Caspian Journal of Environmental Sciences
Online ISSN: 1735-3866
Print ISSN: 1735-3033

Parasitoids of the genus *Trissolcus* as biological control agents of the brown marmorated stink bug (*Halyomorpha halys* Stål) in Kazakhstan

G. Zh. Mengdibayeva[1], N. S. Mukhamadiyev[1], K. Anuarbekov[2]*, N. D. Kurmangaliyeva[1], Y. Dauletkeldi[1], N. T. Kenges[1], A. Seitzhan [1], A.E. Koigeldina[1], G.B. Sarsenbayeva[1]

1. LLP "Kazakh Research Institute of Plant Protection and Quarantine named after Zh. Zhiembayev", Almaty, Kazakhstan
2. Kazakh National Agrarian Research University, Almaty, Kazakhstan

* *Corresponding author's Email: alshyn-kanat@list.ru*

ABSTRACT

The brown marmorated stink bug, *Halyomorpha halys* Stål is a quarantine invasive pest capable of causing significant economic losses in agricultural and forest ecosystems. In Kazakhstan, this species was first recorded in 2016 on agricultural and forest plantations, prompting comprehensive monitoring of its distribution and the assessment of its potential threat to fruit, vegetable, ornamental, and forest plants. During 2024-2025, surveys in the southern and southeastern regions of Kazakhstan, including Almaty City, Almaty, Turkestan, and Kyzylorda regions, investigated *Trissolcus* parasitoids as potential biological control agents of *H. halys* for the first time. The primary objectives were to identify the species composition of egg parasitoids, evaluate their biological effectiveness, and assess their suitability for using *H. halys* as a host. Field studies employed pheromone traps, manual collection, and visual plant inspections. Laboratory experiments examined the parasitoids' life cycle, the duration of preimaginal development, parasitism rates of egg masses, and adult emergence. Morphological identification was corroborated using molecular genetic methods with COI and ITS marker genes. Two parasitoid species were detected – *Trissolcus japonicus* and *T. semistriatus* – demonstrating high parasitism rates (86.3-89.6%) and successful adult emergence (> 92%). The highest densities of *H. halys* were recorded on apple (*Malus domestica*), paulownia (*Paulownia* spp.), and northern catalpa (*Catalpa bignonioides*), indicating stable population reproduction in the region. The duration of preimaginal development and the average adult lifespan of the parasitoids confirm their suitability for mass rearing under laboratory conditions. These results highlight the strong potential of *Trissolcus* spp. as biological control agents of *H. halys* in agricultural and forest ecosystems in Kazakhstan, and underscore the importance of molecular identification in studying beneficial insect biodiversity.

Keywords: *Halyomorpha halys*, *Trissolcus japonicus*, *Trissolcus semistriatus*, Biological control, Egg parasitoids, Invasive and quarantine pests, Agricultural and forest ecosystems.
Article type: Research Article.

INTRODUCTION

Invasive insect species pose a serious threat to agroecosystems and biodiversity, causing substantial economic losses and disrupting ecosystem stability. One of the most destructive invasive pests in Eurasia is the brown marmorated stink bug, *Halyomorpha halys* Stål 1855, a species native to East Asia. Over recent decades, *H. halys* has rapidly expanded its range across numerous countries in Europe, the Americas, and Central Asia, including Kazakhstan, where it represents a significant threat to fruit and vegetable crops (Temreshev *et al.* 2018; Afonin & Musolin 2024). The native range of *H. halys* includes several East Asian countries, namely China, Japan, North and South Korea, Taiwan, and Vietnam (Zhu *et al.* 2016). The species was first detected in the United States in

Caspian Journal of Environmental Sciences, Vol. 24 No. 1 pp.187-194 Received: April 25, 2025 Revised: July 11, 2025 Accepted: Sep. 14, 2025
DOI: 10.22124/cjes.2026.9490

