The Brown Marmorated Stink Bug (Hemiptera: Pentatomidae)—A Major Challenge for Global Plant Production

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Review

The Brown Marmorated Stink Bug (Hemiptera: Pentatomidae)—A Major Challenge for Global Plant Production

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Abstract: The brown marmorated stink bug *Halyomorpha halys* (Stål, 1855), native to East Asia, is an extremely polyphagous pest that infests more than 300 plant species from 49 families. In Europe and North America, this pest causes enormous damage to the production of economically important crops (tree fruit, vegetables, field crops, and ornamental plants). Global warming favours its spread, as the rise in temperature results in the appearance of further generations of the pest. *Halyomorpha halys* (nymph and adult) causes damage typical of the Pentatomidae family by attacking host plants throughout their development (buds, stems, fruits, and pods). Ripe fruits are often disfigured, and later suberification and necrotic spots form on the fruit surface, making them accessible to plant pathogens that cause fruit rot and rendering them unmarketable. The increasing global importance of the pest suggests that more coordinated measures are needed to contain its spread. Understanding the biology and ecology of this species is crucial for the development of reliable monitoring and management strategies. Most insecticides available for the control of *H. halys* have a broad spectrum of modes of action and are not compatible with most integrated pest management systems, so biological control by natural enemies has recently been emphasised. Preventing excessive population growth requires early identification and effective control measures that can be developed quickly and applied rapidly while respecting the environment. This paper presents a comprehensive review of the latest findings on the global distribution of this important pest, its potential spread, biology and ecology, key host plants of economic importance, monitoring methods, and effective biological control strategies, as well as future perspectives for sustainable *H. halys* control measures.

Keywords: *Halyomorpha halys* (Stål, 1855); worldwide distribution; potential spread; biology; ecology; host plants and damage; monitoring methods; management

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1. Introduction

1.1. Invasiveness and Distribution

The brown marmorated stink bug, *Halyomorpha halys* (Stål, 1855), is an invasive species of East Asian origin [1] that has become the major threat to European and North American crop production in the last two decades since its arrival on new continents [2,3]. It infests more than 300 wild and cultivated host plants; prefers economically important tree fruits, vegetables, field crops, and ornamentals [4–6]; and causes millions of dollars of damage to fruit and horticultural crops [2,3,7]. It is an extremely polyphagous pest with a high reproductive potential and a strong dispersal ability that allows it to successfully colonise new areas [2]. It spreads rapidly in new areas due to human activities and the movement of goods, which is why it is expected to continue spreading in all climatically favourable areas with latitudes between 30° and 50° [8,9].

1.2. Biology and Morphology

The biology of pests is also strongly influenced by climatic changes. Global warming favours the spread of invasive species, as the rise in temperature enables and speeds up the development of additional generations of pests [10], which could contribute to further spread and increase the harmfulness of the species. The species belongs to the Pentatomidae family and undergoes an incomplete metamorphosis in which it passes through three developmental stages to become an adult. Males and females show a sex-specific size dimorphism. Due to the larger and stronger body structure and especially the wings, females are the more suitable sex for migratory flight and the rapid spread of the population into new areas [11]. It is a multivoltine species that develops 1–2 generations per year in invaded countries and overwinters as sexually immature adults in man-made structures and is known as a nuisance pest which produces strong human allergens [7,12,13]. Winter diapause is directly related to photoperiodism, a very important adaptation that ensures development and reproduction in accordance with favourable environmental conditions that change with the seasons [14]. The adults emerge from their hibernation sites in spring and the offspring appear in early summer on primary host plants, where they mainly feed [15].

1.3. Damages and Monitoring

They feed continuously throughout the growing season and cause damage typical of Pentatomidae that feed on plants [16]. Direct damage is manifested in the deformation of infested generative and vegetative plant organs, while indirect damage consists of the transmission of plant pathogens that cause plant tissue rot [1,12,16]. Early detection, knowledge of the pest's biology and ecology, as well as available monitoring methods, are the cornerstones of effective pest control measures that should be widely applicable [9,17]. The insect life cycle is usually tracked using pheromone traps, and predictive models based on abiotic factors (degree days and photoperiod) help determine key oviposition dates as well as the presence of insects in the environment [18]. More recently, decision support tools have been developed for effective pest control using pheromone technology [19].

1.4. Control Measures

The emergence of this invasive pest is leading to increased use of broad-spectrum insecticides, which often provide limited results due to the insects' ability to recover, with the development of resistance [20,21]. For effective and sustainable management of *H. halys*, it is essential to prioritize ecologically responsible methods such as biotechnical interventions (e.g., the use of attract-and-kill strategies) and biological control measures (e.g., the use of natural enemies) [5,22]. The use of these sustainable approaches not only emphasizes environmental protection but also ensures a harmonious balance in ecosystems and thus the effectiveness and longevity of pest control methods. This article provides an overview of the global distribution and potential spread, the biology and ecology of the pest, host plants and damage, as well as monitoring and control methods, all of which are very important to prevent the spread and reduce the damage caused by this extremely invasive and polyphagous species.

1.5. Research Activities on Halyomorpha halys and Topics Investigated

The literature search on Google Scholar was queried with the following keyword combinations: "brown marmorated stink bug", "*Halyomorpha halys* in Europe", etc. The search was limited to scientific articles or communications published in English and Croatian between 2000 and 2024. Our aim was to provide an overview of all worldwide research groups, a list of research topics, and a reference list of published articles. Our review of research activities included 180 relevant references covering five *H. halys* research areas from the last 24 years. All research areas are divided into subtopics that describe the focus of the research conducted. The main findings of each research area were listed. We have categorised the assessment of *H. halys* research areas into five main categories according to the type of primary interest, namely (1) origin, worldwide distribution and potential spread; (2) biology and ecology of the species; (3) host plants and damage; (4) monitoring methods; and (5) pest management.

From the collected references, we have first extracted those that deal specifically with "origin, worldwide distribution, and potential spread" in Europe and worldwide. We provide a comprehensive overview of the origin, global distribution, and potential spread of *H. halys*. The paragraph emphasises the widespread distribution and adaptability of *H. halys* and highlights the importance of monitoring and managing this invasive species to reduce its impact on agriculture and ecosystems.

International co-operation in the field of *H. halys* "biology and ecology of the species" over the last 24 years has focused on climate change and its impact on the expanding areas of *H. halys* invasion. We summarise what is known about the overwintering behaviour and life cycle of *H. halys*. In this part, we explain how *H. halys* goes into diapause in response to the shorter daylight in autumn and survives the winter in various shelters, including natural crevices and man-made structures. We have also discussed the behaviour and physiological changes of the pest during hibernation, its life cycle stages, the influence of temperature and photoperiod on its development, and the effects of environmental conditions on its reproductive patterns and generation cycles in different regions. The role of semi-natural habitats in supporting stink bug populations is also emphasised.

"Host plants and damage" of *H. halys* is the third research area and deals with the extensive host spectrum and the economic impact of the extremely polyphagous *H. halys*. It describes in detail the ability of the pest to feed on over 300 known host plants, including a variety of economically important crops such as field crops, ornamental plants, tree fruits, and vegetables. The feeding and reproductive behaviour of the pest is highlighted, as well as its ability to overwinter in ornamental plants and artificial structures. We list specific plants that support the full development of *H. halys* and emphasise the significant threat it poses to global agriculture by causing direct damage through its piercing–sucking feeding behaviour.

We summarise the findings from the different research areas and provide a comprehensive overview of current best practices and emerging technologies for *H. halys* "monitoring methods". The review aimed to understand the strengths and limitations of each method, from traditional traps and pheromone-based systems to innovative technologies such as drones and machine learning.

The important area of research was "pest control", a topic of interest to all *H. halys* researchers. Particular attention was paid to the challenges and strategies in the control of *H. halys*. Some studies point to the limitations of synthetic insecticides, including their short-term efficacy, degradation, and prohibition in the EU. This section emphasises the importance of integrated pest management systems that set decision thresholds for economically and environmentally sustainable pest control. It also emphasises the potential of biological control methods, in particular, the use of natural enemies, as a promising long-term solution for managing *H. halys* populations and mitigating their impact on agriculture.

2. Origin, Worldwide Distribution, and Potential Spread

2.1. Origin and Recent Spread in Asia

The species is native to East Asia, with China, Japan, Korea, and Taiwan being the countries of origin [1]. In this region, the pest is widespread [1,9] and has recently extended its range to Central Asia (Kazakhstan [23] and Uzbekistan [24]), Western Asia (Armenia [25]), and Northern Asia (Nepal) [26] (Figure 1).

2.2. North and South America

Halyomorpha halys was first discovered in North America in the mid-1990s in the United States in Pennsylvania, where it was probably accidentally introduced through international trade, e.g., through bulk freight containers from China, Japan, or Korea [1]. Since then, the species has spread rapidly and has now been officially reported in 48 US states and 4 Canadian provinces (British Columbia, Ontario, Quebec, and Alberta) [27–30]. In South America, *H. halys* has so far only been found in Chile [31] (Figure 1).

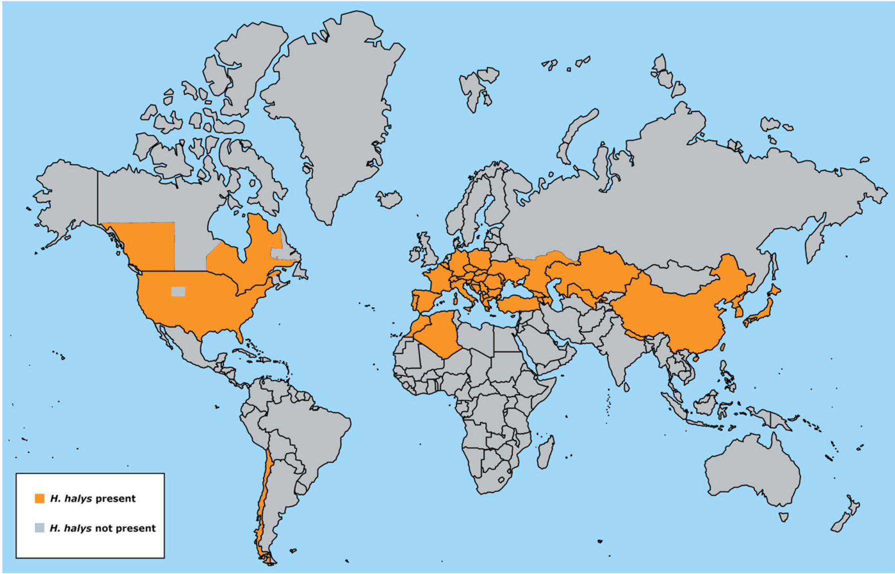

Figure 1. Global distribution of *Halyomorpha halys*.

2.3. Europe

The first records of *H. halys* in Europe date back to 2004 from Switzerland [32] and Liechtenstein [33]. In the following years, the natural spread of *H. halys* occurred over short distances, but through various sources such as aeroplanes, cargo, plant trade, and vehicles, the pest has continued to spread over long distances throughout Europe [34], and new detections have been reported regularly in European countries. Greece and Belgium were first in 2011 [35,36], and then Germany, France, and Italy in 2012 [37–39]. In 2013, the pest was detected in Hungary [40]. In 2014, the pest was detected in Romania [41] and Russia [42], and in 2015, it was detected in Abkhazia [43]. At the same time, the first records were confirmed in Austria [34] and Serbia [44]. This was followed in the next few years by Spain [45], Bulgaria [46], Slovakia [47], and Georgia [48] in 2016, and Croatia [49], Slovenia [50], and Turkey [51] in 2017. In the same year, 2017, the pest was detected on the border between Eastern Europe and Western Asia in Azerbaijan [52]. In 2018, it was also detected in Ukraine [53], Albania [36], Bosnia and Herzegovina [54], the Czech Republic [55], Malta [56], Poland [36,57], and Portugal [58], while in 2019 it was found in North Macedonia [59] and Moldova [60]. In Europe, the pest has currently been intercepted several times in Iceland, Norway, Sweden, and the United Kingdom, but it is not established. According to a process-oriented bioclimatic niche model (CLIMEX) based on historical climate data, these countries do not appear to be at risk from its establishment [61]. Using the same model based on historical data and future climate projections of UK climate parameters, Powell et al. [62] predicted that the species has the potential to colonise the south-east and east of England by 2050 (Figure 1).

2.4. North Africa

In North Africa, this pest has so far only been found in Morocco [63] and in neighbouring Algeria, which are well connected to Mediterranean ports [64] (Figure 1).

2.5. Potential Spread

Climatically suitable areas at high risk of invasion include latitudes between 30° and 50°, including northern Europe, north-eastern North America, southern Australia, and the northern island of New Zealand. Angola in Africa and Uruguay in South America also showed high climatic suitability [8].

