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List of species of Pentatomids (Hemiptera: Pentatomidae) in the hazelnut orchards of Sakartvelo (Georgia) and their potential parasitoids

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A B S T R A C T

During this survey in the hazelnut orchards of Sakartvelo (Georgia) 12 species of pentatomids were recorded. The following species are recorded from Georgia: *Graphosoma lineatum* (Linnaeus,1758), *Halyomorpha halys* (Stal,1855), *Pentatoma rufipes* (Linnaeus,1758), *Rhaphigaster nebulosi* (Poda,1761) and *Nezara viridula* (Linnaeus,1758). From the 72 recorded species in Georgia 21 of them have parasitoids from the superfamilies Platygastroidea and Chalcidoidea and this number reaches 32 species from Palaearctic region. However only 14 species of them had been recorded from Caucasus and 9 from Georgia, where hosts are known. Additionally, *Trissolcus manteroi* (Kieffer, 1909) and *Tr. oobius* (Kozlov, 1972) from the Caucasus are reported, but their hosts are unknown.

Key words: Brown Marmorated Stink Bug, *Trissolcus, Ooencyrtus, Anastatus*

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Introduction

The stink bugs in the family Pentatomidae represents one of the most species diverse group among insects, icluding around 5000 species worldwide [1]. They can be serious economic pests of food crops and ornamental plants around the world [2,3]. Many pentatomids cause significant damage to hazelnut crops in Europe, Turkey and Georgia [4], however there are predators too. According Tavella et al. [5], hazelnut in northwestern Italy was damaged by seven species of true bugs: two coreids, one acanthosomatid and four pentatomids. The Brown Marmorated Stink Bug - *Halyomorpha halys* (Stål) (BMSB) (Hemiptera: Pentatomidae), which is native to East Asia (China, Taiwan, Japan, and South Korea), is a serious threat to agriculture in North America and Europe due to its polyphagous behavior and absence of natural enemies in its invaded range [6]. In its native range, BMSB causes extensive damage to various fruits and soybeans, and it has recently become a serious pest of apples in Japan [7].

BMSB is known to overwinter inside houses and other enclosed structures, becoming a nuisance pest for homeowners before migrating in the spring into crops and weedy areas where its population develops large numbers during summer and fall [6,8,9].

It must be noted that much research has focused on assessment of biological control agents available in its native range of Asia that offer effective population suppression, specifically parasitoid wasps [10,11]. However, exploration for alternative local natural enemies in it's newly invaded areas is actively going on [12,13,14].

The list of hemipterans distributed in Georgia (=Sakartvelo) was done by Zaitseva [15,16] and included 72 species. The list of pentatomid parasit-

oids distributed in Georgia have not been reported previously.

Material and methods

The sampling was conducted in hazelnut orchards of five different regions of Sakartvelo: Guria, Achara, Samegrelo (Western Georgia), Kartli and Kakheti (Eastern Georgia). Eight field trips were organized during the 2019 growing season, from April to November. Beating trays were used for collecting BMSB individuals. The egg masses collected from the field were taken to the laboratory, and rearing was conducted in cages. Species of stink bug collected during the surveys were identified by the first author. *Trissolcus* spp. were treated by Japoshvili et al. [14].

As the most species of *Trissolcus* are olygophagous, and they can parasitize alternative hosts, the literature sources were surveyed to make list of pentatomid parasitoids distributed in the Palaearctic, Caucasus and Georgia, to know potential of biocontrol. All species recorded (reared) for these pests from throughout the Palaearctic region are listed. The species distributed in Caucasus are marked with one asterisk and species from Georgia with two asterisks (Table 1). Parasitoid list was completed based on Kozlov, Kononova [17], Talamas et al. [18], Noyes [19], Powell [20] and Japoshvili et al. [14].

It should be noted that many of the *Trissolcus* parasitoids were identified prior to the taxonomic treatments by Talamas et al. [18] and Tortorici et al. [21], and these publication provide the basis for our name usage. We consider it most likely that identifications of *Tr. flavipes* (Thomson) were actually *Tr. cultratus* (Mayr) [22] and treat these as such in our list.

Results

List of pentatomids recorded in Georgian hazelnut orchards:

Pentatomidae

Genus *Acanthosoma* Curtis, 1824

1. *Acanthosoma haemorrhoidale* (Linnaeus,1758)

Material examined: Georgia, Gonio (1), 12.05.2019

Genus *Carpocoris* Kolenati, 1846

2. *Carpocoris fuscispinus* (Boheman,1850)

Material examined: Georgia, Dziguri.(4), 10.04.2019; Zakagori(1), 6.07.2019.

3. *Carpocoris pudicus* (Poda,1761)

Material examined: Georgia, Shakriani (2), 17.07.2019; 18.06.19; Khobi (1), 11.07.2019.