Publisher: University of Guilan,

1996, where it began to spread aggressively. By 2015, it had been recorded in 41 states (Hoebeke & Carter 2003; Kistner 2017; Leskey & Nielsen 2018). In 2010, *H. halys* was also reported from Canada (Gariepy *et al.* 2014, Pelletier *et al.* 2025). In Europe, the pest was first identified in 2004 in Switzerland and Liechtenstein (De Michele & Grozea 2018, Šapina & Jelaska 2018). Subsequently, starting from 2011, it was detected in Germany (Hess *et al.* 2022), Greece (Andreadis *et al.* 2021), France (Chartois *et al.* 2021), Italy (Maistrello *et al.* 2017; Papa *et al.* 2023), Hungary (Wahengbam *et al.* 2025), Romania (Ciceoi *et al.* 2017), Abkhazia (Gapon 2016; Szanyi *et al.* 2022), and Georgia (Kharabadze 2022). In 2016, the species was officially recorded in Kazakhstan (Vétek *et al.* 2014). Additionally, individual specimens were intercepted in passenger luggage in the United Kingdom and New Zealand in 2010, highlighting the high invasion potential of this pest through international transport pathways (Fraser *et al.* 2017; Vandervoet *et al.* 2019). One of the most promising and widely studied control strategies against *H. halys* is the use of egg parasitoids, generally considered a better alternative to predators since they can kill the host before hatching, preventing early damages to the plants (Gariepy *et al.* 2019; Falagiarda *et al.* 2023). Several monitoring programs of egg masses parasitism by resident and exotic egg parasitoids have been conducted in the invaded areas (Moraglio *et al.* 2020; Sabbatini-Peverieri *et al.* 2020; Ogburn *et al.* 2021). Overall, exotic egg parasitoids like *Trissolcus japonicus* (Ashmead; Hymenoptera: Scelionidae) and *T. mitsukurii* are deemed the best candidates for classical biological control programs against *H. halys* (Peverieri *et al.* 2018; Zapponi *et al.* 2020; Scala *et al.* 2022), and *T. japonicus* augmentative biocontrol programs have been conducted in some countries (Moraglio *et al.* 2020; Bittau *et al.* 2021; Goode *et al.* 2022). Current management of *H. halys* (brown marmorated stink bug) primarily depends on repeated insecticide applications, mainly because effective alternative approaches, such as biological control, have not yet been adequately developed (Rice *et al.* 2014). Native natural enemies exert only minimal pressure on *H. halys* populations; egg parasitoids typically parasitize fewer than 5% of egg masses (Abram *et al.* 2017; Dieckhoff *et al.* 2017). Since 2007, two parasitoid species known to attack *H. halys* in its native range have been evaluated as candidates for classical biological control programs. One of these, *T. japonicus*, has undergone host-specificity testing. Research indicates that this parasitoid can successfully develop on at least seven native stink bug species in Oregon (Hedstrom *et al.* 2017) and fifteen native species in Michigan (Botch & Delfosse 2018), which is likely to prevent regulatory approval for its intentional release in open fields. Despite these concerns, *T. japonicus* has already established self-sustaining populations in the United States, most probably introduced accidentally via parasitized *H. halys* egg masses (Talamas *et al.* 2015). As part of a broader classical biological control initiative targeting *H. halys*, foreign exploration efforts in Asia began in 2007. Four egg parasitoid species belonging to the genus *Trissolcus* have been identified as promising agents and are currently being assessed for potential release against *H. halys* in the U.S. (Talamas *et al.* 2013). Among these candidates, *T. japonicus* stands out due to several favorable biological traits: a short generation time (10.5 days at 25 °C), the ability to produce multiple generations annually, a strongly female-biased sex ratio, and parasitism rates ranging from 50% to 80% on *H. halys* in its native Asian range (Yang *et al.* 2009). Another species, *T. cultratus* (Mayr), is also under consideration; however, its parasitism rates on *H. halys* are generally lower compared to those of *T. japonicus* (Haye *et al.* 2015).

MATERIALS AND METHODS

Study area

During 2024-2025, monitoring was conducted in the southern and southeastern regions of Kazakhstan, including Almaty City, and also Almaty, Zhambyl, Turkestan, and Kyzylorda regions. Entomological material was collected using standard methods, including pheromone traps, manual collection, and visual inspection of host plants. Captured insects were euthanized in ethyl acetate killing jars and preserved on cotton pads. In Almaty City and Almaty Region, the brown marmorated stink bug, *Halyomorpha halys* Stål was widely distributed at all developmental stages, from eggs to adults. Laboratory observations of *H. halys* development were conducted at 25-28.5 °C, 60-70% relative humidity, and a photoperiod of 16:8 h (light: dark). Carrot, zucchini, apple, and sweet pepper were used as a food source. To study the life cycle, individual pairs (one female and one male) were maintained in Petri dishes with a moistened cotton pad. Egg masses of *H. halys* were collected from various habitats – including grain, legume, forage, vegetable, fruit, ornamental, and forest plants – to assess natural parasitism levels. Collected egg masses were incubated in the laboratory to observe parasitoid emergence. Parasitism was confirmed by egg darkening and subsequent emergence of adult parasitoids. Parasitoids were maintained in glass vials at a female-to-male ratio of 1:1, at 24-27 °C, 70% relative humidity, and a 17-hour photoperiod. Adults were fed with a drop of honey, and *H. halys* eggs were replaced every two days. Laboratory

