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A CONTRIBUTION TO THE KNOWLEDGE OF *Neodryinus typhlocybae* (Hymenoptera: Dryinidae) –THE FLATID PLANTHOPPER PARASITOID

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Abstract: *The paper presents the results of a two-year long study of the presence of Neodryinus typhlocybae (Hymenoptera: Dryinidae), a parasitoid and the greatest enemy of the Metcalfa pruinosa (Hemiptera:Flatidae), or the flatid planthopper in the area of Belgrade.*

Keywords: *Metcalfa pruinosa, Neodryinus typhlocybae, Belgrade, urban greenery*

PRILOG POZNAVANJU *Neodryinus typhlocybae* (Hymenoptera: Dryinidae) - PARAZITOIDA MEDEĆEG CVRČKA

Izvod: *U radu su prikazani rezultati dvogodišnjeg istraživanja prisustva Neodryinus typhlocybae (Hymenoptera: Dryinidae), parazitoida i glavnog neprijatelja invazivne vrste Metcalfa pruinosa (Hemiptera: Flatidae), medećeg cvrčaka, u području Beograda.*

Ključne reči: *Metcalfa pruinosa*, *Neodryinus typhlocybae*, *Beograd*, urbano zelenilo

1. INTRODUCTION

Nearctic, polyphagous [330 plant species in 78 plant families in Europe (Alma et al., 2005)] invasive species - planthopper *Metcalfa pruinosa* (Say, 1830) (Hemiptera: Flatidae) has been present in Europe since 1979 when it was incidentally introduced to the province of Treviso, Italy (Zangheri and Donadini, 1980). In the following few decades, positive findings were published for most

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European countries - France, Spain, Slovenia, Switzerland, Croatia, Great Britain, Austria, the Czech Republic, Greece, Turkey, Montenegro, Hungary, Bulgaria, the Republic of Serbia, Bosnia and Herzegovina, Romania (Drosopoulos et al., 2004; Be'la, 2004; Girolami et al., 2002; Lauterer and Malenovsky, 2002; Hrnčić, 2003; Glavendekic et al., 2005). In Serbia, it was first noticed in the area surrounding Belgrade. In the following years, it spread over many areas of Vojvodina and central Serbia, for instance the area surrounding Titel, several sites at the foot of Fruška Gora and along the Danube River, Sremski Karlovci, Petrovaradin, Sremska Kamenica (Kereši, 2011), Novi Banovci (Glavendekić & Mihajlović, 2007), Šabac, Sremska Mitrovica, Slankamen. It most commonly occurs on urban ornamental trees and shrubs. So far, it hasn't been found at higher altitudes. The climatic conditions of our area seem to favor the growth of this species. The minimum temperature required for its development is 13˚C, while the maximum amounts to 31˚C. The lower optimum temperature is 22˚C and the upper one 28˚C. The development of one generation requires a sum of effective temperatures of 500˚C, counting the temperatures above 13˚C. *M. pruinosa* is a species that usually occurs in humid regions, with an average rainfall of 610 to 1625 mm (Strauss, 2010).

The damage done to the attacked plants can be direct and indirect. Direct damage is caused by larvae and imagos sucking juices out of leaves, shoots, twigs and branches. Consequently, the growth of the host plant is decreased and it is physiologically weakened. Indirect damage is caused by the abundant honeydew produced by larvae. The shoots and leaves that are covered with honeydew are suitable for the development of the sooty mould which decreases the assimilation area of the attacked leaves and reduces the value of ornamental plants. The females often lay eggs in the leaf and flower buds which consequently freeze during the winter and the unripe fruit falls off. Some species of the *Flatidae* family are well-known as vectors of various viruses.

Neodryinus typhlocybae (Aschmed, 1893) (Hymenoptera: Dryinidae) is the most important natural enemy of the planthopper *M. pruinosa*. Therefore it is often used in the process of integrated control i.e. biological pest management, either by introducing the individuals grown under laboratory conditions into the infested areas or by encouraging their development and increasing their numbers in natural conditions. For instance, *N. typhlocybae* was introduced into the Veneti region in Italy in 1987, and in recent decades it has been introduced into many urban and agricultural areas of other European countries, such as France, Switzerland, Slovenia and Croatia (Luci & Vilson, 2003; Alma et. al., 2005, ct. Trivellone et. al., 2006).

