerca.gelocal.it/laprovinciapavese/archivio/laprovinciapavese/2006/06/28/PZ3PO_PZ301.html?refresh_ce [Accessed 24.02.2017].
LEE D.H., 2015 - Current status of research progress on the biology and management of *Halyomorpha halys* (Hemiptera: Pentatomidae) as an invasive species. - Appl. Entomol. Zool. 50: 277-290.
LEE D.H., SHORT B.D., JOSEPH S.V., BERGH J.C., LESKEY T.C., 2013a - Review of the biology, ecology, and management of *Halyomorpha halys* (Hemiptera: *Pentatomidae*) in China, Japan, and the Republic of Korea. - Environ. Entomol. 42 (4): 627-641.
LEE F.N., TUGWELL N.P., FANNAH S.J., WEIDEMANN G.J., 1993 - Role of fungi vectored by rice stink bug (Heteroptera: Pentatomidae) in discoloration of rice kernels. - J. Econ. Entomol. 86 (2): 549-556.
LEE D.H., WRIGHT S.E., BOITEAU G., VINCENT C., LESKEY T.C., 2013b - Effectiveness of glues for harmonic radar tag attachment on *Halyomorpha halys* (Hemiptera: Pentatomidae) and their impact on adult survivorship and mobility. - Environ. Entomol. 42 (3): 515-523.
LESKEY T.C, HAMILTON G.C., NIELSEN A.L., WRIGHT S.E., 2012 - Pest Status of the Brown Marmorated Stink Bug, *Halyomorpha halys* in the USA. - Outlooks Pest. Manag. 23: 218-226.
LIMONTA L., DIOLI P., SELVA J. SALVETTI M., 2016. - *Halyomorpha halys* (Stål, 1855) (Insecta, Heteroptera) in Valtellina and Northern Lake of Como. - Il Naturalista Valtellinese, 27, in press.
LITSINGER J., BARRION A., SOEKARNA D., 1986 - Upland rice insect pests and control. In: Progress in Upland Rice Research: Proceedings of the 1985 Jakarta Conference. - Int. Rice Res. Inst., p 403.
LORENZ G., HARDKE J.T., 2013 - Insect management in rice. In: Arkansas rice production Book. - University of Arkansas Agricultural Extension Service, Little Rock, AR.
LUPI D., CENGHIALTA C., COLOMBO M., 2009 - Adult feeding by the rice water weevil *Lissorhoptrus oryzophilus* on different host plants. - Bull. Insectol. 62 (2): 229-236.
LUPI D., GIUDICI M.L., CENGHIALTA C., ROCCO A., JUCKER C., COLOMBO M., 2013b - Japonica cultivars' susceptibility to the rice water weevil *Lissorhoptrus oryzophilus* (Coleoptera: Curculionoidea: Brachyceridae). - J. Appl. Entomol. 137 (5): 355-364.
LUPI D., ROCCO A., ROSSARO B., 2013a - Benthic macroinvertebrates in Italian rice fields. - J. Limnol. 72 (1): 184-200.
MAISTRELLO L., DIOLI P., BARISELLI M., 2013 - Trovata una cimice esotica (*Halyomorpha halys*), dannosa per i frutteti. - Agricoltura 40 (6): 67-68
MAISTRELLO L., DIOLI P., VACCARI G., NANNINI R., BORTOLOTTI P., CARUSO S., COSTI E., MONTERMINI A., CASOLI L., BARISELLI M., 2014 - First records in Italy of the Asian stinkbug *Halyomorpha halys,* a new threat for fruit crops. - Atti Gte. Fitopatol. 2014 (1): 283-288.
MALUMPHY C., 2014. Second interception of *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae) in Britain. - Het News, *3rd series*, 21: 4-5.
MITYUSHEV I.M., 2016 - First record of marmorated bug detection in Russia. - Zashchita Karantin Rasteniĭ 3: 48 (in Russian).
MOCHIDA O., 1988 - Nonseedborne rice pests of quarantine importance. - Rice Seed Health: 117-129.
NARESH J. S., SMITH C. M., 1984 - Feeding preference of the rice stink bug on annual grasses and sedges. - Ent. Exp. Appl. 35 (1): 89-92.
NORTHEASTERN IPM CENTER, 2014. Where is BMSB? Available from: http://www.stopbmsb.org/where-is-bmsb/ [Accessed November 2016].
PANIZZI A.R., MCPHERSON J.E., JAMES D.G., JAVAHERY M., MCPHERSON R.M., 2000 - Chapter 13 Stink Bugs (*Pentatomidae*). In: Schaefer C.W., Panizzi A.R. (Eds.). Heteroptera of economic importance. - CRC, Boca Raton, FL: 421-474
PANSA M.G., TAVELLA L., ASTEGGIANO L., VITTONE G., COSTAMAGNA C. 2013 - Primo ritrovamento di *Halyomorpha halys* nei pescheti piemontesi. - Inftore Agr. 69 (37): 60-61.
PANTOJA A., DAZA E., DUQUE M. C., 1993 - Effect of *Oebalus ornatus* (Sailer) and *Oebalus insularis* Stal (Hemiptera: Pentatomidae) on rice: comparison between species. - Manejo Integrado de Plagas, 26: 31-33.
PATEL D.T., STOUT M.J., FUXA J.R., 2006 - Effects of rice pan-