Previous climate models suggest that *H. halys* could spread significantly in Australia and New Zealand [61] and that its establishment is only a matter of time, and it is therefore necessary to develop control strategies [65] for *H. halys*. There appears to be potential for further spread in North America, particularly in the central and southern states of the United States. In Europe, there is considerable potential for further spread, although the United Kingdom, Ireland, Scandinavia, and the Baltic states of Estonia, Lithuania, and Latvia do not appear to be at risk for infection with *H. halys* under present climatic conditions. In the Southern Hemisphere, regions with humid tropical, subtropical, Mediterranean, and warm temperate climates on all continents appear to be at high risk of invasions in the near future [61]. It should only be noted that *H. halys* has been found during border controls of imported goods in England, Australia, and New Zealand [66–68].

Climate change may alter the habitat suitability of invasive species and promote their establishment. Simulations with climate change scenarios indicate extensive range expansion to higher elevations, an increase in generations per year, an earlier onset of *H. halys* activity in spring, and a longer period for nymph development in fall [69]. The increasing global importance of the pest suggests that more coordinated actions are needed to slow its spread and soothe negative effects in invaded areas (e.g., increased economic and amenity impacts) [61].

3. Biology and Ecology of the Species

The *H. halys* reacts to the shortening of day length in the fall by going into diapause. Only sexually immature adults go into diapause and survive the winter [70]. This pest hibernates in man-made and natural structures [15]. Parked vehicles, including RVs and cargo containers, can also be desirable overwintering sites [71]. Dry crevices in dead, standing trees such as oak (*Quercus* spp.) and black locust (*Robinia* spp.) are commonly used for hibernation in natural landscapes [29] (Figure 2).

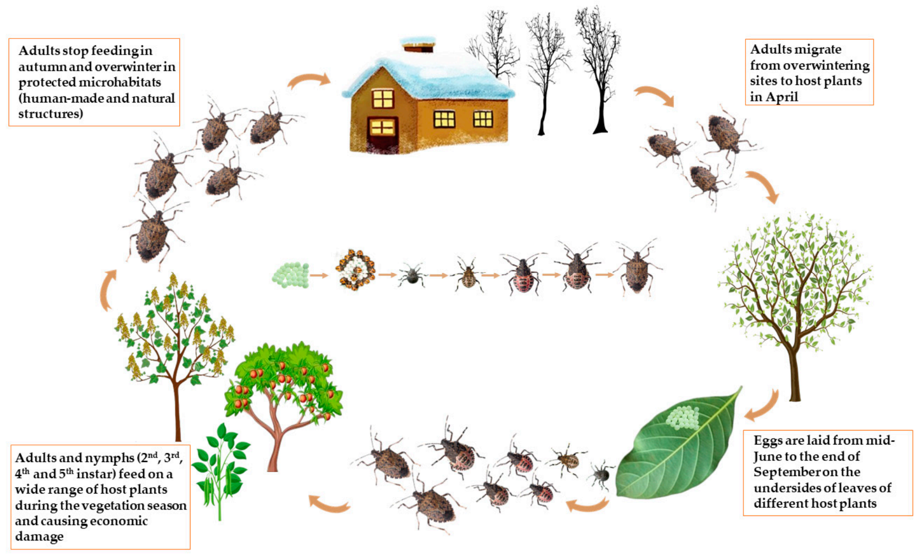

Figure 2. The life cycle of *Halyomorpha halys* in Europe.

It is also a source of intense nuisance to humans in residential areas, as large numbers of individuals can congregate on buildings as they seek shelter for hibernation [72]. During hibernation, the weight, glycogen, and sugar levels of *H. halys* steadily decrease, and a lack of nutrients can cause them to awaken from diapause [73]. This stink bug also exhibits cannibalistic behaviour towards its eggs in the spring due to the depletion of metabolic reserves and dehydration in winter [74].

Insect biology is primarily determined by temperature and photoperiod [75,76]. Temperatures and day length increase in spring; the resting phase ends and adults leave their hibernation sites in search of food (Figure 2). In warmer climates, several generations per year are possible. In the North American distribution area, there are only one or two generations per year [70].

In Western Europe (e.g., in Switzerland), *H. halys* is univoltine, whereas in Southern Europe (e.g., in the Mediterranean region) it is bivoltine [13,32,77].

Overwintering *H. halys* females do not start laying eggs immediately after emerging from the overwintering areas but need some time to finish diapause and become reproductive. In Switzerland, the adults leave their hibernation sites in April and reach maximal oviposition in early July. The females lay about 80 eggs [32] on the underside of the leaves of the host plant. Oviposition usually lasts from mid-June to the end of September (Figure 2). In Europe, the development of a generation (from egg to adult) takes between two and four and a half months [32] while in North America it takes about one to two months [70]. The first instar nymphs aggregate around the egg and clutch and feed on the eggshells before moulting and swarming out to feed on host plants [70]. All other nymphal stages and adults actively feed on host plants. The next generation of adults develops around mid-August when the photoperiod is already less than 15 h, which is related to the diapause and reduces the reproductive capacity of this generation [32].

The mean development times for the immature stages at a room temperature of 20 to 22 °C and natural photoperiod (June–July) were seven days for the egg, five days for the first instar, seven days for the second instar, six days for the third and fourth instars, and ten days for the fifth instar [1].

At temperatures of 20 °C, one generation develops for 75.8 days, while the rise in temperature shortens its development, taking 42.3 days at 25 °C and only 33.2 days at 30 °C. The complete generation develops in 588.24 degree days [32]. When colonising agricultural land, semi-natural habitats such as forests or grasslands, which provide alternative feeding, hibernation or breeding sites, serve as important supporters of *H. halys* populations [78].

4. Host Plants and Damage

Halyomorpha halys is a highly polyphagous invasive pest, which has more than 300 known host plants, including a wide range of economic crops [6]. It attacks numerous cultivated species such as field crops, ornamentals, tree fruits, and vegetables, as well as native vegetation both in its native countries and in the countries it has invaded [4]. Currently, the list of hosts includes plant species from 49 families [79]. The total number of hosts that support not only the pest's nutrition but also its egg laying and development is not known [80]. Ornamental plants provide overwintering sites for pests but also allow them to feed and reproduce throughout the growing season [68]. The pest also transmits harmful phytoplasmas to ornamental trees and shrubs, which impair their growth and vitality [61]. An increasing density of different nymphal stages and adults was observed on *Catalpa bignonioides* (Walter), *Cornus sanguinea* (L.), *Fraxinus excelsior* (L.), *Parthenocissus quinquefolia* (L.) Planch., and *Sorbus aucuparia* (L.), confirming the developmental cycle of *H. halys* [81]. Some hosts such as *Ailanthus altissima* (Mill.) Swingle., *Ilex aquifolium* (L.), *Paulownia tomentosa* (Thunb.) Steud, and *Pyrus persica* Pers. support the complete development from egg to adult [82].

The pest feeds and develops on an extremely large number of wild and cultivated plants, but often migrates from such surrounding habitats and infests crops [83]. Once *H. halys* manages to establish a population in a particular site, it very quickly becomes a major pest throughout the season. The annual increase in the population size of *H. halys* leads to an increase in the risk of major crop damage [84].

Table 1 shows the most important host plants on which economic damage by *H. halys* has been observed worldwide (plant species from 46 families are listed). The pest mainly prefers species from the Rosaceae (hosts from eight plant genera are listed) and the Fabaceae family (hosts from eight plant genera are listed). According to the literature data listed in Table 1, the global cultivation of the following species is most threatened by *H. halys*: *Actinidia chinensis* (Planch.), *Actinidia deliciosa* (A. Chev.) C.F. Liang and A.R. Ferguson, *Citrus junos* (Siebold ex Yu. Tanaka), *Corylus avellana* (L.), *Diospyros kaki* (L.f.), *Glycine max* (L. Merr.), *Malus domestica* (Borgh.), *Pisum sativum* (L.), *Prunus avium* (L.), *Prunus domestica*

(L.), *Prunus persica* (L.) Batsch, *Pyrus communis* (L.), *Zea mays* (L.), and *Ziziphus sativa* (L.) H. Karst.

Table 1. The major host plants of *Halyomorpha halys* worldwide.

Family	Host Plant	References
Aceraceae	*Acer* sp. (L.)	[28,30,85]
Actinidiaceae	*Actinidia chinensis*	[86,87]
Actinidiaceae	*Actinidia deliciosa*	[87]
Adoxaceae	*Sambucus* sp. (L)	[5,71]
Adoxaceae	*Viburnum opulus* (L.)	[30,88]
Altingiaceae	*Liquidambar styraciflua* (L.)	[30,71]
Amaranthaceae	*Celosia argentea* (L.)	[11,68,89]
Aquifoliaceae	*Ilex aquifolium*	[30,71]
Araliaceae	*Aralia elata* (Miq.) Seem., 1868	[85]
Asparagaceae	*Asparagus officinalis* (L.)	[5,85]
Asteraceae	*Arctium* sp. (L. 1753 not Lam. 1779)	[5,11,30]
Asteraceae	*Chrysanthemum morifolium* (Ramat.) Hemsl.	[5,90]
Asteraceae	*Helianthus annuus* (L.)	[5,11,30,90]
Basellaceae	*Basella alba* (L.)	[11]
Basellaceae	*Basella rubra* (L.)	[5,11,89]
Betulaceae	*Betula* sp. (L.)	[5,30]
Betulaceae	*Carpinus betulus* (L.)	[30]
Betulaceae	*Corylus avellana* (L.)	[91–93]
Bignoniaceae	*Catalpa* sp. (Scop.)	[1,5,30]
Brassicaceae	*Armoracia rusticana* (P.G. Gaertn., B. Mey. & Scherb, 1800.	[30]
Brassicaceae	*Brassica juncea* (L.) Czern.	[30]
Brassicaceae	*Brassica napus* (L.)	[5]
Brassicaceae	*Brassica oleracea* (L.)	[30]
Cannabaceae	*Celtis* sp.	[30,94]
Cannabaceae	*Humulus lupulus* (L.)	[30]
Caprifoliaceae	*Abelia* sp. R.Br. (1818)	[30]
Caprifoliaceae	*Lonicera* sp. (L.)	[1,30,85]
Chenopodiaceae	*Beta vulgaris* (L.)	[5,90]
Cornaceae	*Cornus* sp. (L.)	[30,41,94]
Cucurbitaceae	*Cucumis sativus* (L.)	[5,30]
Cucurbitaceae	*Cucurbita pepo* (L.)	[30]
Cupressaceae	*Cryptomeria* sp. (L.f.) D. Don	[85]
Cupressaceae	*Cupressus* sp. (L.)	[85]
Cupressaceae	*Juniperus virginiana* (L.)	[30]
Ebenaceae	*Diospyros kaki*	[16,30,85]
Elaeagnaceae	*Elaeagnus angustifolia* (L.)	[30,88]
Fabaceae	*Caragana arborescens* (Lam.)	[30,88]
Fabaceae	*Cercis* sp. (L.)	[30,94]
Fabaceae	*Glycine max*	[5,30,50,85,88,95,96]
Fabaceae	*Mimosa* sp. (L.)	[30]
Fabaceae	*Phaseolus vulgaris* (L.)	[5,85,95,97]
Fabaceae	*Pisum sativum*	[5,85]
Fabaceae	*Robinia pseudoacacia* (L.)	[5,30,94]
Fabaceae	*Vigna* sp. (Savi)	[5]
Fagaceae	*Quercus* sp. (Nutt.)	[30]
Ginkgoaceae	*Ginkgo biloba* (L.)	[30]
Juglandaceae	*Carya* sp. (L.)	[30]
Juglandaceae	*Juglans nigra* (L.)	[1,30]
Lardizabalaceae	*Decaisnea fargesii* (Franch.)	[85]
Lauraceae	*Cinnamomum camphora* (L.) J. Presl	[5,90]

