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Monitoring Research on Invasive Species of Bedbug (*Corythucha ciliata* Say) in green areas of Kyiv

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ABSTRACT

Samples for research were selected in the course of route surveys of plants of the Botanical Garden named after. acad. A.V. Fomin, National Botanical Garden. N. Grishko National Academy of Sciences of Ukraine and parks, squares, street plantations of plane trees in Kyiv. Platanus identification using the lacemaker's bug (*Corythucha ciliate* Say), uses a light microscope and a smartphone with the «Magnifier Cam software». For the first time, we found damage to the leaves of the plane tree Platanus x acerifolia (Ait.) by the bug *Corythucha ciliata* Say in Kyiv. This is the northernmost border of the phytophage distribution in Ukraine. The phytophage was found in six of the nine surveyed habitats of Platanus acerifolia (50°41'83'' N, 30°56'37'' E; 50°43'99"N, 30°51'83"E; 50°26'99'' N, 30°94'99'' E; 50°26'42"N, 30°32'01"E; 50°39'35"N, 30°50'66"E; 50°38'22"N, 30°47'73"E). The bug was not found in the Botanical Garden named after acad. A.V. Fomin. A high degree of sycamore bug damage was observed on plants growing in habitats. 50°39'35"N, 30°50'66"E (4.7 point) and 50°38'22"N, 30°47'73"E (2.9 point). Bedbugs prefer the south side of the trunk for wintering (72.3% of individuals). The ratio of females and males on the southern side was 2,5/1, on the northern side – 1,7/1. The bug *Corythucha ciliata*, being under the cork cambium in winter, survives in the natural environment when the temperature drops to -22 °C (duration – four days).

Keywords: sycamore lace bug, *Corythucha ciliate*, *Platanus*, invasion, megalopolis.

INTRODUCTION

Accelerated rates of expansion of alien species of phytophages and phytopathogenic organs of woody plants of urban cenoses are observed, this is due to global climate change and intensive intercommunal trade relations [Chumak P.Y. et al., 2020; Bondareva & Chumak, 2020; Kliuchevych et al., 2020a, 2021b; Lesovoy et al., 2020]. In recent years, bugs (Heteroptera: Tingidae) have been distinguished among invasive phytophages by their rapid expansion [Blummer, 2021; Golub, 1999; Putchkov, 2013].

Family of lace bugs (Tingidae Laporte, 1832) includes from 2000 [Lis, 2013] to 2600 recent species. Many types of lace bugs are common in North America.

An analytical review of bugs [Putchkov, 2013] recorded 14 species that entered the European continent from North America. The plane lace bug (*Corythucha ciliata* Say, 1832) is a common and harmful bug. This invasive species is widespread in Europe and in some Asian countries, where species of the genus *Platanus* L. (Platanaceae) are present [Kalinkin, 2020; Blummer, 2021]. The area of invasion of this species is quite wide, most often the sycamore lace bug was found in the middle latitudes with a temperate climate.

In Russia, the range of the phytophage covers the western, central parts and almost the entire Black Sea coast of the Krasnodar Territory [Kalinkin, 2002]. Until now, the northern limit of the distribution of the bug in Ukraine has reached

46°38’ NL. (Kherson) [Nazarenko, 2020] and 46°58’ NL (Mykolaiv) [Putchkov, 2013].

The purpose of the study was to monitoring the state of plane trees (*Platanus* L.) growing in botanical gardens, parks and street green plantations in Kyiv.

MATERIALS AND METHODS

The research were carried out at the Botanical Garden named after acad. A.V. Fomin. (50°44’49.58”N, 30°50’23.6”E и 50°44’25.97”N, 30°50’20.08”E), National Botanical Garden. N. Grishko National Academy of Sciences of Ukraine the Botanical Garden named after. acad. A.V. Fomin (50°41’52” N, 30°55’75” E and 50°41’83” N, 30°56’37” E), at the Holosiivskyi Park of Maksym Rylsky (50°26’ 99” N, 30°94’99” E), at the M. Zankovetskaya Park (50°43’99”N, 30°51’83”E), Metro “Vystavkovyi tsentr” (50°26’42.9”N, 30°32’01.5”E), at the Holoseevsky District, 82 (50°39’32”N, 30°50’56”E) and at the Holoseevsky District, 93 (50°38’22”N, 30°47’73”E).

Monitoring of the pathological state of plants of the genus *Platanus* L. was carried out in 2019–2021 By the method of route surveys of plants. The crowns of plants were examined by visual detection of a phytophage or traces of its vital activity under the cork cambium on the trunk and in the region of the lower part of the crown (1.5–2 meters from the soil level).