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icle age on quantitative and qualitative injury by the rice stink bug (Hemiptera: Pentatomidae). - Fla Entomol. 89 (3): 321-327.

PATHAK M.D., KHAN Z.R., 1994 - Insect pests of rice. - Int. Rice Res. Inst., Manila Philippines: 89pp.

STEVENS M.M., McDONALD F.J.D., WARREN G.N., MO J., 2008 - Pentatomidae (Hemiptera) associated with rice crops in southeastern Australia. - Gen. Appl. Entomol. 37:1-5.

SÜSS L., LUPI D., SAVOLDELLI S., 2008 - Parassiti animali. In: Il riso. Coordinamento scientifico di A. Ferrero. Collana Coltura & Cultura, ideata e coordinata da R. Angelini, Bayer CropScience. Ed. Script, Bologna: 332-353.

TAKEUCHI H., WATANABE T., SUZUKI Y., 2004 - Species-specific feeding marks of stink bugs on rice grain in *Leptocorisa chinensis* Dallas (Hemiptera: Alydidae), *Lagynotomus elongatus* (Dallas)(Hemiptera: Pentatomidae) and *Cletus punctiger* (Dallas) (Hemiptera: Coreidae). - Jpn J. Appl. Entomol. Zool. 48: 39-47 [in Japanese].

USDA-NIFA SCRI, 2013 - Stop BMSB. Biology, ecology, and management of brown marmorated stink bug in specialty crop. Available from: http://www.stopbmsb.org. [Accessed 26 January 2017].

VIATOR H.P., PANTOJA A., SMITH C.M., 1983 - Damage to wheat seed quality and yield by the rice stink bug and southern green stink bug (Hemiptera: Pentatomidae). - J. Econ. Entomol. 76 (6): 1410-1413.

VOGHERA NEWS, 2016 - Città invasa dalle cimici. Available from: http://www.vogheranews.it/wp/2016/10/voghera-20102016-citta-invasa-dalle-cimici-ecco-che-cosa-sono-da-dove-arrivano-che-danni-fanno/ [Accessed 24.02.2017]

WERMELINGER B., WYNIGER D., FORSTER B., 2008 - First records of an invasive bug in Europe: *Halyomorpha halys* Stål (Heteroptera: Pentatomidae), a new pest on woody ornamentals and fruit trees? - Mitt. Schweiz. Entomol. Ges. 81: 1-8.

XU J., FONSECA D.M., HAMILTON G.C., HOELMER K.A., NIELSEN A.L., 2014 - Tracing the origin of US brown marmorated stink bugs, *Halyomorpha halys*. - Biol. Invasions 16 (1): 153-166.

ZHU G., BU W., GAO Y., LIU G., 2012 - Potential geographic distribution of brown marmorated stink bug invasion (*Halyomorpha halys*). - PLoS One 7 (2): e31246.

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