# BENEFICIAL INTERACTIONS BETWEEN PEST HEMIPTERS AND OTHER ARTHROPODS IN MIXED PLANT SPACES

**Ioana GROZEA, Ramona STEF, Ana Maria VIRTEIU, A. CARABET, Monica BUTNARIU, L. MOLNAR, A. GROZEA**
***Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" Timisoara, Romania***
*Corresponding authors: ioana_entomol@yahoo.com; adriangrozea@usab-tm.ro*

***Abstract.*** *Hemipteran insect species are increasingly present in areas occupied by plants either productive (agricultural or horticultural) or from natural ecosystems, feeding intensely on their sap. They have a high degree of adaptability, usually migrating from warmer areas to temperate areas, so in recent years there have been more and more host plants, in as diverse areas and growing populations. Through this paper we intend to make an assessment of hemipteran species from 3 spaces with diversified mixed plants (agro-horticultural) in Arad and Timiș County to see the population level, the preference of the host plant and also the natural enemies present identified as potential pest control agents. The results obtained showed the presence of the following categories of hemipteran: aphids, cicadas, stinky bugs and lace bugs. Their population level varied depending on the area analyzed and the range of host plants also differed depending on the species. The most numerous were the aphids, related to the analyzed surface, of course due to their small size, followed by lace bugs (all active in the colonies) and then bedbugs (which are solitary) and cicadas. As for the identified natural enemies, they belonged to the following categories: predatory spiders, ladybugs and parasitic wasps. The level of interaction of spiders and ladybugs was analyzed in the light of a small-scale laboratory study and that of parasitic wasps by the presence of mummies (parasitic aphids) and it was found that all identified categories can fulfill the role of control agent, within varying limits the predominance of pests in an analyzed space.*

***Keywords****: hemipteran, pests, natural enemies, agro-horticultural spaces.*

## INTRODUCTION

For 100 years, two different orders Hemiptera and Homoptera have been recognized by the scientific world (SLATER AND BARANOWSKI, 1978). Then, new evidence based on DNA has shown that they actually belong to the same major group, Hemiptera. The order Hemiptera, as it is known in the literature (SLATER AND BARANOWSKI, 1978; GILLOT, 2005; GROZEA 2015) includes most insect species that have hemimetabolic development. In turn, it is subclassified into several suborders that include insects with diverse morphology and feeding mechanism. Of these, the following groups are worth mentioning: aphids, cicadas, bed bugs, shield bugs plant hoppers and leaf hoppers.

Most are phytophagous and produce destructive effects on agricultural, horticultural, forestry and protected areas. During feeding, aphids and cicadas can transmit various viruses and phytoplasmosis, acting as vectors (EASTOP, 1977).

Each group of hemipteran has a different behaviour in terms of host plant area and feeding. What is certain is that they are all adapted especially for feeding on leaves than on other plant organs.

Thus, aphids attack in mixed colonies, usually have already established host plants and feeding attracts symptoms characterized by twists or wrinkles (FLINT, 2013; GROZEA AND COSTEA, 2019).

Cicadas attack differently, larvae and nymphs extract sap but without causing leaf twisting while adults sit in Indian rows on tree trunks (VLAD AND GROZEA, 2016).

The bedbugs and shield bugs discolour the leaf tissue, leave a liquid that gives a dirty, stained appearance and also imprints a specific smell.

Lace bugs leave small spots closed and the removed liquid gives a stained appearance (HALBERT AND MEEKER, 1998; OSZI ET AL. 2005).

All the leaves (and other attacked organs) are covered with a liquid either sticky (like aphids, cicadas) which is called honey dew (DELABIE, 2001) or non-sticky but stained.

And in terms of preference for living conditions they differ, so while aphids prefer alternating temperatures and humidity, bedbugs, shield bugs and lace bugs are heat-loving species and cicadas in shady places (GOZEA, 2015).

From another point of view, young aphids, cicadas and bedbugs are colonial insects and mature bedbugs are solitary insects (GROZEA, 2015; MARCU AND GROZEA, 2017).

Usually in addition to these harmful hemipterans, there are other insects on the plants that can be natural enemies. Aphids have many natural enemies, including the following: ladybird beetles, parasitic wasps, hornets, spiders and earwigs (Paterson and Ramirez, 2016).

Recommendations for the use of parasitoids have been issued to attract bed bugs insects (in France) after GARROUSTE R. (2018).

Cicadas are less studied in terms of interaction with local natural enemies. Only a few attempts to introduce the hymenopteran from the American continent *Neodryinus typhlocybae* are known (STRAUS, 2013).

In association with lace bugs the fungi as *Beauveria pseudobassiana* and *Lecanicillium pissodis* were identified (KOVAC ET AL. 2020).

