PRE-WINTERING BEHAVIOR OF *HALYOMORPHA HALYS* (INSECTA: HEMIPTERA: PENTATOMIDAE)

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Abstract. *The species Halyomorpha halys is an arthropod insect (Arthropoda: Insect: Hemiptera: Pentatomidae) that has recently appeared in various places, disrupting both good plant growth but also human comfort and habitat. Although in Romania it was reported 4-5 years ago, and in the western part (Banat) 2-3 years ago, no obvious damages or invasions in the human habitat were recorded. And this is explainable, because at the beginning of the installation in a new area the population level of sting bugs is low. Through the present work we intend to bring to attention the pre-wintering behavior of this species. The period in which the observations were made included 2 months (September and October) of the current year (2019). The place of these observations was conducted in a private mixed garden in Timis county that includes many species of vegetables, fruit trees, ornamental plants, lawn grass, terrace and house. It is interesting the behavior that these stink bugs have during the autumn period, specifically before hibernation. Analyzing their activity at different times of the day I found that they behave differently, being in a continuous movement. At lower temperatures of the day (below 18-20°C) they were removed to sheltered places (terraces, objects present on terraces, warehouses, under layers of leaves, among stones, etc.). At higher temperatures (over 20°C) during the day, the adult forms migrated to the still green plants and continued to feed. There is a dynamic of their flight during this period expressed by chaotic movements from shady to bright places (where the sun is present) and vice versa when the temperatures and intensity become unbearable for them. Being large insects, they can be easily observed in preferred places. Usually they are extremely active and mobile at temperatures between 20-28°C, when the flight was more intense. The aggression of the attack on the plants differs depending on the presence and variety of the preferred plants and the maintenance of the organs of the plant in a green state. In conclusion, this insect has become in the last year (2019) a big problem both for the plants of culture (agricultural, horticultural), for the ornamental ones but especially for the houses of the people.*

Keywords*: Insect, pest, Halyomorpha halys, behavior, pre-wintering.*

INTRODUCTION

The insect under study is *Halyomorpha halys* of the class Insecta, the order Hemiptera (ancient name Heteroptera) and the family Pentatomidae. It is known by the popular name of brown marmorated stink bug (CABI, 2019). This species has recently entered in our country. Studies related to this have been conducted in all areas of the country, in an extremely short interval, of 5-6 years (DEMICHELE and GROZEA, 2018; CICEOI et al., 2017; MACAVEI et al., 2015). Also, at European level it is in a permanent state of conquering new places different climate (HEMALA and KMENT, 2017; MALUMPHY, 2014; RABITSCH and FRIEBE, 2015; MILONAS and PARTSINEVELOS, 2014; MITYUSHEV, 2016; SEAT, 2015).

Its importance is given by the permanent adaptability to new spaces and areas and especially plants (culture, ornamental, tree fruits, small fruits, vegetables or tree forestry). It is known that at present it attacks over 100 species of host plants worldwide (FOGAIN and GRAFF, 2011; LESKEY ET AL., 2012). Only in Europe are affected half of these species of plants (SERTEYN ET AL, 2018; EPPO, 2019).

The species, prior to hibernation, seeks shelter in order to protect themselves from the environment, such as buildings (INCLEY, 2012). It is also extremely active and can moving up

to 2 km in a single day. Researches have shown that at temperatures above 15 degrees and 60% humidity, the flight of adults from Halyomorpha has intensified (LEE ET AL., 2015).

MATERIAL AND METHODS

The observations of pre-wintering behavior of *Halyomorpha halys* were made for 40 days in a private garden in Timis county (lat. N 45.4659/long. E 21.1431) in the autumn of 2019, more precisely between September 15 and October 25. In the laboratory of Diagnosis and Phytosanitary Expertise (DPE) were carried out those studies of detail and of exact identification of the male and female individuals (figure 2), after previously the specimens belonging to the species of pentatomides of the genus Halyomorpha were established. The main feature was the presence of the 5 white spots on the lateral edges of the body (DEMICHELE and GROZEA, 2018).

From each space, considered as an observation point (on an approximate surface of $3m^2$), all the exemplars found at one reading/hour/day were collected and quantified (figure 1).