Table 1. *Cont.*

Family	Host Plant	References
Lythraceae	*Punica granatum* (L.)	[5,90]
Magnoliaceae	*Magnolia grandiflora* (L.)	[30]
Malvaceae	*Abelmoschus esculentus* (L.) Moench, 1794	[30]
Malvaceae	*Hibiscus* sp. (L.)	[5,30,85]
Malvaceae	*Tilia americana* (L.)	[30]
Moraceae	*Ficus carica* (L.)	[1,5,30,50]
Moraceae	*Morus* sp. (L.)	[5,30,94,98]
Oleaceae	*Fraxinus* sp. (L.)	[5,30,88,94]
Oleaceae	*Ligustrum* sp. (L.)	[30]
Oleaceae	*Olea oleaster* (Hoffmanns. and Link)	[5]
Oleaceae	*Syringa* sp. (L.)	[5,30,85]
Oleaceae	*Syringa vulgaris* (L.)	[98]
Orchidaceae	*Brassia* sp. (R.Br.)	[5,90]
Orchidaceae	*Phalaenopsis* sp. (Blume)	[5,90]
Pinaceae	*Tsuga canadensis* (L.) Carrière	[30,71]
Platanaceae	*Platanus* × *hispanica*	[98]
Poaceae	*Panicum miliaceum* (L.)	[5]
Poaceae	*Sorghum bicolor* (L.) Moench	[5,7]
Poaceae	*Triticum aestivum* (L.)	[5,90]
Poaceae	*Zea mays*	[4,5,30,95]
Rhamnaceae	*Rhamnus cathartica* (L.)	[30]
Rhamnaceae	*Ziziphus sativa* (L.)	[99]
Rosaceae	*Crataegus* sp. (L.)	[5,30,90]
Rosaceae	*Malus domestica*	[5,16,30,88,94]
Rosaceae	*Prunus armeniaca* (L.)	[5,30,90]
Rosaceae	*Prunus avium*	[30,50]
Rosaceae	*Prunus domestica*	[16]
Rosaceae	*Prunus mume* (Siebold) Siebold & Zucc.	[1,5,89]
Rosaceae	*Prunus persica*	[5,16,30,50,100–102]
Rosaceae	*Pyracantha coccinea* (M. Roem.)	[85,94]
Rosaceae	*Pyrus communis*	[16,50]
Rosaceae	*Rosa rugosa* (Thunb.)	[30,88]
Rosaceae	*Rubus* sp. (L.)	[5,30,71,85]
Rosaceae	*Sorbus americana* (Marshall)	[30]
Rutaceae	*Citrus junos*	[103]
Salicaceae	*Populus* × *tomentosa* (Carrière)	[5,90]
Salicaceae	*Salix* sp. (L.)	[30,85]
Sapindaceae	*Aesculus* sp. (L.)	[30]
Scrophulariaceae	*Buddleja davidii* (Franch.)	[85]
Scrophulariaceae	*Paulownia tomentosa*	[1,5,12,30,88,94]
Simaroubaceae	*Ailanthus altissima*	[5,30,98,100]
Solanaceae	*Capsicum annuum* (L.)	[5,30,90]
Solanaceae	*Lycium barbarum* (L.)	[5,90]
Solanaceae	*Solanum lycopersicum* (L.)	[5,16,30,95]
Solanaceae	*Solanum melongena* (L.)	[5,30,95]
Solanaceae	*Solanum nigrum* (L.)	[1,5,89]
Theaceae	*Camellia* sp. (L.)	[5,90]
Theaceae	*Stewartia pseudocamellia* (Maxim.)	[30,85]
Ulmaceae	*Ulmus sp.* (L.)	[5,30]
Vitaceae	*Vitis vinifera* (L.)	[5,30,85,98,102,104,105]

Halyomorpha halys inflicts direct damage on plants through its piercing–sucking feeding behaviour. Their salivary secretions, particularly enzymatic, watery saliva, dissolve plant tissue and cause underground corking damage to fruits, vegetables, and nuts [106]. The adults feed mainly on fruits, and the nymphs feed mainly on leaves, stems, and fruits [1,107]. On young stone fruits, infestation by *H. halys* manifests itself in the form of individual rubbery spots and surface discolourations or deformations, which can be more pronounced on ripe fruits [108]. Early infestation of the stone fruits leads to their deformation. When they are ripe and have reached their final size, the infestation leads to the formation of necrotic areas and deliquescent flesh [16]. Apples infested by *H. halys* show greenish-brown spots on the skin (2 to 5 mm in diameter), and the infestation leads to a strong phenolic reaction in the damaged areas [109]. Damage to cherry fruit manifests itself in the form of fruit drop, reduced fruit weight, and increased fungal infestation with *Monilia laxa* [110].

The feeding damage to soybeans manifests itself in the destruction of seeds and pods [111], while in maize the pests pierce the husk and cause discolouration and shrinkage of the individual grains [7]. Injuries to vegetable fruits such as tomatoes and peppers lead to white, spongy patches on the skin and tissue damage inside the fruit [95]. The infestation of beans (*Phaseolus* spp.) causes a deformation of the pods and a lighter surface colour. In addition, this pest causes pod rotting through the transmission of plant pathogens [7]. If the population of *H. halys* is not controlled, total losses in production can be expected [112]; in some Mid-Atlantic states, production losses of 60 to 100% have been recorded for apples and peaches [113].

5. Monitoring Methods

The pest population is monitored with different types of traps, the choice of which usually depends on whether the overwintering pest population or the population in the field is being monitored [5,114]. In overwintering populations, passive traps that mimic potential overwintering structures are placed in and around known artificial structures (e.g., houses and buildings) to estimate the size of overwintering *H. halys* populations or to intercept pests entering houses and buildings [5,114]. In foraging field populations, several types of traps (e.g., light traps, large or small pyramid traps, or transparent sticky traps) with commercially available lures are usually used to monitor the activity and relative density of *H. halys* [114].

The insect cycle is usually tracked with pheromone traps, and predictive models based on abiotic factors (degree days and photoperiod) help determine key oviposition dates as well as the presence of insects in the environment [115]. Black pyramid pheromone traps are the most effective method for monitoring pest dynamics and density in the field [116] as they can catch individuals when population rates are low and can capture populations early in the season.

In the early days of monitoring the species, the aggregation pheromone of the brown-winged green bug (*Plautia stali* (Kotaki and Yagi, 1989)) was used as an attractant in pheromone-based pyramid traps (methyl (2E, 4E, 6Z)-decatrienoate) [117]. Further studies have shown that this pheromone does not affect the movements of *H. halys* in spring and early summer and is therefore only suitable for trapping the bug in late summer and fall [118,119]. Recently, aggregation pheromones produced by males of *H. halys* have been described (mixture of (3S, 6S, 7R, 10S)-10,11-epoxy-1-bisabolen-3-ol as the major component and (3R, 6S, 7R, 10S)-10,11-epoxy-1-bisabolen-3-ol as the minor component) [120,121], and baits consisting of both components (e.g., aggregation pheromones of *H. halys* and *P. stali*) are now available on the market to improve the detection performance of the species throughout the growing season [114]. Pyramid traps are recommended for monitoring the life stages of *H. halys* throughout the season, as they catch significantly more nymphs and adults than clear sticky traps [84,122]. Clear sticky traps are recommended for early detection of *H. halys* in areas with low *H. halys* population densities [84]. Throughout the season, the pest can also be monitored by visual inspection of plants, the use of trap nets, and the application of the shake-off method [5].

Innovative advances in monitoring methods have greatly advanced the development of automated systems for pest monitoring [123]. State-of-the-art technologies such as RGB cameras, computer vision algorithms, and drones offer new possibilities for tracking the population of *H. halys*. The combination of drones with machine learning within integrated pest management strategies is promising to increase the effectiveness of *H. halys* control measures [124].

6. Pest Management

Earlier research by Lee et al. [5] showed that synthetic insecticides such as pyrethroids, organophosphates, carbamates, organochlorines, neonicotinoids, and others were increasingly used to control *H. halys*. While initially effective, these insecticides can vary in their long-term efficacy due to the degradation of residues and recovery of pests after initial intoxication [125]. For example, studies have shown that insecticide residues may be effective in reducing populations of *H. halys* but may not provide long-term control due to the pest's high mobility and ability to recover from initial exposure [82]. In addition, many of these insecticides are now banned in the European Union (EU), complicating the control of *H. halys* in this region [126]. The high mobility of the *H. halys* and its diverse diet, which causes it to move frequently between host plants, make effective control even more difficult [127,128]. In a study by Masetti et al. [129], three chitin synthesis inhibitors (CSIs) were tested on *H. halys* nymphs and adults. Novaluron and triflumuron (not approved in the EU) caused high mortality among early instar larvae from sprayed egg masses, while buprofezin (approved in the EU) showed no effect. When adults were sprayed, none of the CSIs impacted their survival or fecundity, indicating their primary effectiveness on nymph stages and limited impact on adults. Studies on insecticides have shown that while compounds such as pyrethroids and neonicicotinoids can cause immediate mortality, their efficacy declines over time and sublethal effects can lead to pest resurgence [4]. The broad spectrum of activity of most insecticides also poses a challenge to their compatibility with integrated pest management systems [125]. An important aspect of effective integrated management of *H. halys* populations would be the establishment of decision thresholds. These thresholds help determine the economic level at which pest control measures should be taken to prevent unacceptable damage [19]. Regular revision of these thresholds is crucial as they can vary depending on pest pressure, crop value, and environmental conditions [107]. Accurate thresholds ensure that pest control measures are economically justified and environmentally sustainable, minimizing unnecessary pesticide applications and reducing the risk of pest resistance development [130]. The study by Short et al. [19] developed a pheromone-based decision support tool to establish a trap-based treatment threshold for managing the invasive *H. halys* in apple orchards. The results showed that using a threshold of 10 adults per trap effectively reduced fruit injury and decreased insecticide applications by 40%. In contrast, thresholds of 20 adults per trap or no spraying at all led to significantly higher fruit injury. Studies in pecan orchards by Grabarczyk et al. [131] have revealed that *H. halys* is unevenly distributed across the orchards. Notably, edge effects and vertical distribution within the canopy significantly influence pest density and damage levels. Higher populations are typically found at the orchard edges and in the mid to upper-canopy layers. This finding highlights the importance of targeted pest control measures. To mitigate the ecological impact of crop production, the integration of novel, sustainable approaches such as attract-and-kill strategies, exclusion nets, and biological control methods is essential [22,132,133]. Biological control using natural agents such as parasitoids, predators, and entomopathogens is a promising long-term strategy for suppressing *H. halys* populations and mitigating the damage they cause [133,134].

Biological Control

In the coming years, classical biological control may become the most promising approach for the sustainable management of *H. halys* populations [135–137]. In its native range, *H. halys* has numerous natural enemies, of which *Trissolcus japonicus* (Ashmead, 1904) and *Trissolcus mitsukurii* (Ashmead, 1904) stand out as the most important egg parasitoids [138]. *Trissolcus japonicus* was detected in North America in 2014 and in Europe in 2017 [138], which is due to an accidental introduction [139], while *T. mitsukurii* was first detected in Australia at the beginning of the 20th century and later in Europe in 2016 [138]. *Trissolcus japonicus* shows greater adaptability to new environments around the world and better adaptation to lower latitudes on a global scale compared to *T. mitsukurii* [138]. Due to its efficacy and its relatively limited host range, which focuses primarily on stink bugs (a characteristic feature of oligophagy), it proves to be a prime candidate for introduction into foreign territories [134]. However, the presence of adventive populations of *T. mitsukurii* in Europe also represents a promising potential for biological control of *H. halys*, but any deliberate introduction or re-introduction of this species requires a comprehensive risk assessment [136]. In a study by Yang et al. [140], *Trissolcus halyomorphae* (Yang, n.sp.) (Hymenoptera: Scelionidae) (synonym of *T. japonicus*) was identified as the most important natural enemy of *H. halys*, with egg parasitization rates of up to 70%. In addition to *Trissolcus* species, research conducted in Europe has identified *Anastatus bifasciatus* (Geoffroy, 1785) and *Ooencyrtus telenomicida* (Vassiliev, 1904) as the most significant and promising egg parasitoids of *H. halys* [115,141].

The establishment and spread of the invasive *H. halys* populations in Europe and North America also pose a challenge to the native natural enemies. Although some native parasitoids attack the eggs of *H. halys*, their offspring rarely develop successfully in fresh eggs of this host [142].

Table 2 shows the predominant natural enemies of *H. halys* worldwide, including parasitoids, predators, and confirmed pathogens (viruses and fungi). Among the parasitoids, species of parasitoid wasps from five families stand out, of which species from the families Scelionidae (gen. *Trissolcus*) and Eupelmidae (gen. *Anastatus*) dominate. Most of the listed parasitoid species (Fam. Encyrtidae, Eupelmidae, Pteromalidae, and Scelionidae) are exclusively egg parasitoids, while species from the family Tachinidae primarily parasitize adults and nymphs. Among the predators, species from 13 families are listed, with the true bugs (Fam. Anthocoridae, Geocoridae, Pentatomidae, and Reduviidae), which feed on all living stages of *H. halys*, and the ants (Fam. Formicidae), which feed on nymhps, standing out. The ant species of the genus *Crematogaster,* which feed on nymphs, and egg parasitoids of the genus *Trissolcus* can be used together to effectively control the population of *H. halys* without interfering with each other's efforts [143]. Predators which exclusively eat eggs are species from the families Anthocoridae, Carabidae, Coccinellidae, and Tettigoniidae (Table 2). Among the pathogens, five species of fungi, *Beauveria bassiana* (Bals.-Criv.) Vuill. (1912), *Metarhizium anisopliae* (Metchnikoff) Sorokin, *Colletotrichum fioriniae* Marcelino and Gouli (2008), *Nosema maddoxi* sp. nov., and *Ophiocordyceps nutans* (Pat.), and the *Plautia stali* intestine virus are the most promising.

