INVASIVE INSECT SPECIES ON WOODY ORNAMENTAL PLANTS IN LIFE SCIENCE UNIVERSITY PARK (TIMIȘOARA: TIMIȘ COUNTY) – CURRENT STATUS

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Abstract. *Habitat loss and fragmentation are among the most well-known causes of biodiversity loss, non-native organisms for an ecosystem will/can develop invasive behavior that causes significant damage to other ecosystems by competing with native species. These invasive species have been recognized as one of the major factors in the decline of biodiversity. The location of the investigated area near the crossing points of the Western border (both with Hungary and with Serbia), which represented not a few times the "main entrance gate" of numerous insect species, motivated us to study the area of Timisoara in an attempt to create an annotated check - list of insect species,; this paper being an extract from a larger research that was carried out in the green landscaping of the Timișoara metropolitan area. The biological material was collected by usual methods from woody ornamental plants in the USVT Park. The research carried out in 2021 in the USVT Park revealed the presence of 14 species of insects. Most of the species, 7 in number, belonged to Hemiptera order, families: Membracidae, Flatidae, Cicadellidae, Tingidae, Pentatomidae, Aphididae, but the qualitative/aesthetic damage to the ornamental trees was caused by insects from Lepidoptera order, through the larvae of the 4 species: Cameraria ohridella, Parectopa robiniella, Phyllonorycter populifolia, Cydalima perspectalis. Out of the total of 14 invasive species, 4 are highlighted as very abundant and producing mass attacks on various species of ornamental trees.*

Keywords*: insects, woody species, ornamental plants, University of Life Science Timișoara*

INTRODUCTION

The negative impact of environmental degradation is seen at every step, but in urban habitats they are much more significant. According to the World Health Organization (WHO, 2009), green urban landscapes (parks, squares, alignments) are solutions for urban health. Thus, if we were to make a comparison with the situation almost two decades ago, we would notice a significant increase in these areas at the level of European cities, currently occupying approximately 40% of their total, Europeans benefiting from an average of 18 m^2 green space/urban dweller, double the standard recommended by the WHO (HAASE et al., 2014; GÜNTHER et al., 2019; DE HAAS et al., 2021).

In the last few years, more than in any other habitat, in urban ones, the accelerated pace of human activities, through the lens of current globalization and climate change, with increasingly frequent extreme phenomena, are responsible for the translocation of arthropod species beyond their natural ranges, at the same time causing major imbalances in the composition and distribution of those organisms. (SEEBENS et al., 2017, 2018; BESTION et al., 2019; ROQUES et al., 2020; VENETTE & HUTCHINSON, 2021). Among the most numerous such organisms, which can be introduced into urban green landscapes, and not only, can establish and spread, having a negative effect on native species, are insects (MEYERSON & MOONEY, 2007; BLACKBURN et al., 2014; SCHINDLER et al., 2015; BROCKERHOFF & LIEBHOLD, 2017).

These invasive insects' species have been recognized as one of the major factors in the decline of biodiversity (MUNTEAN & GROZEA, 2019).

Therefore, it is essential to approach as many insect species as possible, to know the biology, the plants attacked and to establish Integrated Management Programs at the level of each area/country to reduce the risks and minimize the potential economic impact. In this context, the aim of this paper is to highlight the main species of insects found in the Life Science University Park (Timisoara) that attack woody species, ornamental trees and shrubs, decreasing their landscape value. To achieve the goal, the following *objectives* were drawn: - an updated annotated checklist of insect species present on ornamental woody plants; - description of the main 4 species for the western part of Romania, in terms of distribution, host plants and impact on the habitat.

MATERIAL AND METHODS

Study area - The investigated area is represented by the University of Life Science Park. Located in the central-northern area of Timiş county (45°78'28" latitude and 21°21'56" longitude, altitude of 90 m above sea level), the USVT Park – covers an area of ~ 3.0 ha, occupied mainly with woody ornamental plant species, predominantly deciduous trees, but also shrubs.