Genus *Dolycoris* Mulsant & Rey, 1866

4. *Dolycoris baccarum* (Linnaeus,1758)

Material examined: Georgia, Dziguri sasaplao (15), 10.04.2019; Mta Peria (3), 14.04.2019. Shakriani (1), 10.05.2019.

Genus *Elasmucha* Stal 1864

5. *Elasmucha betulae* (De Geer,1773)

Material examined: Georgia, Eniseli (1), 18.06.2019.

Genus *Eurydema* Laporte de Castelnau, 1833

6. *Eurydema oleracea* (Linnaeus,1758)

Material examined: Georgia, Shakriani (1), 17.05.2019.

7. *Eurydema ornata* (Linnaeus,1758)

Material examined: Geoegia, Shakriani (4), 10.05.2019.

Genus *Graphosoma* de Laporte, 1832

8. *Graphosoma lineatum* (Linnaeus,1758)

Material examined: Georgia, Shakriani, 18.06.2020.

Genus *Halymorpha* Mayr, 1864

9. *Halymorpha halys* (Stal,1855)

Material examined: Georgia, Junetseri (3), 15.07.2019; Khobi (3), 11.07.2019; Agruni (1), 13.10.2019; Lanchkhuti (1), 12.04.2019.

Genus *Mustha* Amyot & Serville, 1843

10. *Mustha spinosula* (Lefebvre,1831)

Material examined: Georgia, Isani (1), 26.06.2019.

Genus *Pentatoma* (Olivier, 1789)

11. *Pentatoma rufipes* (Linnaeus,1758)

Material examined: Georgia, Tsitelmta (1), 15.06.2019.

Genus *Rhaphigaster* Laporte, 1833

12. *Rhaphigaster nebulosa* (Poda,1761)

Material examined: Georgia, Eniseli (1), 18.06.2019.

Note: Number of individuals are given in brackets.

Conclusion

Our survey in the hazelnut orchards of Sakartvelo (Georgia) revealed 12 species of pentatomids, among them are well known pests of different agricultural and forest plants: *Graphosoma lineatum*, *Halyomorpha halys*, *Pentatoma rufipes* and *Rhaphigaster nebulosa*. Literature sources records also *Nezara viridula* [16], which was not found during our

studies in Hazelnut orchards. From the 72 recorded species in Georgia [16] 21 of them have parasitoids from Platygastroid and Chalcidoid families and this number reaches 32 species from the Palaearctic region. However only 14 species of them had been recorded from Caucasus and 9 from Georgia, where hosts are known. Additionally, *Tr. manteroi* and *Tr. oobius* for Caucasus are reported, but their hosts are unknown.

This data gives very optimistic hopes in the biological controlling measures against such dangerous pests as it is Brown Marmorated Stink Bug – *Halyomorpha halys*. Thus future intensive investigations are needed to elaborate effective integrated pest menegment methods and reduce insecticide mass applications.

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Table 1. The pentatomids (Hemiptera: Pentatomidae) species recorded from Sakartvelo with their parasitoids recorded from the Palaearctic region.

№	**Pentatomidae**	**Parasitoids**
1	*Aelia rostrarta* Boh	Platygastroidea
		Trissolcus colemani (Crawford)** *Tr. rufiventris* (Mayr)* *Telenomus chloropus* (Thomson)**
		Chalcidoidea
		Ooencyrtus pityocampae (Mercet) *O. telenomicida* (Vassiliev)**
2	*Aelia acuminata* L.	Platygastroidea
		Trissolcus basalis (Wollaston) *Tr. belenus* (Walker)** *Tr. colemani* (Crawford)** *Tr. semistriatus* (Nees)** *Tr. scutellaris* (Thomson)** *Tr. rufiventris* (Mayr)*
		Chalcidoidea
		Ooencyrtus nigerrimus Ferriere & Voegele *O. pityocampae* (Mercet) *O. telenomicida* (Vassiliev)**

3	*Arma custos* F.	Platygastroidea
		Telenomus heydeni Mayr*
4	*Apodiphus amygdali* Germ	Platygastroidea
		Trissolcus saakowi (Mayr)* *Tr. tumidus* (Mayr)**
		Chalcidoidea
		Oopristus erganicus Tarla & Doganlar *O. tayfursokmeni* Tarla & Doganlar *O. turkestanicus* Skriptshinsky
5	*Carpocoris fuscispinus* Boh	Platygastroidea
		Trissolcus basalis (Wollaston) *Tr. rufiventris* (Mayr)* *Tr. scutellaris* (Thomson)** *Telenomus chloropus* (Thomson)**
		Chalcidoidea
		Ooencyrtus nigerrimus Ferriere & Voegele *O. pityocampae* (Mercet) *O. telenomicida* (Vassiliev)**
6	*Carpocoris pudicus* Poda	Platygastroidea
		Trissolcus colemani (Crawford)** *Tr. flavipes* (Thomson)* *Tr. scutellaris* (Thomson)** *Tr. viktorovi* Kozlov**
		Chalcidoidea
		Ooencyrtus nigerrimus *O. pityocampae* (Mercet) *O. telenomicida* (Vassiliev)**
7	Dolycoris baccarum L.	Platygastroidea
		Trissolcus belenus (Walker)** *Tr. colemani* (Crawford)** *Tr. mitsukuri* (Ashmead) *Tr. rufiventris* (Mayr)* *Tr. scutellaris* (Thomson)** *Tr. semistriatus* (Nees)** *Tr. viktorovi* Kozlov** *Telenomus chloropus* (Thomson)** *Te. heydeni* Mayr*
		Chalcidoidea
		Ooencyrtus pityocampae (Mercet) *O. telenomicida* (Vassiliev)** *O. solidis* Khlopunov