Table 2. The most important natural enemies of the various developmental stages of the brown marmorated stink bug.

Type of Natural Enemies	Family	Species	Attacked Stage	References
Parasitoides	Encyrtidae	*Ooencyrtus* sp.	Eggs	[5,144]
		Ooencyrtus telenomicida	Eggs	[141]
	Eupelmidae	*Anastatus* sp.	Eggs	[5,145]
		Anastatus bifasciatus	Eggs	[146]
		Anastatus mirabilis (Walsh and Riley, 1869)	Eggs	[147]
		Anastatus pearsalli (Ashmead, 1898)	Eggs	[148]
		Anastatus reduvii (Howard, 1880)	Eggs	[147]
	Pteromalidae	*Acroclisoides* sp.	Eggs	[5,144]
		Acroclisoides sinicus (Huang and Liao, 1988)	Eggs	[147]

Table 2. *Cont.*

Type of Natural Enemies	Family	Species	Attacked Stage	References
Parasitoides	Scelionidae	*Gryon obesum* (Masner, 1983)	Eggs	[147]
		Telenomus podisi (Ashmead, 1893)	Eggs	[149]
		Telenomus utahensis (Ashmead)	Eggs	[7]
		Trissolcus basalis (Wollaston, 1858)	Eggs	[150]
		Trissolcus brochymenae (Ashmead, 1881)	Eggs	[147]
		Trissolcus cultratus (Mayr)	Eggs	[5,146]
		Trissolcus edessae (Fouts, 1920)	Eggs	[147]
		Trissolcus euschisti (Ashmead, 1893)	Eggs	[147]
		Trissolcus itoi (Ryu and Hirashima, 1984)	Eggs	[151]
		Trissolcus japonicus	Eggs	[140,152–154]
		Trissolcus mitsukurii	Eggs	[151]
		Trissolcus plautiae (Watanabe)	Eggs	[151,152]
		Trissolcus scutellaris	Eggs	[146]
		Trissolcus semistriatus (Nees, 1834)	Eggs	[155]
		Trissolcus solocis (Johnson)	Eggs	[150]
		Trissolcus thyantae	Eggs	[7]
		Trissolcus utahensis (Ashmead)	Eggs	[7]
	Tachinidae	*Bogosia* sp.	Adults	[152]
		Pentatomophaga latifascia (Villeneuve, 1932)	Adults	[156]
		Trichopoda pennipes (Fabricius, 1781)	Nymphs and adults	[157]
Predators	Anthocoridae	*Orius* sp.	Eggs	[5,144]
		Orius insidiosus (Say, 1832)	Eggs	[149]
	Asilidae	*Astochia virgatipes* (Coquillett)	Unknown	[5]
	Canidae	*Nyctereutes procyonoides* (Gray)	Adults	[158]
	Carabidae	*Harpalus sp.* (Latreille, 1802)	Eggs	[149]
	Coccinellidae	*Harmonia axyridis* (Pallas, 1773)	Eggs	[7]
	Crabronidae	*Astata bicolor* (Say, 1823)	Nymphs	[149]
		Bicyrtes quadrifasciatus (Say, 1824)	Nymphs	[159]
	Formicidae	*Crematogaster matsumurai* (Forel, 1901)	Nymphs	[160]
		Crematogaster osakensis (Forel, 1900)	Nymphs	[160]
		Crematogaster scutellaris (Olivier, 1792)	Nymphs	[161]
	Geocoridae	*Geocoris punctipes* (Say, 1832) *Geocoris uliginosus* (Say, 1832)	Eggs and nymphs	[149]
	Gryllidae	*Oecanthus sp.* (Serville, 1831)	Eggs	[149]
	Pentatomidae	*Arma chinensis* (Fallou)	Eggs and adults	[5,144,162]
	Reduviidae	*Arilus cristatus* (Linnaeus, 1763)	Nymphs and adults	[152]
		Isyndus obscurus (Dallas)	Nymphs and adults	[163]
	Tettigoniidae	*Atlanticus testaceus* (Scudder, 1901) *Conocephalus strictus* (Scudder, 1875) *Orchelimum* sp.	Eggs Eggs Eggs	[149]
	Thomisidae	*Misumenops tricuspidatus* (F.)	Eggs and adults	[144]
Virus	Dicistroviridae	*Plautia stali* intestine virus	Nymphs and adults	[164]

Table 2. *Cont.*

Type of Natural Enemies	Family	Species	Attacked Stage	References
Fungi	Clavicipitaceae	*Metarhizium anisopliae* (Metchnikoff) Sorokin	Adults	[165]
	Cordycipitaceae	*Beauveria bassiana* (Bals.-Criv.) Vuill. (1912)	Nymph and adults	[165,166]
	Glomerellaceae	*Colletotrichum fioriniae*	Nymphs and adults	[167]
	Nosematidae	*Nosema maddoxi* sp. nov.	Nymphs and adults	[168]
	Ophiocordycipitaceae	*Ophiocordyceps nutans*	Nymphs and adults	[169,170]

Recent research on the biology of parasitoids has shown that *A. bifasciatus*, which is recognised as the most abundant native egg parasitoid, can develop on viable eggs of *H*. halys and is thus the most promising candidate for augmentative biological control in Europe [171]. However, the incidence of *O. telenomicida* in the field is generally low [141]. Isolates of *B. bassiana* and *M. anisopliae* have been shown to be the most promising pathogen treatments for biological control of *H. halys* [165,166]. Under controlled conditions, *B. bassiana* achieved a mortality of almost 80% in *H. halys* nymphs [166]. Isolates of both fungi were tested against adult *H. halys* [165], with *B. bassiana* (active ingredient of BotaniGard®) causing 85% mortality after 9 days and 100% mortality after 12 days, while *M. anisopliae* showed lower mortality rates. These results underline the potential of entomopathogenic fungi for pest control [165].

7. Future Perspectives and Conclusions

Effective pest control in sustainable agriculture is being revolutionized by the integration of advanced technologies that specifically target highly disruptive and invasive pests such as *H. halys*. While traditional pest-monitoring methods remain essential, they are now increasingly complemented by innovative approaches like automated pest-monitoring systems [123]. Recent advancements have highlighted the use of machine learning algorithms and remote sensing to enhance pest monitoring. For instance, a recent study by Giannetti et al. [172] demonstrates the potential of using drones and artificial intelligence for automated monitoring, particularly effective in detecting the mobile stages of *H. halys*. This method could optimize insect monitoring by providing real-time assessment of infestation rates in the monitored areas. Similarly, the research by Forresi et al. [173] introduced a data-driven approach to monitor and analyse the occurrence, distribution, and spread of *H. halys* in the Emilia-Romagna region of Italy. Their data platform facilitated analytical activities that provided a deeper understanding of the population dynamics of *H. halys* in the specific area. Establishing thresholds for chemical treatments tailored to the specific climatic conditions and characteristics of each agricultural area is crucial. Fields and orchards near man-made structures, such as storage facilities or adjacent woodlands [131], are often more susceptible to higher *H. halys* populations as these structures provide overwintering sites. This requires a dynamic approach to pest control that considers the local environment and pest behaviour to ensure that measures are effective. The development of predictive models that take into account climatic data and pest population dynamics can further improve the decision-making process for pest control measures [19,174]. Climate change is significantly altering the suitability of habitats for many invasive pests, including *H. halys* suggesting that new global invasions are likely to occur in the future [8,9,61]. The greatest threats are expected in the main horticultural areas of central Chile, northeastern Argentina, Uruguay, southern Brazil, the South Island of New Zealand, and southern Africa [8,61], where this pest could potentially cause economic losses similar to those experienced by growers in Europe and North America [2,7]. As they colonize previously unsuitable regions, there is an urgent need for adaptive pest control strategies [175]. Studies on genetic diversity and invasion pathways by Cesari et al. [176] and Gariepy et al. [177] are pivotal for the implementation of effective biosecurity measures. Understanding the pathways and origins of pest invasions enables the development of targeted quarantine protocols and prevention measures. Population genomic research, such as that of Parvizi et al. [178], provides detailed insights into the genetic structure and adaptive potential of *H. halys* populations. This knowledge helps in predicting the future spread of *H. halys*, and further similar experiments are needed for different areas infested by this pest. Genetic research is very important for the effective control of pests. The differential expression of cytochrome P450 CYP6 genes [179] emphasizes the importance of understanding insecticide resistance mechanisms at the genetic level in the case of *H. halys*. Targeted insecticides that mitigate the development of resistance are imperative for sustainable control. Transcriptomic analyses, as in Sparks et al. [180], provide comprehensive insights into resistance mechanisms and pave the way for novel pest management strategies, including RNA interference-based technologies [179,180]. Long-term, holistic studies that integrate genetic, ecological, behavioural, and occurrence data are essential for a comprehensive understanding of the dynamics of *H. halys*. Addressing these research gaps will enhance our ability to develop sustainable and adaptive pest control measures, ensuring prolonged effectiveness against this invasive species. Ongoing research and coordinated global efforts are vital to mitigating the impact of *H. halys* on agricultural production.

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References

1. Hoebeke, E.R.; Carter, M.E. *Halyomorpha halys* (Stål) (Heteroptera: Pentatomidae): A polyphagous plant pest from Asia newly detected in North America. *Proc. Entomol. Soc. Wash.* **2003**, *105*, 225–237.
2. Leskey, T.C.; Nielsen, A.L. Impact of the Invasive Brown Marmorated Stink Bug in North America and Europe: History, Biology, Ecology, and Management. *Annu. Rev. Entomol.* **2018**, *63*, 599–618. [CrossRef]
3. Ferrari, V.; Calvini, R.; Boom, B.; Menozzi, C.; Krishnaswamy Rangarajan, A.; Maistrello, L.; Offermans, P.; Ulrici, A. Evaluation of the potential of near infrared hyperspectral imaging for monitoring the invasive brown marmorated stink bug. *Chemom. Intell. Lab. Syst.* **2023**, *234*, 11. [CrossRef]
4. Leskey, T.C.; Hamilton, G.C.; Nielsen, A.L.; Polk, D.F.; Rodriguez-Saona, C.; Bergh, J.C.; Herbert, D.A.; Kuhar, T.P.; Pfeifer, D.; Dively, G.P.; et al. Pest status of the brown marmorated stink bug, *Halyomorpha halys* in the USA. *Outlooks Pest Manag.* **2012**, *23*, 218–226. [CrossRef]
5. Lee, D.H.; Short, B.D.; Joseph, S.V.; Bergh, J.C.; Leskey, T.C. Review of the biology, ecology, and management of *Halyomorpha halys* (Hemiptera: Pentatomidae) in China, Japan, and the Republic of Korea. *Environ. Entomol.* **2013**, *42*, 627–641. [CrossRef] [PubMed]
6. Ali, M.Y.; Liu, Y.D.; Li, F.Q.; Hou, M.L.; Zhang, J.P.; Zhang, F. Molecular identification of the brown marmorated stink bug's egg parasitoids by species-specific PCR collected from Beijing, China. *CABI Agric. Biosci.* **2023**, *4*, 41. [CrossRef]
7. Rice, K.B.; Bergh, C.J.; Bergmann, E.J.; Biddinger, D.J.; Dieckhoff, C.; Dively, G.; Fraser, H.; Gariepy, T.; Hamilton, G.; Haye, T.; et al. Biology, ecology and menagement of brown marmorated stink bug (Hemiptera: Pentatomidae). *J. Integr. Pest Manag.* **2014**, *5*, 1–13. [CrossRef]
8. Zhu, G.; Bu, W.; Gao, Y.; Liu, G. Potential geographic distribution of brown marmorated stink bug invasion (*Halyomorpha halys*). *PLoS ONE* **2012**, *7*, e31246. [CrossRef] [PubMed]