Through this paper we aimed to make an assessment of the species of hemipterans in several areas with combined plants to see the population level, monthly evolution of each goup and also the natural enemies present identified as potential control agents.

## MATERIAL AND METHODS

The study presented in the paper was carried out over two years, respectively 2020 and 2021, in the western part of Romania, respectively Arad and Timis counties. The research locations were chosen on the principle of combining as many categories of plants as possible, so we went to private gardens in 3 localities: Dumbravita, Pesac and Santana.

Each space studied included several groups of plants (table 1) that are known to attract many hemipterans but also natural enemies so that the interactions between pests and potential control agents can be evaluated. The analysed area was 200 $m^2$ for each place and included the planting categories mentioned in Table 1.

*Table 1*

Study places and plant groups analysed for each of them

| Place of study | Geographical coordinates/ identification data | Groups of plants present in each research location (present +/absent -) | | | | |
|---|---|---|---|---|---|---|
| | | ornamental plants trees plants | shrub ornamental | plants herbaceous ornamental | vegetables | fruit trees |
| Place 1* | 45.782976, 21.242015 | + | + | + | + | + |
| Place 2** | 45.993547, 20.829628 | - | + | + | + | + |
| Place 3*** | 46.337700, 21.495350 | - | + | + | + | + |

**Dumbravita, Timis County*
***Pesac, Timis County*
****Santana, Arad County*

The observations were made monthly between April and October when the plants, both grassy and woody, were in vegetation and the pests were in the feeding activity.

The pest assessment was done for each group. The size of aphid populations was assessed by handmade yellow traps. Planthoppers were assessed by counting the larvae and nymphs in the

samples obtained after cutting 10 shoots (5 cm from the top) and similarly the immature stages (larvae and nymphs) of lace bugs. The stinking bedbugs were quantified by direct observations. At each reading, in addition, observations were made on the associations of hemipteran pests with potential natural enemies, of course present on plants.

Part of the pest - natural enemy interaction study was conducted in laboratory conditions, where in the terrariums (where fresh plants preferred by pests were placed daily) were introduced 100 aphids and 20 ladybugs or 50 bed(stink) bugs and 10 spiders for two weeks (in June).

Mummies or aphids parasitized by wasps were counted on plant shoots under the same sampling conditions as for planthoppers evaluation.

## RESULTS AND DISCUSSION

The following species of hemipterans have been identified: *Macrosiphum rosae* (rose aphid), *Aphis pomi* (green apple aphid), *Metcalfa pruinosa* (citrus flatid planthopper), *Halyomorpha halys* (brown marmorated stink bug), *Nezara viridula* (southern green stink bug) and *Corythucha ciliata* (the sycamore lace bug).

In the first year of study (2020) the average values recorded for each category were ranked as follows: aphids with x=259.5 specimens/place1+ place2+ place3, lace bugs with x=243.5 individuals, then planthoppers (x=106.5 ind.) and stink bugs wit x=95.5 ind. In the second year (2021) the situation led to a slightly different ranking from the first year for the 3 places of study. Thus, in the first place were placed the aphids (x =261.1 ind.), then stink bugs (x=152.3 ind.), lace bugs (x= 102.6 ind.) and finally planthoppers (x=56.7 ind.) (figure 3).

Regarding the monthly evolution of hemipterans it can be seen in figure 1 that in 2020 the aphids had a progressive increase until June when the peak was observed, then their number gradually decreased until October. Planthoppers peaked in July, stink bugs and lace bugs peaked in June with a slight gradual decline through October.

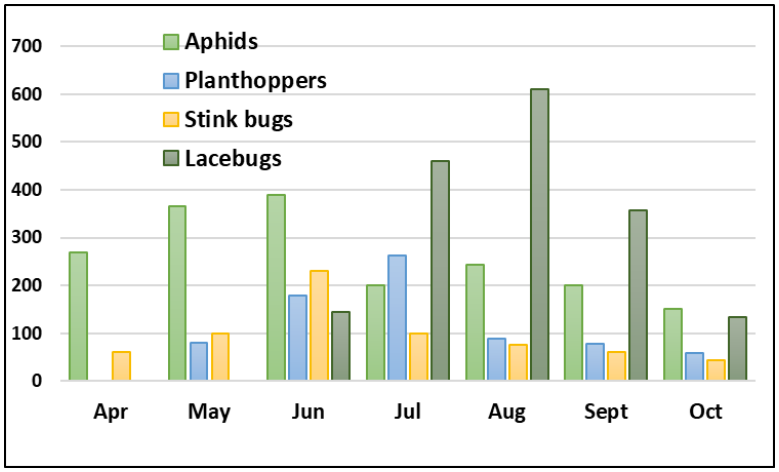


Fig. 1. The evolution of hemipterans during April-October, 2020, in the 3 places under study

Aphids had a monthly evolution in 2021 with a peak in July, the rest with gradual increases and decreases, planthoppers had a similar one to the previous year, with a peak in July. In terms of stink bugs, they peaked in June and lace bugs, as in 2020, peaked in August (figure 2, figure 3).