The area under study is characterized by a cambic chernozem with a clayloamy texture, slightly salinity and moderate alkalinity between 50-100 cm depth and also with 2.97% humus content. The soil is located in a lowland microrelief with a wide depressed area. Groundwater is found at a depth of 1.5 - 2.0 m. The average annual temperature is approximately 10ºC, the warmest month being July, and the coldest February, resulting in an average thermal amplitude of 22.7ºC, below that of the Romanian Plain, which attests to the beneficial influence of oceanic air masses. Practically, the number of days with temperatures favorable for the optimal development of plants, i.e. those with averages above 15ºC, is 143/year, between May 7 and September 26. The active temperature, totaling 2761ºC, ensures very good conditions for the development of plants, including some of Mediterranean origin.

Figure 1. Photo from entomological material collecting time

Data collection - The sampling of the biological material was carried out in 2022, during approx. 7 months, starting from April 2022 until the end of October 2022, the material being collected from woody plants in the USVT Park. Insects were collected using a series of usual methods, among which the most common was the visual method, that of direct observations, being followed by the plants and plant organs attacked, but also manually

collected directly from the plants. Only a small number of species have been collected using yellow sticky traps, yellow pan traps, pheromonal traps or the entomological beating sheets. Morphological characteristics and illustrations from the scientific literature were used to identify the adult species found in samples.

RESULTS AND DISCUSSIONS

Since a complete checklist of exotic insect species has not been recently completed in the USVT Park, in the following lines we review invasive insects feeding on woody ornamental trees.

A number of 14 insects species associated with woody plants were recorded in USVT Park, belonging to 4 orders: *Hemiptera, Coleoptera, Lepidoptera* și *Diptera* , and 11 families: *Membracidae, Flatidae, Cicadellidae, Tingidae, Pentatomidae, Aphididae, Curculionidae, Buprastidae, Gracillariidae, Crambidae, Cecidomyiidae* (Table 1).

Table 1.

Invasive insects species collected from USVT Park, 2022

Order, family, species	Native areal	Invasive areal	Main host plants	Monitoring measures
Hemiptera: Membracidae ***Stictocephala bisonia***	North America	Europe, Western Asia	Polyphagous (prefers *Robinia pseudoacacia, Ulmus sp., Salix sp.,, Populus sp., Medicago sativa, Trifolium sp*.)	Visually – attacked plants, entomological net, beating sheets
Hemiptera: Flatidae ***Metcalfa pruinosa***	North America	Europe (19 countries)	Polyphagous (over 200 plants species – prefers woody ones)	Visually, yellow sticky traps
Hemiptera: Cicadellidae ***Japananus hyalinus***	Eastern Asia(Japan) and Eurosiberia	America de Nord, Europa	*Acer campestre*	Visually – attacked plants, entomological net
Hemiptera: Tingidae ***Corythucha arcuata***	North America	Europa, Asia Mică	*Fagaceae* (preferă speciile de *Quercus*), *Salicaceae, Rosaceae, Fabaceae*	Visually – attacked plants
Corythucha ciliata	North America	Europe (22 countries), V – S Asia, Russia, Australia, South America: Chile	*Platanus sp.* și *Fraxinus sp.*	Visually – attacked plants
Hemiptera: Pentatomidae ***Halyomorpha halys***	China, Japan, Korea and Taiwan (Southeast Asia)	North America, Europe, Asia	Polyphagous (over 300 plant species)	Inspection of overwintering aggregations, attacked plants, pheromonal traps
Hemiptera: Aphididae ***Prociphilus fraxinifolii***	North America	Europe (12 countries), Russia, Asia: China	*Fraxinus excelsior*	Visually – attacked plants, yellow pan traps
Coleoptera: Curculionidae ***Hylesinus crenatus***	Europe (Hungary)	Eastern Europe, Russia, Asia (Turkey), North Africa (Algeria, Marocco)	*Fraxinus ornus*	Visually – split inner bark, V-shaped egg galleries in cambium
Coleoptera: Buprastidae ***Lamprodila festiva***	Mediterranean Europe	Europa: Centrală și de Est, Rusia,	*Cupresaceae*	Visually – attacked plants, yellow and