Figure 1. Adult collection of *Halyomorpha halys*; a, from the spaces protected by houses; b, from the spaces in which plants were present (Photo: Grozea, 2019)

Table 1

Data on the spaces and places analyzed in order to establish the presence or absence of *Halyomorpha halys*

No crt	Analyzed places	Status	The analyzed space
1	on tomato plants	Present	in the garden
2	in lawn grass in the yard	Present	in the house's yard
3	between spinach plants in the garden	Present	in the garden
4	on other plants	Absent	in the garden/ in the house's yard
5	in ornamental trees in the yard	Absent	in the house's yard
6	under fallen leaves	Present	in the garden/ in the house's yard
7	in the external part of the windows of the house	Present	near the house building
8	on the external wall of the house	Present	near the house building
9.	between decorative stones in the garden	Present	near the house building
10	in the space between the door and the warehouse	Present	near the house building
11	in the flower pot on the terrace	Present	near the house building

** the places from the analyzed spaces were monitored in all the 5 data/5 readings mentioned in the text above the table*

The insects were observed as the first phase by periodic (weekly) analysis of the different spaces present in the analyzed garden (table 1). The same places were kept from one reading to another, marking the place at the first reading. Thus, 6 readings were made in 3 periods of the day (morning at hours 9-11, midday (12 -14 h) and after lunch (15 -17 h).

Figure 2. Detailed studies on the specimens of *Halyomorpha halys*;
(the observations were made in the DPE laboratory)

RESULTS AND DISCUSSION

Following the observations made it was found that the species *Halyomorpha halys* is abundant during the autumn. From all the 11 places subjected to the observations it resulted that the species was present in its adult form in 9 of them (figures 2, tables 1). Most exemplars were found in the space close to the house building. But they were found in the garden on several species of plants but also in the yard of the house in various places. No adults were found on in ornamental trees in the yard and on ornamental plant species of yard, like rose, maple, magnolia, bat and others.

Analyzing their evolution during the period mentioned above, it can be seen from table 2 that in places with plants or grass (further away from the house building) adults predominated in September (check 1 – check 3), and in October (check 4-check 6) there were more places near the house. Which can be explained by the presence of still plants in vegetation but also of the high temperatures maintained. The lack of rainfall and the prolongation of the warm season has caused this species to grow very numerically.

Table 2

Date regarding the number of specimens found in various places in a garden and near the inhabited house;
Timis county, from September 15 to October 25, 2019

No of places	Analyzed places	Total number of insects/place					
		Observations/Readings					
		check 1	check 2	check 3	check 4	check 5	check 6
1	on tomato plants	5	7	7	3	0	0
2	in lawn grass in the yard	0	1	1	0	0	0
3	between spinach plants in the garden	1	1	0	0	0	0
4	under fallen leaves	0	0	3	6	10	0
5	in the external part of the windows of the house	0	0	8	14	19	21
6	on the external wall of the house	0	0	5	6	6	7
7	between decorative stones in the garden	0	0	1	0	0	0
8	in the space between the door and the warehouse	0	0	11	13	24	31
9	in the flower pot on the terrace	0	0	4	5	9	0

	C1	C2	C3	C4	C5	C6
n	9	9	9	9	9	9
X	0.67	1.00	4.44	5.88	8.50	7.38
s	1.66	2.29	3.68	5.28	9.07	12.05
Sx	0.55	0.76	1.23	1.76	3.02	4.02
V	248.75	229.13	82.76	89.81	106.72	163.35
Sx%	82.92	76.38	27.59	29.94	35.57	54.45

* only places with positive results are taken into account, where the target species was present
** Check 1: 15.09.2019; Check 2: 23.09.2019; Check 3: 31.09.2019; Check 4: 8.10.2019; Check 5: 16.10.2019; Check 6: 25.10.2019

Most insects were observed in the space between the door and the warehouse and in the external part of the windows of the house, reaching very high values (62-79 adult individuals) (figure 3 and figure 4). Being very large, visible, high mobility envelopes, they can cause plant damage and discomfort in people's living spaces with only 4-5 individuals/m^2. Which means that compared to the analyzed area in each place (3.5 m2) the values are around 20-25 individuals/check.