In Italy, France and Slovenia, the use of *N. typhlocybae* for the purpose of biological control of *M. pruinosa* has led to a high level of parasitism (between 50 and 80%), which at the same time drastically reduced the number of this economically harmful species. Many studies have dealt with the influence of the parasitoid wasp on other, domestic predators of *M. pruinosa*. It has been found that the investigated predators are not dependent on this planthopper and as they consume only a small number of individuals, it has been concluded that they have no negative impact on them. The distribution of *N. typhlocybae* can be affected by its natural enemies, hyperparazitoids and predators. In Europe, four parasitoid

wasps have been recognized as direct natural enemies of *N. typhlocybae*: *Cheiloneurus boldyrevi* (Trjapitzin and Agekyan, 1978) (Hymenoptera: Encyrtidae), *Gelis areator* (Panzer, 1804) (Hymenoptera: Ichneumonidae), *Callitula bicolor* (Spinola, 1811) (Hymenoptera: Pteromalidae) and *Pachyneuron muscarum* (Linnaeus, 1758) (Hymenoptera: Pteromalidae). Except for *C. boldyrevi*, all other wasps have been recorded in our region (https://fauna-eu.org/).

Due to the widespread distribution of *M. pruinosa* in the territory of Serbia, there is a need for a more detailed investigation of its parasitoid *N. typhlocybae*, whose presence in the territory of Serbia was first recorded in 2013 in the area surrounding Belgrade (Glavendenkic, 2017). This paper presents the results of a study that included: the presence, main characteristics and abundance of the host (*M. pruinosa*) and its most important natural enemy (*N. typhlocybae*) in the wider area of Belgrade.

2. STUDY AREA AND RESEARCH METHOD

Intensive research into the possible presence of *N. typhlocybae* parasitoid was carried out in 2016 and 2017 at the following sites: Cerak (Y 44,751389, X 20,416944), Košutnjak (Y 44,764167, X 20,436389), Veliko ratno ostrvo (Y 44,831414, X 20,443180) and Ada Ciganlija (Y 44,790833, X 20,416111) (Figure 1).

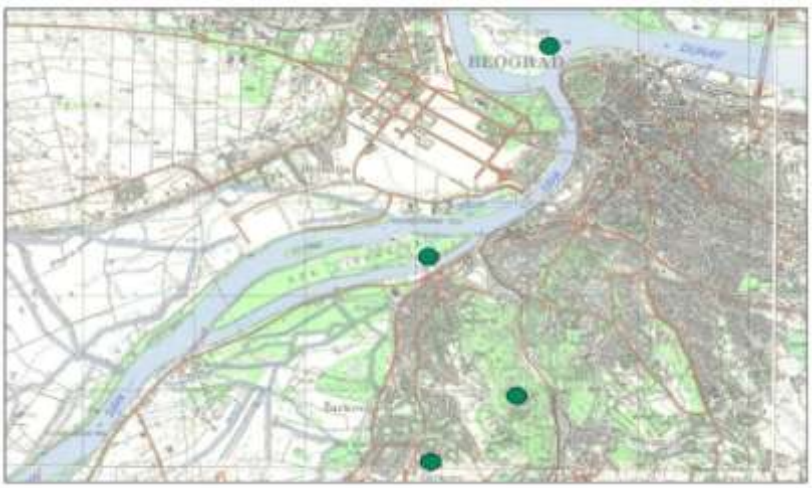

Figure 1. *Research sites with positive findings of N. typhlocybae parasitoid (author of the map B. Sc. Ljiljana Vamović)*

North American, Nearctic species *N. typhlocybae* shows evident sexual dimorphism. The female, like all the female representatives of the fam. Dryinidae (except for the *Aphelopinae* subfamily), possesses the chelae on the front legs which it uses to grip the host for parasitization (Olmi, 1999). The female feeds on sugary liquids and honeydew, as well as on nymphs. The male is glycophagous only. The species can reproduce by arrenotocous parthenogenesis. The aploid males have 20 chromosomes (Girolami & Camporese, 1994).

The female lays eggs between the wings of the host. After a few days, the egg hatches and the emerging larva becomes visible as a cyst on the body of the host. Finally, the larva spins a cocoon under the remains of the host. The larva of *N. typhlocybae* spends most of its life inside a flat, oval cocoon. The cocoons spun by males are slightly smaller than the ones spun by females. When it comes to the size of adult individuals, females (averagely about 4-5mm) are larger than males (about 3mm). The male of *N. typhlocybae* shows a laboratory longevity of 1-3 days, the female of 2-4 weeks. During this period the female can prey on about 30 nymphs and parasitize as many. Potentially it is able to destroy the entire offspring of one *M. pruinosa* whose fecundity is 50-60 eggs on average (Santini & Lucci,1994; Girolami *et. al*., 1996; Girolami & Conte,1999; Girolami & Mazzon,1999). *N. typhlocybae* overwinters as diapausing larva inside cocoons on the lower surface of leaves. In June adults emerge and lay eggs on nymphs of *M. pruinosa.* Part of the mature larvae (bivoltine) from this offspring transform to adults and originate a summer generation. The others (monovoltine) enter in diapause and overwinter (Mazzon *et al*., 2000).