				pheromonal traps
Lepidoptera: Gracillariidae ***Cameraria ohridella***	Macedonia (Europe, Balkans)	Eastern and western Europe, Russia	*Aesculus hippocastanum*	Visually – attacked plants, pheromonal traps
Parectopa robiniella	North America	Europe (11 countries)	*Robinia pseudoacacia*	Visually + attack estimation from 100 leaves/10 trees
Phyllonorycter populifolia	Eurasia	Eastern Europe	*Populus sp.*	Visually – attacked plants
Lepidoptera:Crambidae ***Cydalima perspectalis***	Eastern Asia	Europe, North America	*Buxus sp.*	Visually – attacked plants, pheromonal traps
Diptera: Cecidomyiidae ***Obolodiplosis robiniae***	North America	Europe (30 countries), Asia: China, Japonia, Armenia, Giorgia, South Koreea	*Robinia pseudoacacia*	Visually – attacked plants, attack estimation – no. galls/ 10 trees

From the perspective of the native areal of the species, there were significant differences between the main continents of origin, North America and Asia, most of the species originated from North America (50% from the total), far surpassing the competition from Asia (28, 57%), whereas the other continents grave minor inputs (21, 43%).

The present study confirmed the exponential increase in the establishment of invasive exotic insect species associated to woody plants in green urban landscaping in the western part of Romania. This aspect of pathways invasion and spread was highlighted by many other researchers (KIRICHENKO et al., 2019; VENETTE & HUTCHISON, 2021; ROQUES, 2010, 2020) who showed that in Europe, insect species represent a constant threat to urban habitats, their number registering one of the most spectacular increases, approximately 19.6 new species/year, invading urban green spaces. Furthermore, the recent influx of invasive insects, with 385 such species listed by ESCHEN et al. (2015) on the European continent, seems to have determined the accidental introduction, mainly, of phytophagous species, 75% of which are associated with woody plants (ROQUES, 2015).

The taxonomic composition of the insects entomofauna associated to woody ornamental trees did not differ significantly between USVT Park (figure 1), and other parks from Timisoara (MUNTEAN & GROZEA, 2020; 2021). The Heteroptera insects of the *Corytucha* genus are dominant with an average of 115 specimen/date of collection, followed by leafcurl ash aphid *(Prociphilus fraxinifolii)* with an average of 65 specimens/date of collection (figure 1). The contribution of other major lepidopteran species, including *Cameraria ohridella* (n= 43,5 larvae/ pheromonal traps), *Cydalima perspectalis* (n= 19 larvae/ pheromonal traps) and *Parectopa robiniella* (n= 15 larvae/ 100 leaves) is significant, their larvae presenting high values, and the damages are significant, the landscape value of the trees being significantly affected (figure 1).

The reason why invasive hemiptera and lepidoptera species have been in the center of our attention, was due to the increasing number of specimens found in urban areas, information about their biology, potential invasions, their impact on urban ecosystems, as well as possible monitoring methods, being still limited (VENETTE & HUTCHISON, 2021; DANG et al., 2022), and for the western part of Romania, the lack of concrete measures by the local authorities have allowed the excessive development of these species to a level where they cause concern among the general public, as they have become easy to notice, annoying and even dangerous for human health.