Above the specified level, a camera with the function of approaching the object at least 10x “zoom” was used. Leaves damaged by the phytophage (up to 30 specimens from each individual plant) were photographed without separation.

The photos were processed in the laboratory on a computer. In order to identify the phytophage, individuals were collected using a transparent adhesive tape [Chumak et al., 2020].

To do this, in early spring, during the period of bud swelling and before the leaves bloom on the trunk, a small area of the cork cambium was separated and, when a bug colony was found, the imago of the phytophage was removed with a transparent adhesive tape.

During the vegetation season of plants, nymphs, adults and oviposition of the bug were removed from the surface of the leaves. The sticky side with glued specimens was applied to the glass slide and separated from the roll.

The resulting imprint from the leaves of adults was examined under a microscope with a magnification of 200× and 400× (females and males are clearly visible), larvae and oviposition of the sycamore lace bug. Photographs of insects were taken with a «Samsung S8» smartphone with the "Magnifer Cam" program.

The degree of damage (in points) by the phytophage of plane trees was determined by photographing at least 30 leaves on one plant. The number of bugs on each leaf was counted on a computer. The degree of plant damage by the phytophage was determined on a five-point scale (Table 1).

Figure 1. Use of adhesive tape to remove adults, nymphs and ovipositions of the sycamore lace bug *Corythucha ciliata* Say, 1832 from the leaves

Table 1. Indicators of the degree of damage by the bug *Corythucha ciliata* Say to the leaves of *Platanus* L

Leaf damage level	The area of the leaf surface with signs of damage, %	Score
No damage	Natural color of leaves	0
Damage little differences (light brown necrotic spots)	3–4 %	1
Low	5–10	2
Medium	11–20	3
Strong	21–50	4
Very strong	> 50	5

The damage index was determined by the generally accepted formula:

$$Is = \Sigma (a \times b) \times 100 / N \times 5 \quad (1)$$

where: Is – damage index in %;
$\Sigma (a \times b) \times 100$ – the sum of the indicators obtained by multiplying the number of examined leaves (a) by the degree of damage by the phytophage (b);
N – the total number of studied leaves;
5 – the highest degree of damage on a five-point scale.

The obtained digital data were processed by quantitative indicators accepted in statistics. Materials of the study of the bug *Corythucha ciliata* Say are stored in the Laboratory of resistance of agricultural crops to pests of the Institute of Plant Protection of the National Academy of Sciences of Ukraine.

RESULTS AND DISCUSSION

Studies of the pathological state of plants of the genus *Platanus* L. in Kyiv showed that three species of this genus are grown in botanical gardens: *P. occidentalis* L., *P. orientalis* L. and *P. x acerifolia* (Ait.) Willd [Lesovoy et al., 2019].

In the parks and street *plantations* of the city, only the latter species grows. Plane lace bug damage (*Corythucha ciliata* Say) in the Botanical Garden named after. acad. A.V. Fomin is not found. Bed bug damage to the maple or London plane tree *P. x acerifolia* was found for the first time in the National Botanical Garden. N. Grishko National Academy of Sciences of Ukraine, parks and street plantations in the southern part of the city (Table 2).

The study of maple leaf sycamore damage by the bug showed that the degree of damage to plants differs depending on the growth station of plane trees.

Plane trees growing in the park of M. Zankovetskaya for three years of observation were damaged by the bug to a much lesser extent (0.63 points) than on Holoseevsky District, 82 (2.7 points) and Holoseevsky District 93 (4.1 points) (Table 3).

The sycamore lace bug, like most other species of this genus, tends to live on the underside of leaves, where the females lay their eggs. The larvae emerging from the eggs lead a crowded

Table 2. *Platanus x acerifolia* habitats, where the sycamore lace bug (*Corythucha ciliata* Say) was found (Kyiv, 2020–2022)

Location of detection		Detected (+), not detected (–)
Station	Plane tree coordinates	
A.V. Fomin Botanical Garden	50°44’49” N, 30°50’23” E	–
	50°44’25” N, 30°50’20” E	–
M.M. Gryshko National Botanical Garden	50º41’52’’ N, 30º55’75’’ E	–
	50º41’83’’ N, 30º56’37’’ E	+
M. Zankovetskaya Park	50°43’99” N, 30°51’83” E	+
Holosiivskyi Park of Maksym Rylsky	50º26’ 99’’ N, 30º94’99’’ E	+
Metro «Vystavkovyi tsentr»	50°26’42” N, 30°32’01” E	+
Holoseevsky District,82	50°39’35” N, 30°50’66” E	+
Holoseevsky District, 93	50°38’22” N, 30°47’73” E	+

Table 3. The degree of damage by the bug *Corythucha ciliata* Say to *Platanus x acerifolia* plants growing in different habitats of the city of Kyiv (2020–2022)