The leaves showing the presence of the host colonies and silky cocoons similar to those of the *N. typhlocybae* species were sampled on several occasions from park and forest shrub and tree species. The leaves containing silky cocoons were classified by localities and placed in Petri dishes for further growth and study. The cocoons were grown in controlled conditions of the environment (D:N - 14:10 h, 23°C), in an SPX-300B-G environmental test chamber.

3. RESULTS AND DISCUSSION

During the research period, at selected sites, *M. pruinosa* was found on a number of forest and horticultural woody species, but the cocoons of its *N. typhlocybae* parasitoid were recorded only in the host colonies on *Acer campestre* (L.), *Acer platanoides* (L.), *Acer pseudoplatanus* (L.), *Fraxinus angustifolia* (Vahl.), *Juglans regia* (L.), cultivars of Rosaceae sp., *Maclura pomifera* (Raf.), *Prunus laurocerasus* (L.), *Syringa vulgaris* (L.), *Tillia cordata* (L.), *Ulmus laevis* (Pall.) and *Vitis vinifera* (L.) (Figures 2 and 3).

Metcalfa pruinosa

Figure 2. *Nymphs on the underside of leaves*

Figure 3. *Imago colonies*

In the first year of the research, the parasitoid cocoons were found only at the site of Cerak. Under laboratory growth conditions, the imagos were formed within the silky cocoons but the adults didn`t emerge. In the second year of the research, parasitoid cocoons were recorded at other sites. This time again, the formed imagos didn`t all emerge. Some of the imagos broke through the silky cocoon, but they didn`t leave it (Figure 5). A total of 141 cocoons, 58 with females and 83 with males were analyzed. In a number of cocoons, the development was paused at the stage of the larva - overwintering individual (Fig. 4).

Figure 4. *Overwintering larvae*

Neodryinus typhlocybae

Figure 5. *Fully-developed imagos that did not leave silky cocoons*

Figure 6. *The male and the female grown under laboratory conditions and the female on a leaf*

The average dimension of the silky cocoons containing males was 3.9 x 3.04 mm, while the average dimension of the cocoons with the females amounted to 6.1 x 4.3 mm.

Under laboratory growth conditions, imagos of both males and females were obtained. The females of *N. typhlocybae* were significantly larger than the males, as indicated by various literature sources (Figure 6).

4. CONCLUSIONS

N. typhlocybae, a parasitoid of the flatid planthopper, was found at all investigated sites on the territory of Belgrade: Cerak, Košutnjak, Veliko Ratno ostrvo, Ada Ciganlija, but its abundance, distribution and parasitoid activity were not satisfactory. Under laboratory growth conditions, imagos were formed in a number of cocoons but their eclosion did not occur. It is assumed that the same happens in natural conditions and this may be one of the reasons for its slow spread. In any case, its abundance in the area of Belgrade in the research period

was not correlated with the abundance of the host, i.e. it had no significant impact on the decrease in the number of *M. pruinosa* individuals and colonies.

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A CONTRIBUTION TO THE KNOWLEDGE OF *Neodryinus typhlocybae* (Hymenoptera: Dryinidae) –THE FLATID PLANTHOPPER PARASITOID

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Summary

The flatid planthopper *Metcalfa pruinosa* (Say) (Hemiptera: Flatidae) is an invasive species widely distributed in our region. Its most prominent adaptive feature lies in its extremely polyphagous nature - 330 plant species and 78 plant families in Europe. The damage done to the attacked plants can be direct and indirect. Direct damage is caused by larvae and imagos sucking juices out of leaves, shoots, twigs and branches. Consequently, the growth of the host plant is decreased and it is physiologically weakened. Indirect damage is caused by the abundant honeydew produced by larvae. The shoots and leaves that are covered with honeydew are suitable for the development of the sooty mould. In order to reduce the negative impact of pesticides, biological methods of control have been increasingly used. The use of natural enemies is one of the best methods to suppress harmful insects.