9. Haye, T.; Gariepy, T.; Hoelmer, K.; Rossi, J.P.; Streito, J.C.; Tassus, X.; Desneux, N. Range expansion of the invansive brown marmorated stink bug, *Halyomorpha halys*; an increasing threat to field, fruit and vegetable crops worldwide. *J. Pest Sci.* **2015**, *88*, 665–673. [CrossRef]
10. Skendžić, S.; Zovko, M.; Živković, I.P.; Lešić, V.; Lemić, D. The Impact of Climate Change on Agricultural Insect Pests. *Insects* **2021**, *12*, 440. [CrossRef]
11. Pajač Živković, I.; Mulamehmedović, J.; Göldel, B.; Lemić, D. Sexual dimorphism of brown marmorated stink bug. *J. Cent. Eur. Agric.* **2022**, *23*, 62–68. [CrossRef]
12. Funayama, K. Importance of apple fruits as food for the brown-marmorated stink bug, *Halyomorpha halys* (Stal) (Heteroptera: Pentatomidae). *Appl. Entomol. Zool.* **2004**, *39*, 617–623. [CrossRef]
13. Rot, M.; Maistrello, L.; Costi, E.; Trdan, S. Biological Parameters, Phenology and Temperature Requirements of *Halyomorpha halys* (Hemiptera: Pentatomidae) in the Sub-Mediterranean Climate of Western Slovenia. *Insects* **2022**, *13*, 956. [CrossRef] [PubMed]
14. Reznik, S.Y.; Dolgovskaya, M.Y.; Karpun, N.N.; Zakharchenko, V.Y.; Saulich, A.K.; Musolin, D.L. The Invasive Caucasian Populations of the Brown Marmorated Stink Bug *Halyomorpha halys* (Hemiptera: Heteroptera: Pentatomidae) Rapidly Adapt Their Ecophysiological Traits to the Local Environmental Conditions. *Insects* **2023**, *14*, 424. [CrossRef] [PubMed]
15. Koutsogeorgiou, E.I.; Kouloussis, N.A.; Koveos, D.S.; Andreadis, S.S. Females of *Halyomorpha halys* (Hemiptera: Pentatomidae) Experience a Facultative Reproductive Diapause in Northern Greece. *Insects* **2022**, *13*, 866. [CrossRef] [PubMed]
16. Bariselli, M.; Bugiani, R.; Maistrello, L. Distribution and damage caused by *Halyomorpha halys* in Italy. *Bull. OEPP/EPPO Bull.* **2016**, *46*, 332–334. [CrossRef]
17. Lee, D.H.; Nielsen, A.L.; Leskey, T.C. Dispersal capacity and behavior of nymphal stages of *Halyomorpha halys* (Hemiptera: Pentatomidae) evaluated under laboratory and field conditions. *J. Insect Behav.* **2014**, *27*, 639–651. [CrossRef]
18. Bout, A.; Jail, R.; Hamidi, R.; Gachein, A. Prédire les pics de présence de la punaise diabolique *Halyomorpha halys*. *Phytoma* **2022**, *755*, 9–14.
19. Short, B.D.; Khrimian, A.; Leskey, T.C. Pheromone-based decision support tools for management of *Halyomorpha halys* in apple orchards: Development of a trap-based treatment threshold. *J. Pest Sci.* **2017**, *90*, 1191–1204. [CrossRef]
20. Giovannini, L.; Mazza, G.; Chitarra, W.; Sabbatini-Peverieri, G.; Sonnati, C.; Roversi, P.F.; Nerva, L. New insights from the virome of *Halyomorpha halys* (Stål, 1855). *Virus Res.* **2022**, *316*, 198802. [CrossRef]
21. Fornasiero, D.; Scaccini, D.; Lombardo, V.; Galli, G.; Pozzebon, A. Effect of exclusion net timing of deployment and color on *Halyomorpha halys* (Hemiptera: Pentatomidae) infestation in pear and apple orchards. *Crop Prot.* **2023**, *172*, 106331. [CrossRef]
22. Morrison III, W.R.; Blaauw, B.R.; Short, B.D.; Nielsen, A.L.; Bergh, J.C.; Krawczyk, G.; Park, Y.-L.; Butler, B.; Khrimian, A.; Leskey, T.C. Successful management of *Halyomorpha halys* (Hemiptera: Pentatomidae) in commercial apple orchards with an attract-and-kill strategy. *Pest. Manag. Sci.* **2019**, *75*, 104–114. [CrossRef]
23. Zhunisbai, R.T.; Dinasilov, A.S.; Islamova, R.A. Brown marmorated stink bug (*Halyomorpha halys*)—A new invader in the territory of the Republic of Kazakhstan. *Zashchita I Karantin Rasteniĭ* **2019**, *10*, 38–40. (In Russian)
24. Gandjaeva, L.; Abdullaev, I. First record of *Halyomorpha halys* (Heteroptera: Pentatomidae) from Uzbekistan. *Zoosyst. Ross.* **2022**, *31*, 329–331. [CrossRef]
25. Kalashian, M.Y.; Ghrejyan, T.L.; Karagyan, G.H. Brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) (Heteroptera: Pentatomidae) penetrated into Armenia. *Russ. J. Biol. Invasions* **2022**, *13*, 305–308. [CrossRef]
26. Gyawali, A.; Regmi, B.; Pudasaini, R.; Acharya, N. Diversity and abundance of insect pest of low land rice field in Lamahi, Dang district of Nepal. *J. Am. Chem. Soc.* **2019**, *2*, 238–243. [CrossRef]
27. Fogain, R.; Graff, S. First records of the invasive pest, Halyomorphahalys (Hemiptera: Pentatomidae), in Ontario and Quebec. *J. Entomol. Soc. Ont.* **2011**, *142*, 45–48.
28. Gariepy, T.D.; Bruin, A.; Haye, T.; Milonas, P.; Vétek, G. Occurrence and genetic diversity of new populations of *Halyomorpha halys* in Europe. *J. Pest Sci.* **2015**, *88*, 451–460. [CrossRef]
29. Lee, D.H. Current status of research progress on the biology and management of *Halyomorpha halys* (Hemiptera: Pentatomidae) as an invasive species. *Appl. Entomol. Zool.* **2015**, *50*, 277–290. [CrossRef]
30. Bergmann, E.; Bernhard, K.M.; Bernon, G.; Bickerton, M.; Gill, S.; Gonzales, C.; Hamilton, G.C.; Hedstrom, C.; Kamminga, K.; Koplinka-Loehr, C.; et al. Host Plants of the Brown Marmorated Stink Bug in the US. Stop BMSB. 2015. Available online: https://www.stopbmsb.org/where-is-bmsb/host-plants/ (accessed on 10 January 2024).
31. Faúndez, E.I.; Rider, D. The brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) (Heteroptera: Pentatomidae) in Chile. *Arq. Entomolóxicos* **2017**, *17*, 305–307.
32. Haye, T.; Abdallah, S.; Gariepy, T.; Wyniger, D. Phenology, life table analysis and temperature requirements of the invasive brown marmorated stink bug, *Halyomorpha halys*, in Europe. *J. Pest. Sci.* **2014**, *87*, 407–418. [CrossRef]
33. Arnold, K. *Halyomorpha halys* (Stål, 1855), eine für die europäische Fauna neu nachgewiesene Wanzenart (Insecta: Heteroptera: Pentatomidae: Cappaeini). *Mitteilungen Des Thüringer Entomol.* **2009**, *16*, 19.
34. Rabitsch, W.; Friebe, G.J. From the west and from the east? First records of *Halyomorpha halys* (Stål, 1855) (Hemiptera: Heteroptera: Pentatomidae) in Vorarlberg and Vienna Austria. *Beitr. Entomofaunist.* **2015**, *16*, 115–139.
35. Milonas, P.G.; Partsinevelos, G.K. First report of brown marmorated stink bug *Halyomorpha halys* Stål (Hemiptera: Pentatomidae) in Greece. *Bull. OEPP/EPPO Bull.* **2014**, *44*, 183–186. [CrossRef]

36. Claerebout, S.; Haye, T.; Ólafsson, E.; Pannier, É.; Bultot, J. First occurrences of *Halyomorpha halys* for Belgium and updates of its distribution in Europe (Hemiptera: Heteroptera: Pentatomidae). *Bull. Ann. Soc. R. Belg. Entomol.* **2018**, *154*, 205–227.
37. Heckmann, R. Erster Nachweis von *Halyomorpha halys* (Stål, 1855) (Heteroptera: Pentatomidae) für Deutschland. *Heteropteron* **2012**, *36*, 17–18.
38. Callot, H.; Brua, C. *Halyomorpha halys* (Stål, 1855), la Punaise diabolique, nouvelle espéce pour la faune de France (Heteroptera Pentatomidae). *L'Entomologiste* **2013**, *69*, 69–71.
39. Maistrello, L.; Dioli, P.; Vaccari, G.; Nannini, R.; Bortolotto, P.; Caruso, S.; Costi, E.; Montermini, A.; Casoli, L.; Bariselli, M. First records in Italy of the Asian stinkbug *Halyomorpha halys*, a new threat to fruit crops. *Atti. Giornate Fitopatol.* **2014**, *1*, 283–288.
40. Vétek, G.; Papp, V.; Haltrich, A.; Rédei, D. First record of the brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Heteroptera: Pentatomidae), in Hungary, with description of the genitalia of both sexes. *Zootaxa* **2014**, *3780*, 194–200. [CrossRef]
41. Macavei, L.I.; Baetan, R.; Oltean, I.; Florian, T.; Varga, M.; Costi, E.; Maistrello, L. First detection of *Halyomorpha halys* Stål, a new ivasive species with a high potential of damage on agricultural crops in Romania. *Lucr. Ştiinţifice* **2015**, *58*, 105–108.
42. Mityushev, I.M. First record of *Halyomorpha halys* detection in Russia. *Zashchita I Karantin Rasteniy* **2016**, *3*, 48.
43. Musolin, D.L.; Konjević, A.; Karpun, N.N.; Protsenko, V.Y.; Ayba, L.Y.; Saulich, A.K. Invasive brown marmorated stink bug *Halyomorpha halys* (Stål) (Heteroptera: Pentatomidae) in Russia, Abkhazia, and Serbia: History of invasion, range expansion, early stages of establishment, and first records of damage to local crops. *Arthropod Plant Interact.* **2018**, *12*, 517–529. [CrossRef]
44. Šeat, J. *Halyomorpha halys* (Stål, 1855) (Heteroptera: Pentatomidae) a new invasive species in Serbia. *Acta Entomol. Serbica* **2015**, *20*, 167–171.
45. Dioli, P.; Leo, P.; Maistrello, L. First records in Spain and Sardinia of the alien species *Halyomorpha halys* (Stål, 1855), with notes on its distribution in Europe (Hemiptera, Pentatomidae). *Rev. Gaditana De Entomol.* **2016**, *7*, 539–548.
46. Simov, N. The invasive brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) (Heteroptera: Pentatomidae) already in Bulgaria. *Ecol. Montenegrina* **2016**, *9*, 51–53. [CrossRef]
47. Hemala, V.; Kment, P. First record of *Halyomorpha halys* and mass occurrence of *Nezara viridula* in Slovakia (Hemiptera: Heteroptera: Pentatomidae). *Plant Prot. Sc.* **2017**, *53*, 247–253. [CrossRef]
48. Gapon, D.A. First records of the brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) (Heteroptera, Pentatomidae) in Russia, Abkhazia, and Georgia. *Entomol. Rev.* **2016**, *96*, 1086–1088. [CrossRef]
49. Šapina, I.; Šerić Jelaska, l. First report of invasive brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) in Croatia. *Bull. OEPP/EPPO* **2018**, *48*, 1–6. [CrossRef]
50. Rot, M.; Devetak, M.; Carlevaris, B.; Žežlina, J.; Žežlina, I. First record of brown marmorated stink bug (*Halyomorpha halys* (Stål, 1855)) (Hemiptera: Pentatomidae) in Slovenia. *Acta Entomol Slov.* **2018**, *26*, 5–12. [CrossRef]
51. Güncan, A.; Gümüş, E. Brown marmorated stink bug, *Halyomorpha halys* (Stål, 1855) (Hemiptera: Heteroptera, Pentatomidae), a new and important pest in Turkey. *Entomol. News* **2019**, *128*, 204–210. [CrossRef]
52. Nuriyeva, I.A. A new, dangerous species for crop production in Azerbaijan Brown marmorated stink bug (*Halyomorpha halys* Stal.). *ANAS Sci. Life* **2018**, *1*, 66–68.
53. Uzhevskaya, S.F. Invasive insect species in Odessa region. *Izvestiia Muzeinogo Fonda im. A.A. Braunera.* **2017**, *14*, 57–64.
54. Zovko, M.; Ostojić, I.; Jurković, D.; Karić, N. First report of the brown marmorated stink bug, *Halyomorpha halys* (Stål, 1855) in Bosnia and Herzegovina. *Work. Fac. Agric. Food Sci. Univ. Sarajevo* **2019**, *64*, 68–78.
55. Kment, P.; Březíková, M. First record of the invasive Brown marmorated stink bug (*Halyomorpha halys*) (Hemiptera: Heteroptera: Pentatomidae) in the Czech Republic. *Klapalekiana* **2018**, *54*, 221–232.
56. Tassini, C.; Mifsud, D. The brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Heteroptera: Pentatomidae) in Malta. *EPPO Bull.* **2019**, *49*, 132–136. [CrossRef]
57. Bury, J. Pierwsze stwierdzenie *Halyomorpha halys* (Stål, 1855) (Hemiptera: Heteroptera: Pentatomidae) w Beskidzie Wschodnim/First records of *Halyomorpha halys* (Stål, 1855) (Heteroptera: Heteroptera: Pentatomidae) in the Eastern Beskids. *Heteroptera Poloniae Acta Faun.* **2021**, *15*, 11–14. [CrossRef]
58. Grosso-Silva, J.M.; Gaspar, H.; Castro, S.; Loureiro, J.; Amorim, F.; van der Heyden, T. Confirmation of the presence of *Halyomorpha halys* (Stål, 1855) (Hemiptera: Pentatomidae) in mainland Portugal. *Arq. Entomolóxicos* **2020**, *22*, 373–376.
59. Konjević, A. First Records of the Brown Marmorated Stink Bug *Halyomorpha halys* (Stål, 1855) (Hemiptera: Pentatomidae) in Republic of North Macedonia. *Acta Zool. Bulg.* **2020**, *72*, 687–690.
60. Derjanschi, V.; Chimișliu, C. The brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) (Heteroptera, Pentatomidae)—A new invasive alien species in the fauna of the Republic of Moldova. *Bul. Ştiinţific. Rev. De Etnogr. Ştiinţele Nat. Şi Muzeol.* **2019**, *30*, 18–22.
61. Kriticos, D.J.; Kean, J.M.; Phillips, C.B.; Senay, S.D.; Acosta, H.; Haye, T. The potential global distribution of the brown marmorated stink bug, *Halyomorpha halys*, a critical threat to plant biosecurity. *J. Pest Sci.* **2017**, *90*, 1033–1043. [CrossRef]
62. Powell, G.; Barclay, M.; Couch, Y.; Evans, A. Current invasion status and potential for UK establishment of the brown marmorated stink bug, *Halyomorpha halys* (hemiptera: Pentatomidae). *Br. J. Entomol. Nat. Hist.* **2021**, *34*, 9–21.
63. Nouere, S.; Amiri, S.; Lahlali, R. Situation des problèmes phytosanitaires du myrtillier (*Vaccinium corymbosum*) au Maroc. *Rev. Marocaine Sci. Agron. Et Vétérinaires* **2019**, *8*, 321–330.
64. Van der Heyden, T.; Saci, A.; Dioli, P. First record of the brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) in Algeria and its presence in North Africa (Heteroptera: Pentatomidae). *Rev. Gaditana De Entomol. XII* **2021**, *1*, 147–154.