8	*Eysarcoris ventralis* Westw	Platygastroidea
		Telenomus chloropus (Thomson)**
9	*Eurydaema oleracea* L.	Platygastroidea
		Tr. belenus (Walker)** *Tr. colemani* (Crawford)**
10	*Eurydema ornata* L.	Platygastroidea
		Trissolcus basalis (Wollaston) *Tr. belenus* (Walker)** *Tr. colemani* (Crawford)** *Tr. scutellaris* (Thomson)* *Tr. semistriatus* (Nees)** *Tr. viktorovi* Kozlov**
		Chalcidoidea
		Ooencyrtus telenomicida (Vassiliev)** *Anastatus bifasciatus* (Goeffroy)
11	*Eurydema spectabilis* Hrv	*Trissolcus viktorovi* Kozlov**
12	*Eurydema ventralis* Kol.	*Trissolcus scutellaris* (Thomson)** *Tr. colemani* (Crowford)** *Tr. belenus* (Walker)**
13	*Graphosoma lineatum* L.	Platygastroidea
		Trissolcus belenus (Walker)** *Tr. colemani* (Crawford)** *Tr. rufiventris* (Mayr)* *Tr. scutellaris* (Thomson)** *Tr. semistriatus* (Nees)** *Tr. viktorovi* Kozlov** *Telenomus chloropus* (Thomson)**
		Chalcidodiea
		Ooencyrtus gonoceri Viggiani *O. nigerrimus* Ferriere & Voegele *O. pityocampae* (Mercet) *O. telenomicida* (Vassiliev)**
14	*Graphosoma semipunctatum* F.	Platygastroidea
		Trissolcus basalis (Wollaston) *Tr. belenus* (Walker)** *Tr. bennisi* (Voegele) *Tr. colemani* (Crawford)** *Tr. scutellaris* (Thomson)** *Tr. semistriatus* (Nees)**
		Chalcidodiea
		Ooencyrtus gonoceri Viggiani *O. nigerrimus* Ferriere & Voegele *O. pityocampae* (Mercet) *O. telenomicida* (Vassiliev)**

15	*Halyomorpha halys* Stal	Platygastroidea
		Trissolcus cultratus (Mayr)** *Tr. japonicus* (Ashmead)
		Chalcidodiea
		Anastatus bifasciatus (Goeffroy)** *Ooencyrtus telenomicida* (Vassiliev)*
16	*Holcostethus venalis* Wolff.	Platygastoirea
		Trissolcus belenus (Walker)** *Tr. colemani* (Crawford)**
17	*Neottiglossa pusilla* Gmel.	*Trissolcus colemani* (Crawford)**
18	*Nezara viridala* L.	Platygastroidea
		Trissolcus basalis (Wollaston) *Tr. mitsukurti* Ashmead *Tr. scutellaris* (Thomson)**
		Chalcidoidea
		Ooencyrtus nezarae Ishii *Ooencyrtus nigerrimus* Ferriere & Voegele *Ooencyrtus papilionis* Ashmead *Ooencyrtus pityocampae* (Mercet) *Ooencyrtus telenomicida* (Vassiliev)** *Anastatus bifasciatus* (Geoffroy)** *Anastatus japonicus* (Ashmead) *Acroclisoides* sp. *Pteromalus* sp.
19	*Palomena prasina* L.	Platygastroidea
		Trissolcus belenus (Walker)** *Tr. cultratus* (Mayr)** *Tr. elasmuchae* (Watanabe) *Telenomus chloropus* (Thomson)** *Te. heydeni* Mayr*
		Chalcidoidea
		Anastatus japonicas (Geoffroy)** *Oencyrtus telenomicida* (Vassiliev)**
20	*Palomena viridissima* Poda	Platygastroidea
		Telenomus chloropus (Thomson)** *Te. heydeni* Mayr*
21	*Pentatoma rufipes* L.	Platygastroidea
		Trissolcus kozlovi Rjachovsky *Tr. scutellaris* (Thomson)**
22	*Rhaphigaster nebulosa* Poda	Platygastroidea
		Telenomus heydeni Mayr*
		Chalcidodiea
		Ooencyrtus pityocampae (Mercet) *Anastatus bifasciatus* (Goeffroy)**