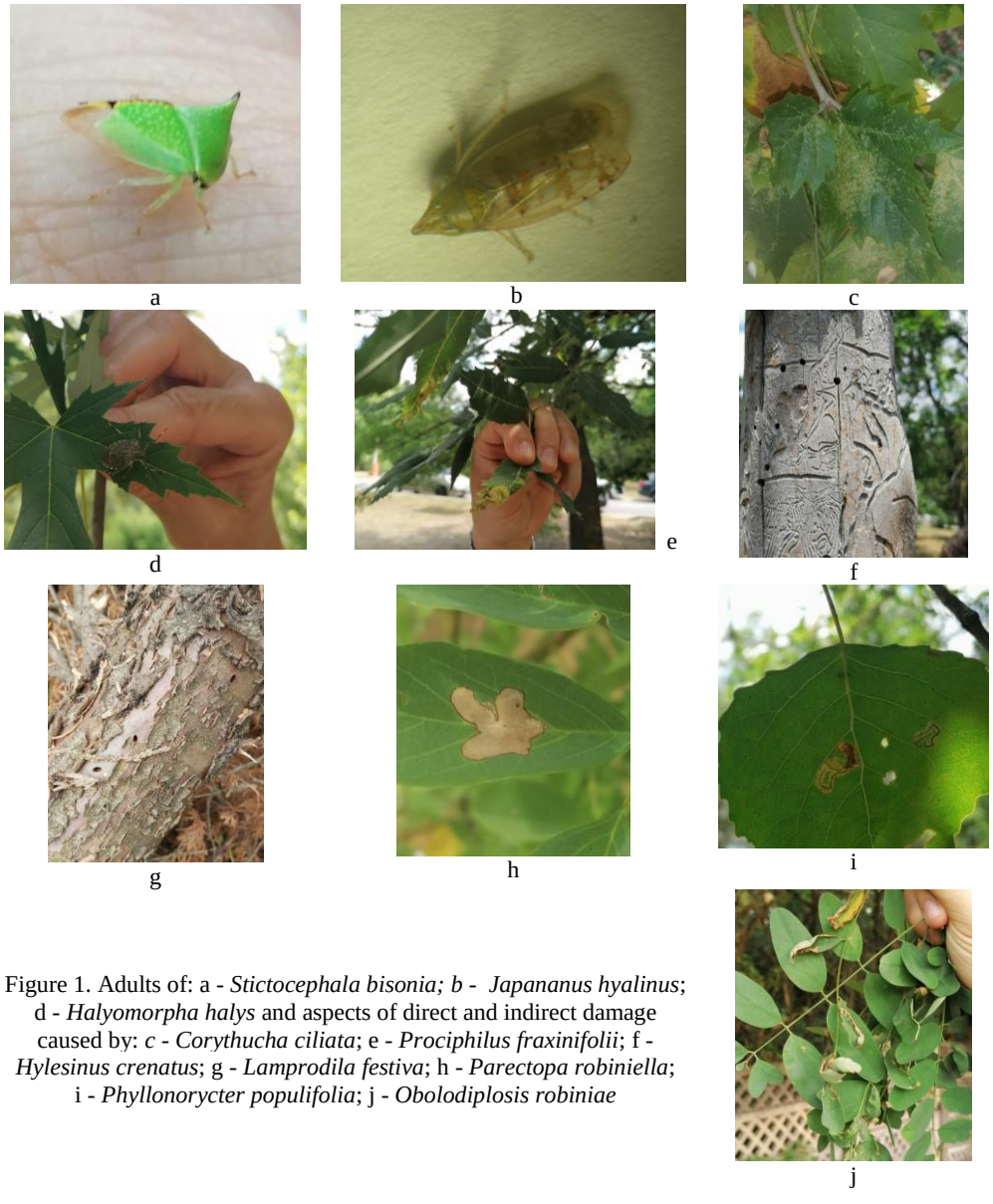

Figure 1. Adults of: a - *Stictocephala bisonia; b - Japananus hyalinus*; d - *Halyomorpha halys* and aspects of direct and indirect damage caused by: *c - Corythucha ciliata*; e - *Prociphilus fraxinifolii*; f - *Hylesinus crenatus*; g - *Lamprodila festiva*; h - *Parectopa robiniella*; i - *Phyllonorycter populifolia*; j - *Obolodiplosis robiniae*