Place of growth	Leaf damage level, score			
	2020 year	2021 year	2022 year	Mean
A.V. Fomin Botanical Garden	0.0	0.0	0.1	0.03
M. Zankovetskaya Park	0.3	0.8	0.8	0.63
Holosiivskyi Park of Maksym Rylsky	1.2	1.7	1.6	1.5
Metro "Vystavkovyi tsentr"	1.1	1.2	1.5	1.3
Holoseevsky District, 82	3.5	4.2	4.7	4.7
Holoseevsky District, 93	2.3	2.7	3.1	2.9

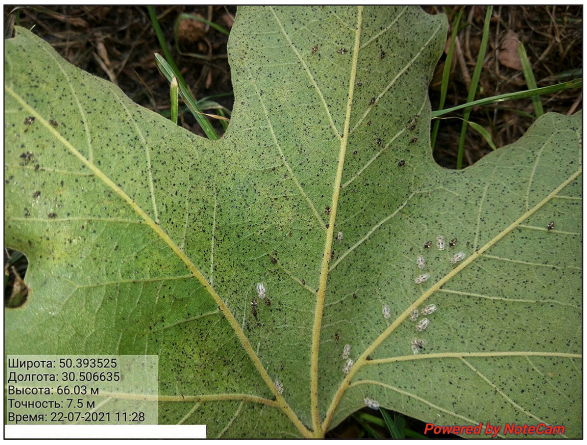

Figure 2. Larvae and adults of sycamore sycamore *Corythucha ciliata* Say on a leaf of *Platanus x acerifolia*. Photo by P. Chumak

lifestyle and often feed on one part of the leaf until the first adult winged individuals appear.

Some time, the larvae and adults feed together, covering the underside of the leaf with excrement. In this case, the upper side of the leaf acquires a light brown color.

Examining the ability of the bug to survive in the winter period of the year, being under a layer of cork cambium, a high tolerance of adults to low temperatures was revealed (Table 4).

This is the first report of the detection of the bug *Corythucha ciliata* Say in 2020 in Kyiv, the northernmost biotope of the phytophage distribution in Ukraine. Previously, bug damage to plane trees was noted in Odessa in 2007 [Gninenko, 2009]. In the same work, it was noted that during the examination of plane trees in Kyiv and Chernivtsi, the bug was not found. After 12 years, the phytophage was noted in Ukraine in Nikolaev city [Putchkov, 2013], and in 2019 in Kherson city [Nazarenko, 2020]. Based on our monitoring of the distribution of the sycamore lace bug in Kyiv and literary sources, we assume that the phytophage entered parks and street plantations of plane trees not from the south of Ukraine and not from botanical gardens. Thus, in the collections

Figure 3. *Platanus x acerifolia* leaves damaged by the bug *Corythucha ciliate* Say. Photo by P. Chumak

of botanical gardens of Kyiv Platanes are grown more than 100 years [Kolysnichenko, 2004].

We found the only and insignificant damage to plane trees by the bug only in 2021 in one of the two locations where these plants grow in the N. Grishko National Academy of Sciences of Ukraine. It can be assumed that the bug has been living in Kyiv for more than 10 years, since the landscaping of areas near the Metro "Vystavkovyi tsentr"station and near the M. Zankovetskaya Park. The phytophage penetrated the biocenoses of the city with planting material from the nurseries of Western Europe. Comparing the degree of damage to plane trees by the bug, it should be noted that the indicators of plant damage can depend on many factors: the place where the plants grow, their age, environmental conditions, and other factors.

Table 4. Survival of *Corythucha ciliata* Say at low temperatures

Year	Month	Minimum temperature, (ºC)	Duration, (day)	Survivirs imago, (%)
2020	January	-14	3	87.4
	February	-8	1	
2021	January	-6	1	91.7
	February	-8	3	
2022	January	-22	4	79.2
	February	-22	1	

Figure 4. Colony of the bug *Corythucha ciliata* Say under the bark. The bark has been removed 09/01/2021 (Photo by P. Chumak)

After analyzing the degree of bug damage to plane trees, a street plantations on Holoseevsky District, 82 (heavily loaded highway, > 4500 cars/hour) with plane trees growing on the opposite side of this avenue in the depths of Holoseevsky Park named after Maxim Rylsky, therefore. Damage to plants in the park is 3.1 times lower than in street plantations of plane trees. One of the factors of the dependence of the indicator of damage to plane trees on their age was found. Young plants are characterized by a smooth bark of the trunk, with age the bark of plane trees at the base of the trunk and above forms a thick cork cambium. The dead layers of the cork cambium, as a rule, are destroyed, form cracks, are separated fall off in separate pieces. Niches and wintering conditions for phytophages are created. In autumn, under the bark, we found from 3–5 to more than 150 bugs per 10 square centimeters.