Figure 3. Adults of *Halyomorpha halys* observed in the hidden places near the house (from left to right): between decorative stones, in the space between the door and the warehouse; in the external part of the windows of the house, in the flower pot on the terrace, on the external wall of the house (photo taken by Grozea during the period September-October, 2019)

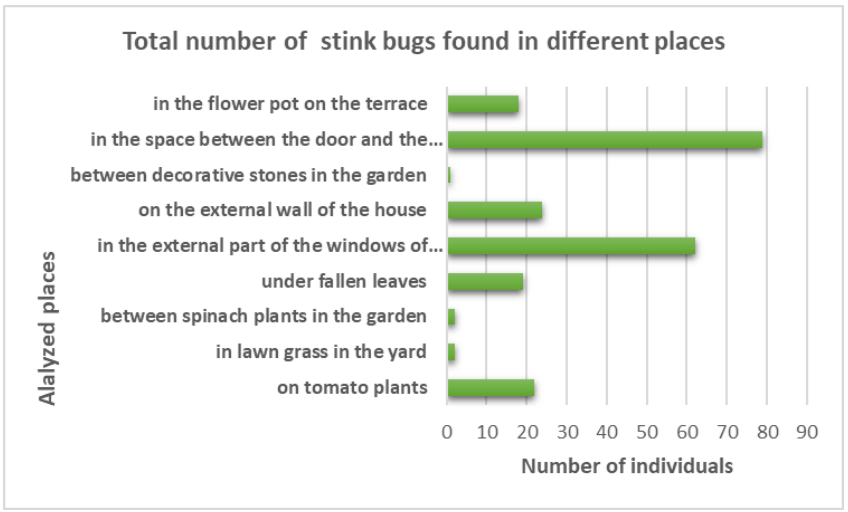

Figure 4. The total number of adult specimens of *Halyomorpha halys* find throughout the analyzed period in all places with positive results

At an average level (18-24 ind/ m^2) are located individuals found in the flower pot on the terrace, on the external wall of the house, under fallen leaves and in on tomato plants (figure 4, figure 5). Between 1-2 individuals/m^2 were observed in the following places: in lawn grass in the yard, between spinach plants in the garden and between decorative stones; being considered a low level and therefore without negative repercussions on plants or human comfort (figure 3, figure 5 and figure 5).

Regarding the period of the day when the insects were observed, they were different both between the analyzed sites and between checks (table 3). It is noted that most specimens in the places in the garden space were observed in the middle of the day. The explanation could be that, being plants near the end of the vegetation cycle and that were kept green or in fruiting (the case of tomatoes) they attracted the adults of the insect for feeding before hibernation. Also, the days of September were extremely warm and rainless and this favored their flight to plants.

Table 3

Data on the evolution of the species at different times of the day in all analyzed locations

No crt	Analyzed places	Adults of *Halyomorpha halys* Presence /Absence					
		check 1	check 2	check 3	check 4	check 5	check 6
1	on tomato plants	* (D)	* (M)	*(D)	*(D)	a	a
2	in lawn grass in the yard	a	* (D)	(D)	a	a	a
3	between spinach plants in the garden	* (D)	(D)	a	a	a	a
4	under fallen leaves	a	a	*(A)	*(M)	**(M)	a
5	in the external part of the windows of the house	a	a	*(A)	*(A)	** (M)	**(M)
6	on the external wall of the house	a	a	* (D)	* (A)	* (A)	*(D)
7	between decorative stones in the garden	a	a	*(A)	a	a	a
8	in the space between the door and the warehouse	a	a	**(M)	**(M)	*** (A)	***(A)
9	in the flower pot on the terrace	a	a	*(M)	*(M)	*(M)	a

1-9 ind./place (low level); 10-24 in/place (middle level); >25 ind (high level); (M)- in the morning; (D)- middle of the day; (A)- in the afternoon

Figure 5. Adults of *Halyomorpha halys* observed in the garden (from left to right): on tomato plants, in lawn grass in the yard, between spinach plants in the garden (photo taken by Grozea, during the period September, 2019)

In places near the house and warehouse, insects were observed in the morning and in the evening, usually when the temperatures are considerably lower than in the middle of the day (table 3, figure 3). Which means they are moving back to warmer, more sheltered places.