studies were conducted at the Kazakh Research Institute of Plant Protection named after Zh. Zhiembayev. In 2025, *H. halys* egg masses were collected in Almaty, Turkestan, and Kyzylorda regions. Parasitoids of the genus *Trissolcus* were isolated from these egg masses. Initial identification was based on morphological characters. Genomic DNA was extracted using the DNeasy Blood & Tissue Kit (Qiagen, Germany) according to the manufacturer's protocol. PCR amplification and sequencing were performed using COI and ITS marker genes with universal primers LCO1490/HCO2198 and ITS1/ITS2. PCR products were analyzed by electrophoresis on 1% agarose gels. Sanger sequencing was performed using an ABI 3500xL analyzer. Obtained sequences were compared to the GenBank database using the BLASTN algorithm. Species-specific primers Hhal1dF/Hhal1dR2 were used to detect *H. halys* DNA within parasitoid bodies. All reactions included appropriate positive and negative controls.

RESULT

During 2024-2025, comprehensive monitoring of the brown marmorated stink bug, *Halyomorpha halys* was conducted across southern and southeastern Kazakhstan in agricultural and forest ecosystems. Surveys confirmed that this invasive species is widely established in Almaty City, as well as Almaty, Turkestan, and Kyzylorda egions, occurring on cultivated, ornamental, and forest plants. The highest densities of adults and preimaginal stages of *H. halys* were recorded on northern catalpa, *Catalpa bignonioides*, apple, *Malus domestica*, and paulownia, *Paulownia* spp. On these plants, eggs, nymphs of various instars, and adults were simultaneously present, indicating stable population reproduction in the region. Results of the monitoring of *H. halys* infestation are presented in Table 1. During field surveys and egg mass assessments, it was found that egg density varied depending on the host plant species and local environmental conditions. A total of 135 *H. halys* eggs were collected from paulownia, 110 eggs from northern catalpa, and 72 eggs from apple. Some egg masses exhibited darkening of the chorion, indicating parasitoid infection. In laboratory conditions, parasitoid wasps of the genus *Trissolcus* emerged from the collected egg masses. In Almaty Region, two species were identified: *Trissolcus japonicus* and *T. semistriatus*, while in Turkestan and Kyzylorda Regions, only *T. semistriatus* was detected. Quantitative data on parasitism rates are summarized in Tables 2 and 3.

Table 1. Results of monitoring the infestation of brown marmorated stink bug on fruit, berry, and forest plants, 2024-2025.

Study site	Crop	Stink bug occurrence
Almaty Region, Talgar District, Tuzdybastau Village, S. Ashimbayev Street	Northern catalpa *(Catalpa bignonioides)*	+++
Almaty city, Medeu District, Abay Street	Apple (*Malus*)	+++
Almaty City, Bostandyk District, Al-Farabi Avenue, First President's Park	Apple (*Malus*) Paulownia (*Paulownia*) Sour cherry (*Prúnus subg. Cérasus*) Linden *(Tília)* Northern catalpa *(Catalpa bignonioides)*	+++
Almaty city, Nauryzbay District, Kultobe 1 Street	Paulownia (*Paulownia*) Apple (*Malus*) Elm *(Ulmus)* Poplar (*Pópulus)*	+++
Almaty city, Bostandyk District, Almerek Street, "Okzhetpes" Sanatorium	Northern catalpa *(Catalpa bignonioides)* Apricot (*Prunus armeniaca)* Apple (*Malus*) Chestnut (*Castanea)*	+++

Note: (+) - rare occurrence; (++) - moderate occurrence; (+++) - frequent occurrence.