One of the most effective natural enemies of the flatid planthopper is *Neodryinus typhlocybae* (Aschmed) (Hymenoptera: Dryinidae). It is a predator and a parasitoid native to North America just like its host. In the area of Belgrade, it was first recorded in 2013. Intensive research on the possible presence of *N. typhlocybae* parasitoids was carried out in 2016 and 2017 at the following sites: Cerak, Košutnjak, Veliko ratno ostrvo and Ada Ciganlija, where the flatid planthopper can be found on many forest and horticultural woody species, but the cocoons of its parasitoid *N. typhlocybae* were confirmed only in the host colonies of *Acer campestre* (L.), *Acer platanoides* (L.), *Acer pseudoplatanus* (L.), *Fraxinus angustifolia* (Vahl.), *Juglans regia* (L.), cultivars of Rosaceae sp., *Maclura pomifera* (Raf.), *Prunus laurocerasus* (L.), *Syringa vulgaris* (L.), *Tillia cordata* (L.), *Ulmus laevis* (Pall.) and *Vitis vinifera* (L.).

A total of 141 cocoons, 58 with females and 83 with males were collected. The average dimensions of the cocoons were 3.9 x 3.04 mm (males) and 6.1 x 4.3 mm (females).

Based on the results of the laboratory growth of collected cocoons, i.e. the fact that a number of imagos didn`t emerge from the cocoons, it can be assumed that something similar happens in natural conditions, so this may be one of the reasons why this species did not spread rapidly.

PRILOG POZNAVANJU PARAZITOIDA *Neodryinus typhlocybae* (Hymenoptera: Dryinidae) NA PODRUČJU BEOGRADA

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Rezime

Medeći cvrčak *Metcalfa pruinosa* (Say) (Hemiptera: Flatidae), je invazivna vrsta, koja je na našim prostorima široko rasprostranjena. Ono što se može smatrati njenom najboljom adaptivnom osobinom, jeste to što je široko polifaga - 330 plant species in 78 plant families in Europe. Štete na napadnutim biljkama mogu biti direktne i indirektne. Direktne štete pričinjavaju larve i imaga, a nastaju usled sisanja sokova iz lišća, izbojaka, grančica i grana. Kao posledica ovog oštećenja, javlja se smanjenje prirasta i fiziološko slabljenje napadnutih biljaka. Indirektne štete nastaju usled obilnog lučenja medne rose, koju produkuju larve. Izbojci i lišće koji su prekriveni mednom rosom, pogodni su za razvoj gljiva čađavica. U cilju smanjenja negativnih uticaja pesticida sve više se pribegava korišćenju biološkog metoda suzbijanja. Prirodni neprijatelji su jedan od najboljih metoda za suzbijanje štetnih insekata.

Jedan od najefikasnijih prirodnih neprijatelja medećeg cvrčka je *Neodryinus typhlocybae* (Aschmed) (Hymenoptera: Dryinidae), predator i parazitoid, koji vodi poreklo kao i njen domaćin, iz Severene Amerike, a u području Beograda, je evidentiran 2013. godine. Intenzivna istraživanja mogućeg prisustva parazitoida *N. typhlocybae*, obavljena su u 2016. i 2017. godini, na sledećim lokalitetima: Cerak, Košutnjak, Veliko ratno ostrvo i Ada Ciganlija, gde je medeći cvrčak nađen na mnogim žbunastim i drvenastim, šumskim i hortikulturnim, vrstama, ali kokoni njegovog parazitoida *N. typhlocybae* potvrđeni su samo u kolonijama domaćina na *Acer campestre* (L.), *Acer platanoides* (L.), *Acer pseudoplatanus* (L.), *Fraxinus angustifolia* (Vahl.), *Juglans regia* (L.), kultivari Rosaceae sp., *Maclura pomifera* (Raf.), *Prunus laurocerasus* (L.), *Syringa vulgaris* (L.), *Tillia cordata* (L.), *Ulmus laevis* (Pall.) i *Vitis vinifera* (L.).

Ukupno je prikupljen i analiziran 141 kokon - 58 sa ženkama i 83 sa mužjacima. Prosečne dimenzije kokona iznosile su 3,9 x 3,04 mm (mužjaci) i 6,1 x 4,3 mm (ženke). Iz rezultata laboratorijskog gajenja prikupljenih kokona, odnosno neizletanja jednog broja formiranih imaga iz njih, proizašla je pretpostavka da se slično dešava i u prirodnim uslovima, te da to može biti jedan od razloga zašto se ova vrste nije brže raširila.