Also, this study highlights the presence of *Prociphilus fraxinifolii* and *Japananus hyalinus* species for the first time in the western part of Romania. *Prociphilus fraxinifolii* was detected on common ash trees, the rate of infestation varied from 5 – 15% of the trees exanimate. At first sight it seems that the economic and ecological impact of *P. fraxinifolii* is not significant, but the study demonstrated the importance of the pest in terms of ornamental impact. Aspects regarding the attack produced by *P. fraxinifolii* in our country were mentioned: - in the Moldavian area by OLENCI et al. (2018) who detected the species by the pseudogalls it forms by twisting leaves from the tips of ash branches; - in the Oltenie area by

NETOIU et al. (2018) which indicates the presence of this species in the street alignments of 4 localities of the area; and in 2020 BĂLĂCENOIU et al. observed the species in 5 of the 6 parks in the country's capital, Bucharest, where green ash leaves (*Fraxinus pennsylvanica*) with large malformations inside which aphid excretions were present, were studied.

The Japanese maple leafhopper has as main host the species of maples, in USVT Park they were collected from *Acer pseudoplatanus*, the number of individuals being relatively small (n= 3). Even if the species is mentioned as being present in our country since 1961, its presence in green landscaping was not highlighted or was overlooked, until 2011, when CHIRECEANU & GUTUE, detected the species in the *Metcalfa pruinosa* colonies on maple trees.

In the following lines we briefly describe 4 examples of invasive damaging insects of woody ornamental plants belonging to two insect orders and discuss their distribution, pathways, impact and management, and various aspects of their invasion ecology.

METCALFA PRUINOSA
(HEMIPTERA: FLATIDAE)

An invasive species from the Nearctic region that was introduced from North America to Europe (ZANGHERI & DONADINI, 1980; GROZEA et al., 2011) from where it spread precisely covering the entire European continent, but also the Asian one (STRAUSS, 2009; YEYEUN et al., 2011), the main cause of expansion being ornamental plants and fruit trees trade, most likely the plant material being infested with the eggs of this species.

Based on literature observations, this polyphagous insects prefers to attack woody plants species, in Europe over 300 host are mentioned (ALMA et al., 2005), and in Romania, CHIRICEANU & GUTUE (2011) mention 33 host plants belonging to 18 botanical families in the Bucharest area and GROZEA et al. (2015) report 38 host species in the Timișoara area, of which the largest number of species (27) were woody ornamental trees and shrubs, and approximately 11 species were fruit trees and vines.

In the USVT Park, both adults and larvae were collected simultaneously, and the attack was observed in the form of a whitish waxy, powdery secretion which especially detracts from the aesthetics/quality of the park's ornamental appearance.

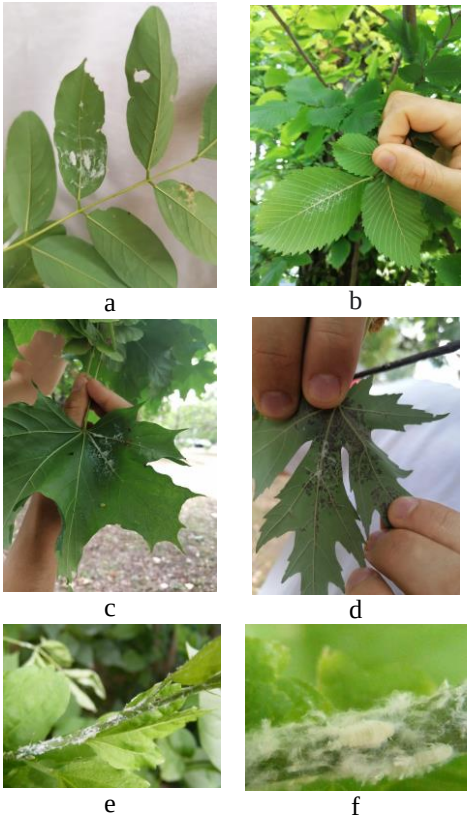

Figure 2. *Metcalfa pruinosa* attack on: *Robinia pseudacaccia;* b – *Ulmus glabra*; c – *Acer pseudoplatanus*; d – *Acer saccharinum;* e – *Hibiscus rosa – sinensis*; f- larvae

The species was reported on *Robinia pseudacaccia, Ulmus glabra, Acer pseudoplatanus, Acer saccharinum* as main host plants in 2022 (figure 2).