CONCLUSIONS

The species under study is present in extremely large populations during the autumn, especially near people's homes (and where there is also green space with garden and plants, trees, grass). The differences in temperature between day and night in the autumn days are probably the causes of these migrations from plant spaces to warmer places.

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BIBLIOGRAPHY

CABI, 2019. Invasive Species Compendium. Detailed coverage of invasive species threatening livelihoods and the environment worldwide (Report on https://www.cabi.org (accessed on oct, 2019) (UK).

CICEOI R., BOLOCAN I.G., DOBRIN I., 2017. The spread of brown marmorated stink bug, *Halyomorpha halys*, in Romania. Journal of horticulture, forestry and biotechnolog, 21(3):15-20 (RO).

EPPO, 2019. EPPO Global Database. Paris, France: EPPO (https://gd.eppo.int/) (FR).

DE MICHELE A., GROZEA I. 2018. Review of the spreading of *Halyomorpha halys* in Italy and confirmation of presence in Romania Research Journal of Agricultural Science. 50 (4): 111-115 (RO).

FOGAIN R., GRAFF S., 2011. First records of the invasive pest, *Halyomorpha halys* (Hemiptera: Pentatomidae), in Ontario and Quebec. Journal of the Entomological Society of Ontario. 142:45-48 (US).

HEMALA V., KMENT P., 2017. First record of *Halyomorpha halys* and mass occurrence of Nezara viridula in Slovakia (Hemiptera: Heteroptera: Pentatomidae). Plant Protect. Sci., 53.

HECKMANN R., 2012. Erster Nachweis von *Halyomorpha halys* (Stal, 1855) (Heteroptera: Pentatomidae) für Deutschland. Heteropteron. 36: 17-18.

INKLEY D.B., 2012. Characteristics of home invasion by the brown marmorated stink bug (Hemiptera: Pentatomidae). Journal of Entomological Science. 47(2):125-130 ().

LESKEY T.C., SHORT B. BUTLER B.R., WRIGHT S.E., 2012. 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. Journal of Entomology, 2012 (Doi: 10.1155/2012/535062) (US).

MACAVEI L. I., BAETAN R., OLTEAN I., FLORIAN T., VARGA M., COSTI E., MAISTRELLO LARA, 2015. First detection of *Halyomorpha halys* Stal a new invasive species with ahigh potential of damage on agricultural crops in Romania. Lucrari Stiinþifice seria Agronomie.58, (1):105-108 (RO).

MALUMPHY C., 2014. Second interception of *Halyomorpha halys* (Stal) (Hemiptera: Pentatomidae) in Britain. Het News, 21: 4-5.

MILONAS P.G., PARTSINEVELOS G.K, 2014. First report of brown marmorated stink bug *Halyomorpha halys Stal* (Hemiptera: Pentatomidae) in Greece. Bulletin OEPP/EPPO Bulletin, 44: 183-186.

MITYUSHEV I.M., 2016. First record of the brown marmorated stink bug *Halyomorpha halys* Stal, in the Russian Federation. In: Sukachev V.N., Tsitsin N.V. (eds): Monitoring and Biological Control Methods of Woody Plant Pests and Pathogens: from Theory to Practice. Proceedings International Conference, SIF SB RASc., 147-148.

RABITSCH W., FRIEBE G.J., 2015. From the west and from the east? First records of *Halyomorpha halys* (Stal, 1855) (Hemiptera: Heteroptera: Pentatomidae) in Vorarlberg and Vienna, Austria. Beiträge zur Entomofaunistik, 16: 115-139.

SEAT J., 2015. Halyomorpha halys (Stal, 1855) (Heteroptera:Pentatomidae) a new invasive species in Serbia. Acta Entomologica Serbica, 20: 167-171.

SERTEYN L, PONNET L., SAIVE M., FAUCONNIER M. L., FREDER F., 2018. Interaction between *Halyomorpha halys* Stal and its host plant: induced defense and feeding behavior. XI Eur. Congr. Entomol. Societa Entomologica Italiana.