Analysis of the data showed a high level of egg parasitism under laboratory conditions: 86.3% for *T. semistriatus* and 89.6% for *T. japonicus*. Parasitism was confirmed by characteristic egg color changes and subsequent emergence of adult parasitoids. The overall emergence of adults from egg masses exceeded 92% for both species (Table 4), indicating a high adaptability of these parasitoids to using *H. halys* as a host. Laboratory studies on parasitoid biology showed that the entire preimaginal development of *Trissolcus* occurs inside the host egg. Developmental duration depended on temperature and sex. At 27 °C, male *T. semistriatus* completed development in an average of 11 days, whereas females required 13 days; at 24 °C, development lasted 10 and 12 days,

respectively. In the case of *T. japonicus*, preimaginal development lasted 10-13 days at 27 °C and 9-12 days at 24 °C (Table 4).

Fig. 1. Parasitoids infecting stink bug eggs.

Table 2. Natural enemies of brown marmorated stink bug in Almaty City and Almaty Region, 2025.

Crop	Number of eggs collected (pcs.)	Number of parasitoids emerged (pcs.)		
		in field	in laboratories	mummified
Paulownia	26	1	24	1
	28	0	23	2
	29	0	29	0
	26	1	24	0
	26	2	10	13
Northern catalpa (*Catalpa bignonioides*)	28	0	25	3
	26	1	24	0
	28	3	25	0
	28	1	27	0
Apple (*Malus*)	26	1	16	8
	24	2	15	7
	22	0	22	0

Table 3. Egg parasitism in laboratory conditions.

Parasitoid species	Number of eggs (pcs.)	Parasitized (pcs.)	Parasitism rate (%)
Trissolcus semistriatus	204	176	86.3
Trissolcus japonicus	145	130	89.6

Table 4. Number of adult parasitoids emerging from *Halyomorpha halys* egg masses.

Parasitoid species	Number of egg masses	Total adults emerged	Rate (%) of normal emergence (nymphs)
T. semistriatus	28	26	92.8
T. japonicus	25	23	92.0

Table 5. Longevity of entomophagous parasitoids under laboratory conditions.

Parasitoid species	Temperature (°C)	Preimaginal development (days)		Adult longevity (days)
		male	female	
Trissolcus semistriatus	24	10	12	12,6
	27	11	13	14,5
Trissolcus japonicus	27	10	13	14,3
	24	9	12	13,2

Fig. 2. Parasitized egg masses of *Trissolcus semistriatus* on brown marmorated stink bug.

Fig. 3. Laboratory rearing conditions of natural *Trissolcus semistriatus.*

Adult longevity at the optimal temperature of 27 °C reached 14.5 days in *T. semistriatus* and 14.3 days in *T. japonicus*. When temperature decreased to 24 °C, mean longevity declined to 12.6 and 13.2 days, respectively. These results indicate favorable conditions for laboratory rearing and the potential for mass production of these parasitoid species. Molecular genetic analysis confirmed the results of morphological identification. Sequencing of the COI and ITS marker genes showed 100% identity of specimens from Almaty Region with *Trissolcus japonicus*. Specimens from Turkestan and Kyzylorda regions fully matched *T. semistriatus* based on the ITS marker, whereas COI similarity was lower, highlighting the diagnostic value of using multiple molecular markers for accurate parasitoid identification. Additional PCR assays using species-specific primers targeting mitochondrial DNA of *H. halys* yielded amplification only in positive control samples of the host insect. The absence of amplification in *Trissolcus* samples may be associated with degradation of host DNA at later parasitoid developmental stages or with its low residual concentration. Overall, the obtained results demonstrate that natural

populations of *Trissolcus japonicus* and *Trissolcus semistriatus* detected in southern and southeastern Kazakhstan possess a high potential as biological control agents against the brown marmorated stink bug.

CONCLUSION

Monitoring and investigation of the brown marmorated stink bug, *Halyomorpha halys* in Kazakhstan began after its first detection in 2016 on agricultural and forest plants in the southern and southeastern regions of the country. Survey data revealed extensive spread of the pest and its active infestation of fruit, vegetable, ornamental, and forest plantations. Since 2024, systematic studies of *Trissolcus* parasitoids (*T. japonicus* and *T. semistriatus*) as potential biological control agents of *H. halys* have been conducted in Kazakhstan for the first time. Laboratory and field experiments demonstrated high egg parasitism rates (86-90%) and successful adult emergence (> 92%), confirming the high effectiveness of these entomophages in regulating stink bug populations. The duration of the life cycle and adult survivorship provide favorable conditions for mass rearing and implementation of *Trissolcus* in agroecosystems and forest plantations. Thus, for the first time in southern and southeastern Kazakhstan, the presence of highly effective parasitoids capable of controlling the quarantine pest *H. halys* in agricultural and forest crops has been confirmed. The obtained data substantiate the promising potential of *Trissolcus* spp. for use in sustainable and environmentally safe plant protection programs and emphasize the need for continued monitoring and comprehensive studies of beneficial insect biodiversity in the country.