Taking into account the abundance of waxy secretions on the surface of the leaf blade in all host plant species, we can state that the species produced an intense attack, and the larval populations showed high densities, on average 25 larvae/leaves or shoot.

CORYTHUCHA ARCUATA
(HEMIPTERA: TINGIDAE)

Native species on the North American continent, where it is spread over extensive areas (DRAKE & RUHOFF, 1965). The first European report was in 2000, in the Lombardy and Piedmont regions of northern Italy (BERNARDINELLI & ZANDIGIACOMO, 2000).

The first Romanian observation point of this species was in the western part of the country in 2016 (DON ET AL.), but in the following years, 2017 and 2018 respectively, a massive attack on oaks and sessile oak in the southern part of the country been highlighted (CHIRICEANU ET AL., 2017; TOMESCU ET AL., 2018). The preferred host woody plant species are *Quercus* (*Q. robur, Q. pubescens, Q. petraea, Q. cerris*), but DOBREVA (2013) and KUCUKBASMACI (2014) also highlight *Rubus ideaus, Castanea sativa, Rosa canina, Ulmus minor* and *Malus sylvestris* as secondary host plants. In 2021, GROZEA et al. mentions *Chaenomeles japonica* as new host plant of this species in the western part of Romania.

In the USVT Park, in 2022 the species was identified on *Quercus cerris*, the pest produced very strong infestations, with very high larval population levels, which led to early defoliation (figure 3).

Figure 3. *Corythucha arcuata* attack on *Quercus cerris* leaves

CAMERARIA OHRIDELLA
(LEPIDOPTERA: GRACILLARIIDAE)

The species *C. ohridella* is considered to be native to the Balkans, the species being first mentioned in Macedonia in the early 1980's (DESCHKA AND DIMIĆ, 1986). Since then it has spread rapidly throughout most of Europe, being present from west to east, from north to south (KIRICHENKO et al., 2019).

Figure 4. *Cameraria ohridella* attack on *Aesculus hippocastanum* leaves

Following the evaluations, we found an extremely high level of attack, the mines in some cases covering the entire surface of the leaf blade, the chestnuts having a dry tree appearance, which leads to total defoliation in the first months of summer (figure 4).

CYDALIMA PERSPECTALIS
(LEPIDOPTERA:CRAMBIDAE)

23 years after its first report in Europe, in south-west Germany (KRŰGER, 2008), the species has colonized 36 of the 48 countries of the European continent (GUGEA & VÎRTEIU, 2017). In Europe the species has spread naturally (MUSS et al., 2009), the larvae feeding on *Buxus sempervirens* leaves (KÄPPELI, 2008; SIGG, 2009), producing in the first phase the defoliation and later the death of the ornamental shrubs (MARUYAMA, 1993).

Figure 5. *Cydalima perspectalis* attack on *Buxus sempervirens* leaves

The observations were made on the *Buxus sempervirens* alignment in the USVT Park, all developmental stages of the species being highlighted. The larval populations proved to be at a very high level which led to the total defoliation of the shrubs (figure 5).

CONCLUSIONS

The large number of invasive insect species collected from the USVT Park highlights their importance for green urban landscapeing, the impact on the habitat being a significant one: over 65% of the species have "major" classes of impact - causing total defoliation, and even the death of woody ornamental plants, approximately 20% have "minimal"classes of impact - the attack being of non - ornamental importance, and 15% of these being accidental. The need to implement integrated management measures is imperative; in the implementation of these control measures it is important to take into account the role of each impact class on urban development.

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