Observations have established that the bug prefers the southern side of the trunk for wintering (72.3% of individuals). The ratio of females and males is 2.5/1 on the south side, and 1.7/1 on the north side. From the given data it follows that the number of females leaving for the winter is 2.1 times greater than the number of males. It has been proven that the success of invader insects in various temperature zones is closely related to their resistance to temperature extremes [Ju, Xiao, Li, 2011; Ju, et al., 2010]. The experiments of Chinese researchers in laboratory conditions on the influence of low and high temperatures on the survival of adults of the bug *Corythucha ciliata* showed that females die when the temperature drops to –11.49 °C, and males die at –9.54 °C [Ju, et al., 2010]. From our observations it follows that the population of the bug at Kyiv is more tolerant to low ambient temperatures. Bug adults in winter, being under a layer of cork cambium, are able to survive at fairly low temperatures. The temperature regime in winter was the most severe in 2021 for three years of observations. The temperature dropped to –22 °C twice: in January (from 17–20.01) and in February (16.02.2021). Spring counts showed that under the protection of the cork cambium, 79.2% of the bug imago survived. We assume that such a significant difference in tolerance between these two populations of the bug is due to a number of factors. We observed the natural population. Individuals, which gradually entered their natural state – a decrease in the length of the light period of the day and temperature. The physiological processes of insect vital activity were gradually restructured: favorable niches for overwintering were searched for, their activity decreased and completely stopped.

Thus, our studies have shown that the bug *Corythucha ciliata* survives in the natural environment, being under cork cambium when the temperature drops to –22 °C in winter for four days.

As for the distribution of *Corytucha ciliata* to different locations of sycamore trees in Kiev, as well as in the western and northern parts of Ukraine, it is a matter of time. Considering the biology and specificity of the distribution of the sycamore bug, it is possible to simulatesituation with range expansion, as this phytophage easily tolerates situation with range expansion, as this phytophage easily tolerates reduced temperatures during hibernation, and the average temperature This phytophage easily tolerates low temperatures during winter, and the average temperature of the cold period is practically at the same level in central, western and northern parts of Ukraine, which are located in the middle latitudes with temperate climate. According to our observations, this species has spread across Ukraine in Odessa, Nikolaev and Kherson [Gninenko, 2007; Putchkov, 2013; Nazarenko, 2020] and was recorded

in Kiev for a short period of 16–17 years, we can predict the appearance of *Corytucha ciliata* in western and northern regions of Ukraine in the areas of sycamore mapleleleys, the main host plants of phytophage in 5–7 years.

We note that this is a prediction of the authors and it should not be treated as a hypothesis, not as a specific scientific fact. Further research will confirm or refute our forecast.

CONCLUSION

As a result of monitoring the phytopathological state of plane trees, for the first time, damage by the bug *Corythucha ciliata* Say to the leaves of the plane tree Platanus acerifolia (Ait.) Willd in Kyiv. This is the northernmost border of the phytophage distribution in Ukraine.

The phytophage was found in six out of nine examined habitats of maple-leaved sycamore (50°41'83''N, 30°56'37''E; 50°43'99"N, 30°51'83"E; 50°26'99''N, 30°94'99''E; 50°26'42"N, 30°32'01"E; 50°39'35"N, 30°50'66"E; 50°38'22"N, 30°47'73"E).

The bug has not been found on plane trees growing in the Botanical Garden named after. acad. A.V. Fomin. A high degree of bug damage to plane trees was found on plants growing in stations 50°39'35"N, 30°50'66"E (4.7 points) and 50°38'22"N, 30°47'73"E (2.9 points).

When choosing a place for wintering, the bugs prefer the southern side of the trunk (72.3% of individuals). The ratio of females and males became 2.5/1 on the southern side, and 1.7/1 on the northern side.

The bug *Corythucha ciliata*, being in the winter period under the cork cambium, survives in the natural environment when the temperature drops to –22 °C (duration – four days). Considering the trend of climate change on the planet Earth, we can imagine that fluctuations of temperature preferences in the range 1–3 °C, which will affect the climate of Ukraine, will not have a significant impact on the distribution and development of *Corytucha ciliata.* We know that the movement of the sycamore lace bug occurs by road and other modes of transport with planting material [Lesovoy et al., 2019], but we have another version – it occurs by transfer of this phytophage by migrating birds (woodpeckers, tits, orioles, etc.), which feed on sycamores, but with the obligatory presence of sycamores maples, main host plants of phytophage, where it will be moved.

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