65. Yonow, T.; Kriticos, D.J.; Ota, N.; Avila, G.A.; Hoelmer, K.A.; Chen, H.; Caron, V. Modelling the Potential Geographic Distribution of Two *Trissolcus* Species for the Brown Marmorated Stink Bug, *Halyomorpha halys*. *Insects* **2021**, *12*, 491. [CrossRef] [PubMed]
66. Harris, A. *Halyomorpha halys* (Hemiptera: Pentatomidae) and *Protaetia brevitarsis* (Coleoptera: Scarabaeidae: Cetoniinae) intercepted in Dunedin. *The Wētā.* **2010**, *40*, 42–44.
67. Malumphy, C. Second interception of *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae) in Britain. *HetNews* **2014**, *21*, 4–5.
68. Bergmann, E.J.; Venugopal, P.D.; Martinson, H.M.; Raupp, M.J.; Shrewsbury, P.M. Host Plant Use by the Invasive *Halyomorpha halys* (Stål) on Woody Ornamental Trees and Shrubs. *PLoS ONE* **2016**, *11*, e0149975. [CrossRef]
69. Stoeckli, S.; Felber, R.; Haye, T. Current distribution and voltinism of the brown marmorated stink bug, *Halyomorpha halys*, in Switzerland and its response to climate change using a high-resolution CLIMEX model. *Int. J. Biometeorol.* **2020**, *64*, 2019–2032. [CrossRef]
70. Hodges, A.; Penca, C. Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål) (Insecta: Hemiptera: Pentatomidae). *EDIS* **2019**, *1*, 1–7. [CrossRef]
71. Duthie, C.D.; Michael, T.; Stephenson, B.; Yamoah, E.; McDonald, B. *Risk Analysis of* Halyomorpha halys *(Brown Marmorated Stink bug) on All Pathways*; Biosecurity Risk Analysis Group, Ministry of Agriculture and Forestry of New Zealand: Wellington, New Zealand, 2012; p. 57.
72. Egri, A.; Mészáros, Á.; Kriska, G.; Fail, J. Dichromacy in the brown marmorated stink bug? Spectral sensitivity of the compound eyes and phototaxis of *Halyomorpha halys*. *J. Pest Sci.* **2023**, *96*, 657–666. [CrossRef]
73. Skillman, V.P.; Wiman, N.G.; Lee, J.C. Nutrient declines in overwintering *Halyomorpha halys* populations. *Entomol. Exp. Appl.* **2018**, *166*, 778–789. [CrossRef]
74. Papa, G.; Negri, I. Cannibalism in the Brown Marmorated Stink Bug *Halyomorpha halys* (Stål). *Insects* **2020**, *11*, 643. [CrossRef] [PubMed]
75. Tobin, P.C.; Nagarkatti, S.; Loeb, G.; Saunders, M.C. Historical and projected interactions between climate change and insect voltinism in a multivoltine species. *Glob. Chang. Biol.* **2008**, *14*, 951–957. [CrossRef]
76. Grisafi, F.; Papa, G.; Barbato, M.; Tombesi, S.; Negri, I. Influence of Microclimate Factors on *Halyomorpha halys* Dehydration. *Insects* **2021**, *12*, 897. [CrossRef] [PubMed]
77. Costi, E.; Haye, T.; Maistrello, L. Biological parameters of the invasive brown marmorated stink bug, *Halyomorpha halys*, in Southern Europe. *J. Pest Sci.* **2017**, *90*, 1059–1067. [CrossRef]
78. Tamburini, G.; Laterza, I.; Nardi, D.; Mele, A.; Mori, N.; Pasini, M.; Scaccini, D.; Pozzebon, A.; Marini, L. Effect of landscape composition on the invasive pest *Halyomorpha halys* in fruit orchards. *Agric. Ecosyst. Environ.* **2023**, *353*, 108530. [CrossRef]
79. Skrypnyk, N. Brown-harlequin bug (*Halyomorpha halys* Stål.). *Karantin I Zahist Rosl.* **2019**, 1–4. [CrossRef]
80. McPherson, J.E.; McPherson, R. *Stink Bugs of Economic Importance in America North of Mexico*, 1st ed.; CRC Press: Boca Raton, FL, USA, 2000; p. 272. [CrossRef]
81. Haye, T.; Wyniger, D.; Gariepy, T. Recent range expansion of brown marmorated stink bug in Europe. In Proceedings of the 8th International Conference on Urban Pests, Zurich, Switzerland, 20–23 July 2014; Executive Committee of the International Conference on Urban Pests: Lund, Sweden, 2014; pp. 309–314.
82. Leskey, T.C.; Hamilton, G.; Biddinger, D.J.; Buffington, M.L.; Dieckhoff, C.; Fraser, H.; Gariepy, T.D.; Hedstrom, C.; Herbert, D.A.; Hoelmer, K.A.; et al. Datasheet *Halyomorpha halys*, CABI Invasive Species Compendium. 2014. Available online: http://www.cabi.org/isc/datasheet/27377 (accessed on 8 March 2024).
83. Bergh, J.C.; Joseph, S.V.; Short, B.D.; Nita, M.; Leskey, T.C. Effect of pre-harvest exposures to adult *Halyomorpha halys* (Hemiptera: Pentatomidae) on feeding injury to apple cultivars at harvest and during post-harvest cold storage. *Crop Prot.* **2019**, *124*, 104872. [CrossRef]
84. Rot, M.; Persolja, J.; Bohinc, T.; Žežlina, I.; Trdan, S. Seasonal Dynamics of the Brown Marmorated Stink Bug, *Halyomorpha halys* (Hemiptera: Pentatomidae), in Apple Orchards of Western Slovenia Using Two Trap Types. *Agriculture* **2023**, *13*, 1500. [CrossRef]
85. Wermelinger, B.; Wyniger, D.; Forster, B. First records of an invasive bug in Europe: *Halyomorpha halys* Stal (Heteroptera: Pentatomidae), a new pest on woody ornamentals and fruit trees. *Mitt. Schweiz. Entomol. Ges.* **2008**, *81*, 1–8.
86. Andreadis, S.S.; Navrozidis, E.I.; Farmakis, A.; Pisalidis, A. First evidence of *Halyomorpha halys* (Hemiptera: Pentatomidae) infesting kiwi fruit (Actinidia chinensis) in Greece. *J. Entomol. Sci.* **2018**, *53*, 402–405. [CrossRef]
87. Francati, S.; Masetti, A.; Martinelli, R.; Mirandola, D.; Anteghini, G.; Busi, R.; Dalmonte, F.; Spinelli, F.; Burgio, G.; Dindo, M.L. *Halyomorpha halys* (Hemiptera: Pentatomidae) on kiwifruit in Northern Italy: Phenology, infestation, and natural enemies' assessment. *J. Econ. Entomol.* **2021**, *114*, 1733–1742. [CrossRef] [PubMed]
88. Nielsen, A.L.; Hamilton, G.C. Life history of the invasive species *Halyomorpha halys* (Hemiptera: Pentatomidae) in Northeastern United States. *Ann. Entomol. Soc. Am.* **2009**, *102*, 608–616. [CrossRef]
89. Gyeltshen, J.; Bernon, G.; Hodges, A.; Stocks, S.; Brambila, J. Featured Creatures—Brown Marmorated Stink Bug. 2011. Available online: http://entomology.ifas.ufl.edu/creatures/veg/bean/brown_marmorated_stink_bug.htm (accessed on 13 December 2023).
90. Yu, G.; Zhang, J. The Brown-marmorated Stink Bug, Halyomorpha halys (Heteroptera: Pentatomidae) in PR China. In Proceedings of the International Workshop on Biological Control of Invasive Species of Forests, Beijing, China, 20–25 September 2007.
91. Bosco, L.; Moraglio, S.T.; Tavella, L. *Halyomorpha halys*, a serious threat for hazelnut in newly invaded areas. *J. Pest Sci.* **2018**, *91*, 661–670. [CrossRef]