ACKNOWLEDGEMENTS

This research was conducted within the framework of the grant project AP22788572 “Development of entomophage breeding methods and application in biological defence against the brown marmorated stink bug (*Halyomorpha halys*)”, funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan for the period 2024-2026.

REFERENCES

Abram, PK, Hoelmer, KA, Acebes-Doria, A, Andrews, H, Beers, EH, Bergh, JC, Bessin, R, Biddinger, D, Botch, P & Buffington, ML 2017, Indigenous arthropod natural enemies of the invasive brown marmorated stink bug in North America and Europe. *Journal of Pest Science,* 90: 1009–1020.

Afonin, A & Musolin, D 2024, The potential of distribution of the brown marmorated stink bug *Halyomorpha halys* (Heteroptera: Pentatomidae) in Europe determined on the basis of the comparative analysis of the ecogeographical borders of its range. *Russian Journal of Biological Invasions,* 15:11–25.

Andreadis, SS, Gogolashvili, NE, Fifis, GT, Navrozidis, EI & Thomidis, T 2021, First report of native parasitoids of *Halyomorpha halys* (Hemiptera: Pentatomidae) in Greece. *Insects,* 12: 984.

Bittau, B, Dindo, ML, Burgio, G, Sabbatini-Peverieri, G, Hoelmer, KA, Roversi, PF & Masetti, A 2021, Implementing mass rearing of *Trissolcus japonicus* (Hymenoptera: Scelionidae) on cold-stored host eggs. *Insects,* 12: 840.

Botch, PS & Delfosse, ES 2018, Host-acceptance behavior of *Trissolcus japonicus* (Hymenoptera: Scelionidae) reared on the invasive *Halyomorpha halys* (Heteroptera: Pentatomidae) and nontarget species. *Environmental Entomology,* 47: 403–411.

Chartois, M, Streito, JC, Pierre, É, Armand, JM, Gaudin, J & Rossi, JP 2021, A crowdsourcing approach to track the expansion of the brown marmorated stinkbug *Halyomorpha halys* (Stål, 1855) in France. *Biodiversity Data Journal,* 9: e66335.

Ciceoi, R, Bolocan, I & Dobrin, I 2017, The spread of brown marmorated stink bug, *Halyomorpha halys*, in Romania.

De Michele, A & Grozea, I 2018, Review of the spreading of *Halyomorpha halys* in Italy and confirmation of presence in Romania. *Research Journal of Agricultural Science,* 50.

Dieckhoff, C, Tatman, KM & Hoelmer, KA 2017, Natural biological control of *Halyomorpha halys* by native egg parasitoids: a multi-year survey in northern Delaware. *Journal of Pest Science,* 90: 1143–1158.

Falagiarda, M, Carnio, V, Chiesa, SG, Pignalosa, A, Anfora, G, Angeli, G, Ioriatti, C, Mazzoni, V, Schmidt, S & Zapponi, L 2023, Factors influencing short-term parasitoid establishment and efficacy for the biological control of *Halyomorpha halys* with the samurai wasp *Trissolcus japonicus*. *Pest Management Science,* 79: 2397–2414.

Fraser, D, Kumar, S & Aguilar, G 2017, Mapping the potential global range of the brown marmorated stink bug, *Halyomorpha halys*, with particular reference to New Zealand. *Climate*, 5: 75.

Gapon, D 2016, First records of the brown marmorated stink bug *Halyomorpha halys* (Stål, 1855)(Heteroptera, Pentatomidae) in Russia, Abkhazia, and Georgia. *Entomological Review*, 96: 1086–1088.

Gariepy, T, Haye, T, Fraser, H & Zhang, J 2014, Occurrence, genetic diversity, and potential pathways of entry of *Halyomorpha halys* in newly invaded areas of Canada and Switzerland. *Journal of Pest Science*, 87: 17–28.

Gariepy, TD, Bruin, A, Konopka, J, Scott-Dupree, C, Fraser, H, Bon, MC & Talamas, E 2019, A modified DNA barcode approach to define trophic interactions between native and exotic pentatomids and their parasitoids. *Molecular Ecology*, 28: 456–470.