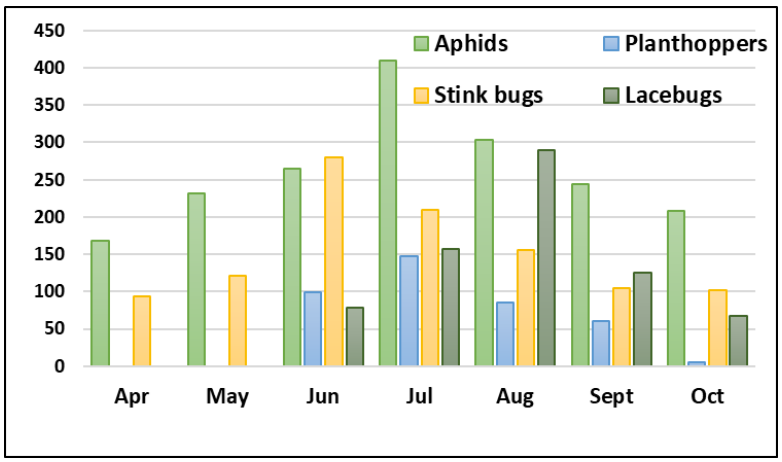


Fig. 2. The evolution of hemipterans during April-October, 2021, in the 3 places under study

Fig. 3. Phytophagous hemipteran pests common in the analyzed gardens. Colony of aphids on ornamental plants (a); bed bugs of the genus Nezara on vegetables (b); larvae and nymphs of planthopper (*Metcalfa p.*) on ornamental tree leaves (c); adults of sycamore lacebugs (*Corythucha c.*) on the leaves of ornamental shrubs (d) (photos by Grozea A., 2021)

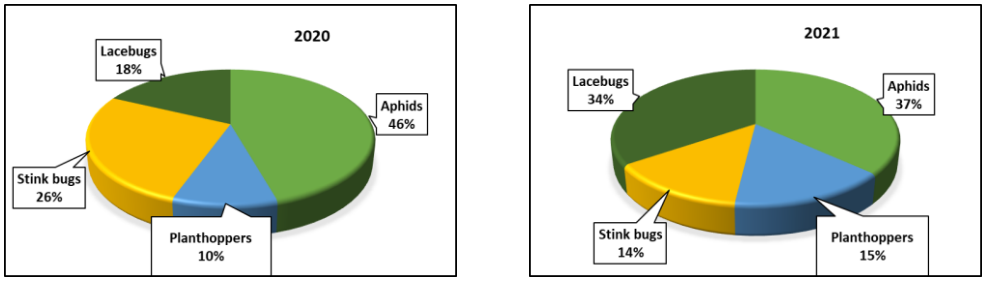


Fig. 4. Percentage of hemipteran insect groups found in the sites analyzed in the two years of study

As a percentage, hemipteran aphids occupied 46% in the first year of study and 37% in the second and stinkbugs 26% and 14% of the total identified groups. Lace bugs and planthoppers had higher percentages in 2021 compared to 2020, ie 15% compared to 10% for planthoppers and 34% compared to 14% for lace bugs (figure 4).

The ladybugs of the Coccinelidae family were the most frequent predators in all 3 places analysed. The most common species were both native (*Coccinella septempunctata, Coccinella vigintiduopunctata*) and invasive Asian species (*Harmonia axyridis*) known as harlequin ladybugs (figure 5).

Fig. 5. Interactions between garden pests and their natural enemies. *Harmonia axyridis* feeding on aphids (left); mummies known as aphids parasitized of braconid wasps (middle); common garden spider lurking for phytophagous pests (right) (photos by Grozea A., 2021)

Also, the wasps of the genus Aphidius were observed in the aphid colonies, the mummies (figure 5) being present mainly on ornamental plants, vegetables and fruit trees. And our studies confirm what GRAY (2006) showed in his work that natural control agents like braconid wasps can be a very important step in responsible and successful gardening.

The common garden spider of the Agelenidae family has been identified among the common spiders in the study sites (figure 5).