92. Murvanidze, M.; Krawczyk, G.; Inasaridze, N.; Dekanoidze, L.; Samsonadze, N.; Macharashvili, M.; Khutsishvili, S.; Shengelaia, S. Preliminary data on the biology of brown marmorated stink bug *Halyomorpha halys* (Hemiptera, Pentatomidae) in Georgia. *Turk. J. Zool.* **2018**, *42*, 617–624. [CrossRef]
93. Hedstrom, C.S.; Shearer, P.W.; Miller, J.C.; Walton, V.M. The effects of kernel feeding by *Halyomorpha halys* (Hemiptera: Pentatomidae) on commercial hazelnuts. *J. Econ. Entomol.* **2014**, *107*, 1858–1865. [CrossRef] [PubMed]
94. Ion, M.; Raluca, S. *Halyomorpha halys* Stål (Heteroptera: Pentatomidae) a new pest for the Oltenia area. *Ann. Univ. Craiova Agric. Mont. Cadastre Ser.* **2019**, *49*, 238–243.
95. Kuhar, T.P.; Kamminga, K.L.; Whalen, J.; Dively, G.P.; Brust, G.; Hooks, C.R.R.; Hamilton, G.; Herbert, D.A. The pest potential of brown marmorated stink bug on vegetable crops. *Plant Health Prog.* **2012**, *13*, 41. [CrossRef]
96. Pajač Živković, I.; Skendžić, S.; Lemić, D. Rapid spread and first massive occurrence of *Halyomorpha halys* (Stål, 1855) in agricultural production in Croatia. *J. Cent. Eur. Agric.* **2021**, *22*, 531–538. [CrossRef]
97. Vétek, G.; Korányi, D. Severe damage to vegetables by the invasive brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Pentatomidae), in Hungary. *Period. Biol.* **2017**, *119*, 131–135. [CrossRef]
98. Mityushev, I.M. Host plants of *Halyomorpha halys* in the urban ecosystem on the Azov Sea Coast of Russia. *EPPO Bull.* **2021**, *51*, 305–310. [CrossRef]
99. Song, H.W.; Wang, C.M. Damage by *Halyomorpha halys* (Stal) and *Erthesina fullo* (Thunberg) to jujube trees and their control. *Entomol Knowl.* **1993**, *30*, 225–228.
100. Rijal, J.; Duncan, R. First report of an established brown marmorated stink bug (Hemiptera: Pentatomidae) population in California agricultural crops. *J. Entomol. Sci.* **2017**, *52*, 450–454. [CrossRef]
101. Penca, C.; Hodges, A. First report of brown marmorated stink bug (Hemiptera: Pentatomidae) reproduction and localized establishment in Florida. *Fla. Entomol.* **2018**, *101*, 708–711. [CrossRef]
102. Zimmermann, O.; Reissig, A.; Trautmann, M.; Haye, T. The unnoticed invasion of a pest with high harmful potential in fruit and vegetable production: The brown marmorated stink bug *Halyomorpha halys* in Germany. In Proceedings of the 18th International Conference on Organic Fruit-Growing, Hohenheim, Germany, 19–21 February 2018.
103. Choi, D.S.; Kim, K.C.; Lim, K.C. The status of spot damage and fruit piercing pests on Yuzu (*Citrus junos*) fruit. *Korean J. Appl. Entomol.* **2000**, *39*, 259–266.
104. Kehrli, P.; Rösti, J.; Lorenzini, F.; Deneulin, P.; Linder, C. Influence of processed *Halyomorpha halys* bugs on the aroma and taste of 'Chardonnay' and 'Merlot' musts and wines. *Vitis* **2021**, *60*, 43–50. [CrossRef]
105. Nannini, R.; Bortolotti, P.P.; Casoli, L.; Montevecchi, G.; Masino, F.; Antonelli, A.; Preti, M. Survey on *Halyomorpha halys* infestations and damage in grapevine productions. *Atti Giornate Fitopatol.* **2018**, *1*, 295–300. (In Italian)
106. Wiman, N.G.; Walton, V.M.; Shearer, P.W.; Rondon, S.I. Electronically Monitored Labial Dabbing and Stylet 'Probing' Behaviors of Brown Marmorated Stink Bug, *Halyomorpha halys*, in Simulated Environments. *PLoS ONE* **2014**, *9*, e113514. [CrossRef] [PubMed]
107. Acebes-Doria, A.L.; Leskey, T.C.; Bergh, J.C. Injury to apples and peaches at harvest from feeding by *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae) nymphs early and late in the season. *Crop Prot.* **2016**, *89*, 58–65. [CrossRef]
108. Joseph, S.V.; Nita, M.; Leskey, T.C.; Bergh, J.C. Temporal Effects on the Incidence and Severity of Brown Marmorated Stink Bug (Hemiptera: Pentatomidae) Feeding Injury to Peaches and Apples during the Fruiting Period in Virginia. *J. Econ. Entomol.* **2015**, *108*, 592–599. [CrossRef]
109. Zamljen, T.; Medič, A.; Veberič, R.; Hudina, M.; Štampar, F.; Slatnar, A. Apple Fruit (*Malus domestica* Borkh.) Metabolic Response to Infestation by Invasive Brown Marmorated Stink Bug (*Halyomorpha halys* Stal.). *Horticulturae* **2021**, *7*, 212. [CrossRef]
110. Moore, L.; Tirello, P.; Scaccini, D.; Toews, M.D.; Duso, C.; Pozzebon, A. Characterizing damage potential of the brown marmorated stink bug in cherry orchards in Italy. *Entomol. Gen.* **2019**, *39*, 271. [CrossRef]
111. Owens, D.R.; Herbert, D.A.; Dively, G.P.; Reisig, D.D.; Kuhar, T.P. Does Feeding by *Halyomorpha halys* (Hemiptera: Pentatomidae) Reduce Soybean Seed Quality and Yield? *J. Econ. Entomol.* **2013**, *106*, 1317–1323. [CrossRef] [PubMed]
112. Bernon, G. *Biology of Halyomorpha Halys, the Brown Marmorated Stink Bug (BMSB). Final Report*; United States Department of Agriculture APHIS CPHST: Riverdale, MD, USA, 2004; p. 17.
113. Liu, M.; Abubeker, S.; Ulrich, K.R.; Feldlaufer, M.; Zhang, A. Identification of feeding deterrent/repellent for the brown marmorated stink bug. In Proceedings of the Entomological Society of America Annual Meeting, Portland, OR, USA, 16–19 November 2014.
114. Weber, D.C.; Morrison, W.R.; Khrimian, A.; Rice, K.B.; Leskey, T.C.; Rodriguez-Saona, C.; Nielsen, A.L.; Blaauw, B.R. Chemical ecology of *Halyomorpha halys*: Discoveries and applications. *J. Pest Sci.* **2017**, *90*, 989–1008. [CrossRef]
115. Bout, A.; Alessia, I.; Streito, J.-C.; Toillon, J.; Bertrand, A.; Hamidi, R. Phytoma: Solutions et stratégies pour maîtriser *Halyomorpha halys*. *Phytoma* **2023**, *763*, 16–22.
116. Leskey, T.C.; Wright, S.E.; Short, B.D.; Khrimian, A. Development of Behaviorally-Based Monitoring Tools for the Brown Marmorated Stink Bug (Heteroptera: Pentatomidae) in Commercial Tree Fruit Orchards. *J. Entomol. Sci.* **2012**, *47*, 76–85. [CrossRef]
117. Fujisawa, T. Damage and control of the brown marmorated stink bug in apple orchards. *Jpn. Agric. Tech.* **2001**, *45*, 42–47.
118. Funayama, K. Seasonal fluctuations and physiological status of *Halyomorpha halys* (Stål) (Heteroptera: Pentatomidae) adults captured in traps baited with synthetic aggregation pheromone of *Plautia crossota* stali Scott (Heteroptera: Pentatomidae). *Appl. Entomol. Zool.* **2008**, *52*, 69–75. [CrossRef]

119. Leskey, T.C.; Short, B.D.; Butler, B.R.; Wright, S.E. Impact of the invasive brown marmorated stink bug, *Halyomorpha halys* (Stal), in Mid-Atlantic tree fruit orchards in the United States: Case studies of commercial management. *Psyche A J. Entomol.* **2012**, *2012*, 535062. [CrossRef]
120. Khrimian, A.; Zhang, A.; Weber, D.C.; Ho, H.-Y.; Aldrich, J.R.; Vermillion, K.E.; Siegler, M.A.; Shirali, S.; Guzma, F.; Leskey, T.C. Discovery of the aggregation pheromone of the Brown marmorated stink bug (*Halyomorpha halys*) through the creation of stereoisomeric libraries of 1-bisabolen-3-ols. *J. Nat. Prod.* **2014**, *77*, 1708–1717. [CrossRef]
121. Leskey, T.C.; Khrimian, A.; Weber, D.C.; Aldrich, J.C.; Short, B.D.; Lee, D.H.; Morrison III, W.R. Behavioral Responses of the Invasive *Halyomorpha halys* (Stål) to Traps Baited with Stereoisomeric Mixtures of 10,11-Epoxy-1-bisabolen-3-OL. *J. Chem. Ecol.* **2015**, *41*, 418–429. [CrossRef] [PubMed]
122. Vidović, V.; Nikolić, P.; Hrnčić, S.; Nježić, B. Monitoring of the Brown marmorated stink bug *Halyomorpha halys* (Stål, 1855) in Banja Luka, Bosnia and Herzegovina. *Agro-Knowl. J.* **2023**, *24*, 27–36. [CrossRef]
123. Čirjak, D.; Miklečić, I.; Lemić, D.; Kos, T.; Pajač Živković, I. Automatic Pest Monitoring Systems in Apple Production under Changing Climatic Conditions. *Horticulturae* **2022**, *8*, 520. [CrossRef]
124. Betti Sorbelli, F.; Palazzetti, L.; Pinotti, C.M. YOLO-based detection of *Halyomorpha halys* in orchards using RGB cameras and drones. *Comput. Electron. Agric.* **2023**, *213*, 108228. [CrossRef]
125. Kuhar, T.P.; Kamminga, K.L. Review of the chemical control research on *Halyomorpha halys* in the USA. *J. Pest Sci.* **2017**, *90*, 1021–1031. [CrossRef]
126. Gensch, L.; Jantke, K.; Rasche, L.; Schneider, U.A. Pesticide risk assessment in European agriculture: Distribution patterns, ban-substitution effects and regulatory implications. *Environ. Pollut.* **2024**, *348*, 123836. [CrossRef] [PubMed]
127. Lee, D.H.; Leskey, T.C. Flight behavior of foraging and overwintering brown marmorated stinkbug, *Halyomorpha halys* (Hemiptera: Pentatomidae). *Bull. Ent. Res.* **2015**, *105*, 566–573. [CrossRef] [PubMed]
128. Maistrello, L.; Caruso, S.; Tommasini, M.G. Bioecology and Management of *Halyomorpha halys* in Fruit Orchards in Southern Europe. In Proceedings of the 19th International Conference on Organic Fruit-Growing, Stuttgart, Germany, 17–19 February 2020; FOEKO: Weinsberg, Germany, 2020; pp. 199–202.
129. Masetti, A.; Rathé, A.; Robertson, N.; Anderson, D.; Walker, J.; Pasqualini, E.; Depalo, L. Effects of three chitin synthesis inhibitors on egg masses, nymphs and adults of Halyomorpha halys (Hemiptera: Pentatomidae). *Pest Manag. Sci.* **2023**, *79*, 2882–2890. [CrossRef]
130. Cira, T.M.; Burkness, E.C.; Koch, R.L.; Hutchison, W.D. *Halyomorpha halys* mortality and sublethal feeding effects following insecticide exposure. *J. Pest Sci.* **2017**, *90*, 1257–1268. [CrossRef]
131. Grabarczyk, E.E.; Cottrell, T.E.; Tillman, P.G. Spatiotemporal distribution of *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae) across a fruit and tree nut agricultural ecosystem. *Environ. Entomol.* **2022**, *51*, 824–835. [CrossRef]
132. Candian, V.; Pansa, M.G.; Briano, R.; Peano, C.; Tedeschi, R.; Tavella, L. Exclusion nets: A promising tool to prevent *Halyomorpha halys* from damaging nectarines and apples in NW Italy. *Bull. Insectology* **2018**, *71*, 21–30.
133. Conti, E.; Avila, G.; Barratt, B.; Cingolani, F.; Colazza, S.; Guarino, S.; Hoelmer, K.; Laumann, R.A.; Maistrello, L.; Martel, G.; et al. Biological control of invasive stink bugs: Review of global state and future prospects. *Entomol. Exp. Appl.* **2021**, *169*, 28–51. [CrossRef]
134. Caron, V.; Yonow, T.; Paull, C.; Talamas, E.J.; Avila, G.A.; Hoelmer, K.A. Preempting the Arrival of the Brown Marmorated Stink Bug, *Halyomorpha halys*: Biological Control Options for Australia. *Insects* **2021**, *12*, 581. [CrossRef]
135. Zapponi, L.; Tortorici, F.; Anfora, G.; Bardella, S.; Bariselli, M.; Benvenuto, L.; Bernardinelli, I.; Butturini, A.; Caruso, S.; Colla, R.; et al. Assessing the Distribution of Exotic Egg Parasitoids of *Halyomorpha halys* in Europe with a Large-Scale Monitoring Program. *Insects* **2021**, *12*, 316. [CrossRef] [PubMed]
136. Giovannini, L.; Sabbatini-Peverieri, G.; Marianelli, L.; Rondoni, G.; Conti, E.; Roversi, P.F. Physiological host range of *Trissolcus mitsukurii*, a candidate biological control agent of *Halyomorpha halys* in Europe. *J. Pest Sci.* **2022**, *95*, 605–618. [CrossRef]
137. Kiritani, K. Predicting impacts of global warming on population dynamics and distribution of arthropods in Japan. *Popul. Ecol.* **2006**, *48*, 5–12. [CrossRef]
138. Tortorici, F.; Bombi, P.; Loru, L.; Mele, A.; Moraglio, S.T.; Scaccini, D.; Pozzebon, A.; Pantaleoni, R.; Tavella, L. *Halyomorpha halys* and its egg parasitoids *Trissolcus japonicus* and *T. mitsukurii*: The geographic dimension of the interaction. *NeoBiota* **2023**, *85*, 197–221. [CrossRef]
139. Bertoldi, V.; Rondoni, G.; Brodeur, J.; Conti, E. An Egg Parasitoid Efficiently Exploits Cues from a Coevolved Host but Not Those From a Novel Host. *Front Physiol.* **2019**, *10*, 746. [CrossRef] [PubMed]
140. Yang, Z.-Q.; Yao, Y.-X.; Qiu, L.-F.; Li, Z.-X. A new species of *Trissolcus* (Hymenoptera: Scelionidae) parasitizing eggs of *Halyomorpha halys* (Heteroptera: Pentatomidae) in China with comments on its biology. *Ann. Entomol. Soc. Am.* **2009**, *102*, 39–47. [CrossRef]
141. Andreadis, S.S.; Gogolashvili, N.E.; Fifis, G.T.; Navrozidis, E.I.; Thomidis, T. First Report of Native Parasitoids of *Halyomorpha halys* (Hemiptera: Pentatomidae) in Greece. *Insects* **2021**, *12*, 984. [CrossRef]
142. Konopka, J.K.; Poinapen, D.; Gariepy, T.; Holdsworth, D.W.; Mcneil, J.N. Timing of failed parasitoid development in *Halyomorpha halys* eggs. *Biol. Control.* **2019**, *141*, 104124. [CrossRef]
143. Schifani, E.; Giannetti, D.; Costi, E.; Franconi, G.; Campostrini, A.; Maistrello, L.; Grasso, D. Interactions between egg parasitoids and predatory ants for the biocontrol of the invasive brown marmorated stink bug *Halyomorpha halys*. *J. Appl. Entomol.* **2023**, *147*, 868–874. [CrossRef]