Goode, AB, Tipping, PW, Gettys, LA, Knowles, BK, Pokorny, E & Salinas, LS 2022, Integrating herbicide rates, coverage, and classical biological control insects (*Megamelus scutellaris*, *Neochetina eichhorniae*, and *Neochetina bruchi*) to manage *Pontederia* (*Eichhornia*) *crassipes*. *Biological Control*, 170: 104930.

Haye, T, Fischer, S, Zhang, J & Gariepy, T 2015, Can native egg parasitoids adopt the invasive brown marmorated stink bug, *Halyomorpha halys* (Heteroptera: Pentatomidae), in Europe? *Journal of Pest Science*, 88: 693–705.

Hedstrom, C, Lowenstein, D, Andrews, H, Bai, B & Wiman, N 2017, Pentatomid host suitability and the discovery of introduced populations of *Trissolcus japonicus* in Oregon. *Journal of Pest Science*, 90**:**1169–1179.

Hess, B, Zimmermann, O, Baufeld, P, Reißig, A, Lutsch, B & Schrader, G 2022, Current distribution and spatial spread patterns of Halyomorpha halys in Germany. *EPPO Bulletin*, 52**:**164–174.

Hoebeke, ER & Carter, ME 2003, *Halyomorpha halys* (Stål)(Heteroptera: Pentatomidae): a polyphagous plant pest from Asia newly detected in North America.

Kharabadze, N 2022, Review of the *Halyomorpha halys* (Stal, 1855)(Hemiptera: Heteroptera: Pentatomidae) in Georgia: Distribution, biology and management. *The Journal of Nature Studies-Annals of Agrarian Science*, 20.

Kistner, EJ 2017, Climate change impacts on the potential distribution and abundance of the brown marmorated stink bug (Hemiptera: Pentatomidae) with special reference to North America and Europe. *Environmental Entomology*, 46: 1212–1224.

Leskey, TC & Nielsen, AL 2018, Impact of the invasive brown marmorated stink bug in North America and Europe: history, biology, ecology, and management. *Annual Review of Entomology*, 63**:**599–618.

Maistrello, L, Vaccari, G, Caruso, S, Costi, E, Bortolini, S, Macavei, L, Foca, G, Ulrici, A, Bortolotti, PP & Nannini, R. 2017, Monitoring of the invasive *Halyomorpha halys*, a new key pest of fruit orchards in northern Italy. *Journal of Pest Science*, 90: 1231–1244.

Moraglio, ST, Tortorici, F, Pansa, MG, Castelli, G, Pontini, M, Scovero, S, Visentin, S & Tavella, L 2020, A 3-year survey on parasitism of *Halyomorpha halys* by egg parasitoids in northern Italy. *Journal of Pest Science*, 93: 183–194.

Ogburn, EC, Heintz-Botz, AS, Talamas, EJ & Walgenbach, JF 2021, Biological control of *Halymorpha halys* (Stål)(Hemiptera: Pentatomidae) in apple orchards versus corn fields and their adjacent woody habitats: High versus low pesticide-input agroecosystems. *Biological Control*, 152: 104457.

Papa, G, Abba, S, Galetto, L, Parise, C, Marzachì, C & Negri, I 2023, Distribution and prevalence of viral genomes in Italian populations of the invasive brown marmorated stink bug *Halyomorpha halys*. *Journal of Invertebrate Pathology*, 200: 107977.

Pelletier, F, Pouchet, C, Larose, M, Avosani, S & Chouinard, G 2025, Seasonal abundance, species composition, fruit damage, and attracticidal control of stink bugs (Hemiptera: Pentatomidae) in apple orchards in Québec, Canada. *Journal of Economic Entomology*, toaf358.

Peverieri, GS, Talamas, E, Bon, MC, Marianelli, L, Bernardinelli, I, Malossini, G, Benvenuto, L, Roversi, PF & Hoelmer, K 2018, Two asian egg parasitoids of *Halyomorpha halys* (Stål)(Hemiptera, Pentatomidae) emerge in northern italy: *Trissolcus mitsukurii* (Ashmead) and *Trissolcus japonicus* (Ashmead)(Hymenoptera, Scelionidae). *Journal of Hymenoptera Research*, 67**:**37–53.