*Table 2*

The ratio of natural enemy - harmful hemipteran found in the analysed places

| Natural enemies | The ratio of natural enemy: harmful pests / Pest hemipteran (in active stages or in egg stage) | | | |
|---|---|---|---|---|
| | Aphids | Planthoppers | Stink bugs | Lace bugs |
| Ladybugs | 1:7 | 1:4 | - | 1:5 |
| Braconid wasps | 1:40 | - | 1:10 * | - |
| Spiders | 1:5 | 1:3 | 1:3 | 1:6 |

*only eggs were parasitized

Regarding the ratio between the identified natural enemies and the hemipterans present in the analyzed gardens (table 2) it can be said that there are obvious positive interactions between ladybugs and aphids where the ladybug consumed an average of 7 aphids per 2 weeks but also between them and planthoppers and lace bugs. The braconid wasps have parasitized many aphids, being quantified around 40 mummies on the analyzed shoots, compared to 1 natural enemy or in the case of stink bugs somewhere to 10 eggs parasitized by 1 wasp. The spiders interacted with all the identified groups of hemipterans and the result was good, with 1 spider preying on 3 to 6 insects.

## CONCLUSIONS

Harmful hemipterans are common in places that combine many plant species, such as gardens near people's homes. Their presence has attracted natural enemies who are also species

that live in gardens and have adapted to feeding on what is in abundance. There are interactions between them and the effect is beneficial for plants because it reduces pest populations.

## BIBLIOGRAPHY


DELABIE J.H.C (2001). Trophobiosis between Formicidae and Hemiptera (Sternorrhyncha and Auchenorrhyncha): an Overview. Neotropical Entomology 30(4): 501-51.

EASTOP V.F. (1977). Worldwide importance of aphids as virus vectors, in: Aphids as virus vectors (K. F. Harrisand K. Maramorosch, eds.), Academic Press, NY.

FLINT M.L. (2013). Aphids: Integrated Pest Management for Home Gardeners and Landscape Professionals. How to manage Pests/Pests in Gardens and Landscapes. Pest Notes. 7404: p.1-7.

GARROUSTE R. (2018). The city-loving 'devil bug' lands in Paris and continues its march around the world.https://theconversation.com/the-city-loving-devil-bug-lands-in-paris-and-continues-its-march-around-the-world-94145.

GILLOTT C. (2005). Entomology (Third edition). Springer. 831 p.

GRAY B. (2006). Beneficials in the garden. Braconid wasp on aphids. Extension Horticulture at Texas A&M University. https://aggie-horticulture.tamu.edu/galveston/beneficials/beneficial-05_braconid_wasp_on_aphid.html.

GROZEA I. (2015). Entomologie generala. Editura Eurobit. 155 p.

GROZEA I., STAN COSTEA A. (2020). Apricot trees, a new attraction for the brown marmorated stink bug. Research Journal of Agricultural Science. 52 (1): 122-127.

HALBERT S.E., MEEKER J.R. (1998). The sycamore lace bug, *Corythucha ciliata* (Say) (Hemiptera: Tingidae). Entomology Circular (Gainesville), 387:2.

KOVAČ M., GORCZAK M., WRZOSEK M., TKACZUK C. (2020). Pernek M. Identification of entomopathogenic fungi as naturally occurring enemies of the invasive Oak Lace Bug, Corythucha arcuata (Say) (Hemiptera: Tingidae). Insects, 11, 679. https://doi.org/10.3390/insects11100679.

MARCU V.C., GROZEA I. (2017). Assesment of population level of the invazive species *Nezara viridula* in diferent crops from south west of Romania. Lucrări Ştiinţifice - seria Agronomie, vol. 60(2): 175-178.

OSZI B., LADANYI M., HUFNAGEL L. (2005). Population dynamics of the Sycamore Lace Bug, Corythucha ciliata (Say) (Heteroptera: Tingidae) in Hungary. Applied Ecology and Environmental Research, 4(1):135-150.

PATTERSON R., RAMIREZ R. (2016). Aphid natural enemies and biological control. Utah State University Extension and Utah Plant Pest Diagnostic Laboratory ENT-180-16.

SLATER J.A., BARANOWSKI R. M. (1978). How to know the true bugs (Hemiptera -Heteroptera). The Pictured Key Nature Series. Wm. C. Brown Co., Dubuque, IA, 256 p.

STRAUSS G. (2013). Environmental risk assessment for Neodryinus typhlocybae, biological control agent against Metcalfa pruinosa, for Austria. European Journal of Environmental Sciences, 2(2), 102–109. Available on https://doi.org/10.14712/23361964.2015.30.

VLAD M., GROZEA I. (2016). Host plant species of the cicada *Metcalfa pruinosa* in Romania. Bulletin UASVM series Agriculture 73 (1), 131-137.