144. Qiu, L.F. Studies on Biology of the Brown Marmorated Stink Bug *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae), Animportant Pest for Pome Treesin China and Its Biological Control. Ph.D. Dissertation, Chinese Academy of Forestry, Beijing, China, 2007.
145. Hou, Z.; Liang, H.; Chen, Q.; Hu, Y.; Tian, H. Application of *Anastatus* sp. against *Halyomorpha halys*. *For. Pest Dis.* **2009**, *4*, 43.
146. Haye, T.; Fischer, S.; Zhang, J.; Gariepy, T. Can native egg parasitoids adopt the invasive brown marmorated stink bug, *Halyomorpha halys* (Heteroptera: Pentatomidae), in Europe? *J. Pest Sci.* **2015**, *88*, 693–705. [CrossRef]
147. Tillman, G.; Toews, M.; Blaauw, B.; Sial, A.; Cottrell, T.; Talamas, E.; Buntin, D.; Joseph, S.; Balusu, R.; Fadamiro, H.; et al. Parasitism and predation of sentinel eggs of the invasive brown marmorated stink bug, *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae), in the southeastern US. *Biol. Control.* **2020**, *145*, 1–13. [CrossRef]
148. Jones, A.L.; Jennings, D.E.; Hooks, C.R.R.; Shrewsbury, P.M. Field surveys of egg mortality and indigenous egg parasitoids of the brown marmorated stink bug, *Halyomorpha halys*, in ornamental nurseries in the mid-Atlantic region of the USA *J. Pest Sci.* **2017**, *90*, 1159–1168. [CrossRef] [PubMed]
149. Ogburn, E.C.; Bessin, R.; Dieckhoff, C.; Dobson, R.; Grieshop, M.; Hoelmer, K.A.; Mathews, C.; Moore, J.; Nielsen, A.L.; Poley, K.; et al. Natural enemy impact on eggs of the invasive brown marmorated stink bug, *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae), in organic agroecosystems: A regional assessment, *Biol. Control.* **2016**, *101*, 39–51. [CrossRef]
150. Balusu, R.R.; Talamas, E.J.; Cottrell, T.E.; Toews, M.D.; Blaauw, B.R.; Sial, A.A.; Buntin, D.G.; Fadamiro, H.Y.; Tillman, G.P. First record of *Trissolcus basalis* (Hymenoptera: Scelionidae) parasitizing *Halyomorpha halys* (Hemiptera: Pentatomidae) in the United States. *Biodivers. Data. J.* **2019**, *7*, 9. [CrossRef]
151. Arakawa, R.; Namura, Y. Effects of temperature on development of three *Trissolcus* spp. (Hymenoptera: Scelionidae), egg parasitoids of the brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Pentatomidae). *Entomol. Sci.* **2002**, *5*, 215–218.
152. Kawada, H.; Kitamura, C. The tachinid fly, *Bogosia* sp. (Diptera: Tachinidae) as a parasitoid of the brown marmorated stink bug, *Halyomorpha mista* Uhler (Heteroptera: Pentatomidae). *Jpn. J. Environ. Entomol. Zool.* **1992**, *4*, 65–70.
153. Li, Z.; Liu, Y. Effect of temperature on development of egg parasitoid *Trissolcus halyomorphae* and the eggs of its host. *Halyomorpha halys*. *Chin. J. Biol.* **2004**, *20*, 64–66.
154. Talamas, E.; Buffington, M.; Hoelmer, K. New Synonymy of *Trissolcus Halyomorphae*. *J. Hymenopt. Res.* **2013**, *33*, 113–117. [CrossRef]
155. Lim, U.; Park, K.; Mahmoud, A.M.A.; Jung, C.; Lim, U.T.; Park, K.S.; Jung, C.E. Areal distribution and parasitism on other soybean bugs of *Trissolcus nigripedius* (Hymenoptera: Scelionidae), an egg parasitoid of *Dolycoris baccarum* (Heteroptera: Pentatomidae). *Korean J. Appl. Entomol.* **2007**, *46*, 79–85. [CrossRef]
156. Chen, J.; Li, W.; Mi, Q.; Zhang, F.; Shi, S.; Zhang, J. A Newly Reported Parasitoid, *Pentatomophaga latifascia* (Diptera: Tachinidae), of Adult *Halyomorpha halys* in Beijing, China. *Insects* **2020**, *11*, 666. [CrossRef]
157. Tillman, G. Laboratory effects of two organically-certified insecticides on *Trichopoda pennipes* (Diptera: Tachinidae) *J. Entomol. Sci.* **2008**, *43*, 408–417. [CrossRef]
158. Sasaki, H.; Kawabata, M. Food habits of the raccoon dog *Nyctereutes procyonoides* viverrinus in a mountainous area in Japan. *J. Mamm. Soc. Jpn.* **1994**, *19*, 1–8.
159. Biddinger, D.J.; Surcică, A.; Joshi, N.K. A native predator utilising the invasive brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Pentatomidae) as a food source. *Biocontrol Sci. Technol.* **2017**, *27*, 903–907. [CrossRef]
160. Kamiyama, M.T.; Matsuura, K.; Yoshimura, T.; Yang, C.C.S. Predation of the brown marmorated stink bug, *Halyomorpha halys* by the Japanese acrobat ants, *Crematogaster matsumurai* and *Crematogaster osakensis*. *Biol. Control* **2021**, *157*, 104570. [CrossRef]
161. Castracani, C.; Bulgarini, G.; Giannetti, D.; Spotti, F.A.; Maistrello, L.; Mori, A.; Grasso, D.A. Predatory ability of the ant Crematogaster scutellaris on the brown marmorated stink bug *Halyomorpha halys*. *J. Pest Sci.* **2017**, *90*, 1181–1190. [CrossRef]
162. Aldrich, J.R.; Chauhan, K.R.; Zhang, A.; Zarbin, P.H. Exocrine secretions of wheel bugs (Heteroptera: Reduviidae: *Arilus* spp.): Clarification and chemistry. *Z. Naturforsch. C J. Biosci.* **2013**, *68*, 522–526. Available online: https://pubmed.ncbi.nlm.nih.gov/24601090/ (accessed on 18 March 2024). [CrossRef]
163. Oda, M.; Nakanishi, Y.; Uesumi, Y. Ecological studies of stink bugs attacking fruit trees. Report 4: Fluctuations in the hibernated population of the brown-marmorated stink bug, *Halyomorpha halys* (Stal) and seasonal prevalence of the adults after hibernation. *Bull. Nara Agric. Stn.* **1982**, *13*, 66–73.
164. Nakashima, N.; Sasaki, J.; Tsuda, K.; Yasunaga, C.; Noda, H. Properties of a new picorna-like virus of the brown-winged green bug, *Plautia stali*. *J. Invertebr. Pathol.* **1998**, *71*, 151–158. [CrossRef]
165. Gouli, V.; Gouli, S.; Skinner, M.; Hamilton, G.; Kim, J.S.; Parker, B.L. Virulence of select entomopathogenic fungi to the brown marmorated stink bug, *Halyomorpha halys* (Stål) (Heteroptera: Pentatomidae). *Pest Manag. Sci.* **2012**, *68*, 155–157. [CrossRef]
166. Tozlu, E.; Saruhan, I.; Tozlu, G.; Kotan, R.; Dadaşoğlu, F.; Tekiner, N. Potentials of some entomopathogens against the brown marmorated stink bug, *Halyomorpha halys* (Stål, 1855) (Hemiptera: Pentatomidae). *Egypt. J. Biol. Pest Control.* **2019**, *29*, 76. [CrossRef]
167. González, J.B.; Lambert, C.A.; Foley, A.M.; Hajek, A.E. First report of *Colletotrichum fioriniae* infections in brown marmorated stink bugs, *Halyomorpha halys*. *J. Invertebr. Pathol.* **2023**, *199*, 107939. [CrossRef]
168. Hajek, A.E.; Solter, L.F.; Maddox, J.V.; Huang, W.-F.; Estep, A.S.; Krawczyk, G.; Weber, D.C.; Hoelmer, K.A.; Sanscrainte, N.D.; Becnel, J.J. *Nosema maddoxi* sp. nov. (Microsporidia, Nosematidae), a Widespread Pathogen of the Green Stink Bug *Chinavia hilaris* (Say) and the Brown Marmorated Stink Bug *Halyomorpha halys* (Stål). *J. Eukaryot. Microbiol.* **2018**, *65*, 315–330. [CrossRef]

169. Sasaki, F.; Miyamoto, T.; Yamamoto, A.; Tamai, Y.; Yajima, T. Relationship between intraspecific variations and host insects of *Ophiocordyceps nutans* collected in Japan. *Mycoscience* **2012**, *53*, 85–91. [CrossRef]
170. Karun, N.; Sridhar, K. Incidence of Entomophagous Medicinal Fungus, *Ophiocordyceps nutans* on Stink Bug, *Halyomorpha halys* (Stål) in the Western Ghats of India. *J. Biol. Control.* **2013**, *27*, 139–143.
171. Stahl, J.M.; Babendreier, D.; Haye, T. Life history of *Anastatus bifasciatus*, a potential biological control agent of the brown marmorated stink bug in Europe. *Biol. Control.* **2019**, *129*, 178–186. [CrossRef]
172. Giannetti, D.; Patelli, N.; Palazzetti, L.; Betti Sorbelli, F.; Pinotti, C.M.; Maistrello, L. First Use of Unmanned Aerial Vehicles to Monitor *Halyomorpha halys* and Recognize It Using Artificial Intelligence. *Pest Manag. Sci.* **2024**, *80*, 4074–4084. [CrossRef]
173. Forresi, C.; Gallinucci, E.; Golfarelli, M.; Maistrello, L.; Preti, M.; Vaccari, G. A Data Platform for Real-Time Monitoring and Analysis of the Brown Marmorated Stink Bug in Northern Italy. *Ecol. Inform.* **2024**, *82*, 102713. [CrossRef]
174. Barzman, M.; Bàrberi, P.; Birch, A.N.E.; Boonekamp, P.; Dachbrodt-Saaydeh, S.; Graf, B.; Sattin, M. Eight Principles of Integrated Pest Management. *Agron. Sustain. Dev.* **2015**, *35*, 1199–1215. [CrossRef]
175. Skendžić, S.; Zovko, M.; Pajač Živković, I.; Lešić, V.; Lemić, D. Effect of Climate Change on Introduced and Native Agricultural Invasive Insect Pests in Europe. *Insects* **2021**, *12*, 985. [CrossRef]
176. Cesari, M.; Maistrello, L.; Piemontese, L.; Bonini, R.; Dioli, P.; Lee, W.; Guidetti, R. Genetic Diversity of the Brown Marmorated Stink Bug *Halyomorpha halys* in the Invaded Territories of Europe and Its Patterns of Diffusion in Italy. *Biol. Invasions* **2018**, *20*, 1073–1092. [CrossRef]
177. Gariepy, T.D.; Haye, T.; Fraser, H.; Zhang, J. Occurrence, Genetic Diversity, and Potential Pathways of Entry of *Halyomorpha halys* in Newly Invaded Areas of Canada and Switzerland. *J. Pest Sci.* **2014**, *87*, 17–28. [CrossRef]
178. Parvizi, E.; Dhami, M.K.; Yan, J.; McGaughran, A. Population Genomic Insights into Invasion Success in a Polyphagous Agricultural Pest, *Halyomorpha halys*. *Mol. Ecol.* **2023**, *32*, 138–151. [CrossRef]
179. Mittapelly, P.; Bansal, R.; Michel, A. Differential Expression of Cytochrome P450 CYP6 Genes in the Brown Marmorated Stink Bug, *Halyomorpha halys* (Hemiptera: Pentatomidae). *J. Econ. Entomol.* **2019**, *112*, 1403–1410. [CrossRef]
180. Sparks, M.E.; Shelby, K.S.; Kuhar, D.; Gundersen-Rindal, D.E. Transcriptome of the Invasive Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål) (Heteroptera: Pentatomidae). *PLoS ONE* **2014**, *9*, e111646. [CrossRef]