Rice, KB, Bergh, CJ, Bergmann, EJ, Biddinger, DJ, Dieckhoff, C, Dively, G, Fraser, H, Gariepy, T, Hamilton, G & Haye, T 2014, Biology, ecology, and management of brown marmorated stink bug (Hemiptera: Pentatomidae). *Journal of Integrated Pest Management*, 5: A1–A13.

Sabbatini-Peverieri, G, Dieckhoff, C, Giovannini, L, Marianelli, L, Roversi, PF & Hoelmer, K 2020, Rearing *Trissolcus japonicus* and *Trissolcus mitsukurii* for biological control of *Halyomorpha halys*. *Insects,* 11.

Šapina, I & Jelaska, LŠ 2018, First report of invasive brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) in Croatia. *EPPO Bulletin,* 48: 138–143.

Scala, M, Fouani, JM, Zapponi, L, Mazzoni, V, Wells, KE, Biondi, A, Baser, N, Verrastro, V & Anfora, G 2022, Attraction of Egg Parasitoids *Trissolcus mitsukurii* and *Trissolcus japonicus* to the chemical cues of Halyomorpha halys and Nezara viridula. *Insects,* 13 p.

Szanyi, S, Ősz, A, Szanyi, K, Potish, L & Nagy, A 2022, distribution of brown marmorated stink bug (*Halyomorpha halys* (Stål, 1855); Hemiptera: Pentatomidae) in the northeast part of the Carpathian Lowland (West Ukraine).

Talamas, EJ, Buffington, ML & Hoelmer, K 2013, New synonymy of *Trissolcus halyomorphae* Yang. *Journal of Hymenoptera Research,* 33: 113–117.

Talamas, EJ, Johnson, NF & Buffington, M 2015, Key to Nearctic species of Trissolcus Ashmead (Hymenoptera, Scelionidae), natural enemies of native and invasive stink bugs (Hemiptera, Pentatomidae). *Journal of Hymenoptera Research,* 43: 45–110.

Temreshev, I, Esenbekova, P & Uspanov, A 2018, New Records of a dangerus invasive pests-Brown marmorated stink bug *Halyomorpha halys* Stal, 1855 (Heteroptera, Pentatomidae) in Kazakhstan. *Acta Biologica Sibirica,* 4: 94–101.

Vandervoet, TF, Bellamy, DE, Anderson, D & Maclellan, R 2019, Trapping for early detection of the brown marmorated stink bug, Halyomorpha halys, in New Zealand. *New Zealand Plant Protection,* 72: 36–43.

Vétek, G, Papp, V, Haltrich, A & Rédei, D 2014, First record of the brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Heteroptera: Pentatomidae), in Hungary, with description of the genitalia of both sexes. *Zootaxa,* 3780: 194–200.

Wahengbam, J, Király, KD, Radácsi, P, Fail, J, Vétek, G, Tortorici, F & Hári, K 2025, First records of egg parasitoids of *Halyomorpha halys* (Stål, 1855)(Hemiptera, Pentatomidae) in Hungary. *NeoBiota,* 103: 215–230.

Yang, ZQ, Yao, YX, Qiu, LF & Li, ZX 2009, A new species of *Trissolcus* (Hymenoptera: Scelionidae) parasitizing eggs of *Halyomorpha halys* (Heteroptera: Pentatomidae) in China with comments on its biology. *Annals of the Entomological Society of America,* 102:39–47.

Zapponi, L, Bon, MC, Fouani, JM, Anfora, G, Schmidt, S & Falagiarda, M 2020, Assemblage of the Egg Parasitoids of the Invasive Stink Bug *Halyomorpha halys*: Insights on plant host associations. *Insects,* 11.

Zhu, GP, Ye, Z, Du, J, Zhang, DL, Zhen, YH, Zheng, CG, Zhao, L, Li, M & Bu, WJ 2016, Range wide molecular data and niche modeling revealed the Pleistocene history of a global invader (*Halyomorpha halys*). *Scientific Reports,* 6: 23192.

Bibliographic information of this paper for citing:

Mengdibayeva, GZ, Mukhamadiyev, NS, Anuarbekov, K, Kurmangaliyeva, ND, Dauletkeldi, Y, Kenges, NT, Seitzhan, A, Koigeldina, AE, Sarsenbayeva, GB 2026, Parasitoids of the genus *Trissolcus* as biological control agents of the brown marmorated stink bug (*Halyomorpha halys* Stål) in Kazakhstan. Caspian Journal of Environmental Sciences, 24: 187-194.