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Parasitoids of *Phyllonorycter platani* (Staudinger) (Lepidoptera, Gracillariidae) in Serbia

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Abstract

In the study of parasitoids of the plane leaf miner *Phyllonorycter platani* during 2004, 18 polyphagous parasitoid species were recorded in four tree rows and four parks in Serbia (3 species of the family Ichneumonidae and 15 species of the family Eulophidae). Among the recorded parasitoids, the most significant were the species *Minotetrastichus platanellus*, *Pediobius saulius* and *M. frontalis*, followed by the species *Pnigalio agraules*, *P. pectinicornis*, *Sympiesis gordius* and *Neochrysocharis formosa.* The other parasitoid species were rare and few. The parasitism rates in the study samples of *Ph. platani* ranged from 15.0 to 37.8 %.

Keywords: Parasitism, Parasitoids, *Phyllonorycter platani*, *Platanus acerifolia*

1. Introduction

Thanks to its high ornamental value, fast growth, resistance to air pollution and dust, European plane (*Platanus acerifolia* (Ait.) Willd.) is frequent in parks and tree rows in Serbia. Unfortunately, its trees are often severely infested by the leaf miner *Phyllonorycter platani.* For that reason, the planes loose much of their ornamental value and their premature defoliations are frequent (Marković *et al*., 2006).

Ph. platani is an invasive species which, in the second half of the 19th century and during the 20th century, spread from the south of the Balkan Peninsula and from western Asia to other parts of Europe, North Africa and central parts of Asia (Šefrová, 2003). In Serbia, it is an allochthonous species which usually develops four overlapping generations per year (Bogavac, 1959). As there is usually no suppression in Serbia, the abundance of its populations in our parks and tree rows is mainly conditioned by the effects of climate factors and its natural enemies.

Natural enemies of *Ph. platani* in Serbia are still insufficiently known, therefore our research addressed to its parasitoids. As it is a very harmful allochthonous species in Serbia, our interest was focused on: 1. the number and the species of its parasitoids in this environment, 2. the most significant species of its parasitoids, 3. the extent to which the parasitoids affect its abundance. In this aim, the study of its parasitoids was undertaken in 2004. At that time, the following parasitoids were already described in Serbia: *Apanteles circumscriptus* (Nees) (Braconidae), *Cirrospilus elegantissimus* Westwood, *Sympiesis sericeicornis* (Nees), *S. gordius* (Walker), *Chlorocytus phryne* (Walker), *Minotetrastichus frontalis* (Nees), *M. platanellus* (Mercet) (Eulophidae). However, as the investigations carried out by Bogavac (1959) covered only a small area in Serbia (Belgrade and its surroundings) where the above parasitoid species were found, and as only the names of the recorded parasitoid species were reported in the results, without the analysis of their significance, we decided to investigate the *Ph. platani* parasitoids in Serbia in more detail. *Ph. platani* parasitoids have been reported by several authors to date (Schimitschek, 1939; Ferrière, 1952; Bouček, 1959; Bouček & Askew 1968; Graham, 1969; Herting, 1975; Van

Frankenhuyzen, 1983; Vidal & Buszko 1990). The most detailed research has been performed in Germany (Mey, 1991), England (Godfray *et al*., 1995), Bulgaria and Switzerland (Girardoz *et al*., 2007). According to the results of all the above studies, *Ph. platani* is a host of about 40 parasitoid species, mainly of the family Eulophidae.

2. Material and Methods

2.1 Ph. platani parasitoid complex

The parasitoid complex of *Ph. platani* was studied in 4 tree rows and 4 parks in Serbia. The localities of the investigated tree rows were Belgrade – Banjica I (44°45'53"N, 20°28'15"E), Ćuprija (43°55'39"N, 21°23'01"E), Jagodina (43°58'20"N, 21°16'05"E) and Paraćin (43°51'59"N, 21°25'00"E), and the localities of the parks were Belgrade – Topčider (44°46'59"N, 20°26'17"E), Novi Beograd – Siv (44°49'20"N, 20°25'41"E), Sokobanja (43°39'03"N, 21°51'13"E) and Zemun – Kalvarija (44°50'25"N, 20°24'09"E).

During the appearance of the first adults of the first, second and third *Ph. platani* generations, in sunny and warm weather, 50 randomly selected leaves with *Ph. platani* mines were taken from the lower parts (h < 3 m) of *P. acerifolia* crowns at the above sites. On being brought into the laboratory, the leaves were placed in emergence boxes, which were kept in the insectarium under field conditions. During the flight of *Ph. platani* and its parasitoids, the emergence boxes were examined daily. The emerged adults were collected, killed by ether, prepared, identified (by A. Stojanović), and counted. The adults of parasitoids are stored in the collection of the Faculty of Forestry in Belgrade.

A total of 24 samples were collected. The significance of *Ph. platani* parasitoids was assessed based on the following:

1). number of localities in which a parasitoid species was identified

2). number of samples in which a parasitoid species was identified; and

3). domination (relation between the number of adults of species of parasitoids and total number of parasitoids, in percentage).

2.2 Level of parasitism of Ph. platani

The levels of parasitism of the first, second and third *Ph. platani* generations were identified in four parks: Belgrade – Banjica II, Belgrade - Topčiderski Park, Novi Beograd – Siv, Zemun – Kalvarija. At these sites, 50 leaves with *Ph. platani* mines were randomly selected from *P. acerifolia* trees for each generation. The leaves were taken at the time when the mines were mainly infested with *Ph. platani* pupae. In the laboratory, 100 to 170 randomly selected leaf mines were opened, and the identified live pupae and larvae were dissected. The maximal number of mines opened per leaf was 5. The mines with young larvae from the overlapping generations were not opened. Mines of the first, second and third *Ph. platani* generations from which the butterflies had already emerged at the time of sampling, were included by random selection of the mines for the analysis**.** In addition, empty mines (attacked by predators) were also randomly selected as well as the mines containing pupae and larvae killed by diseases or unidentified agents**.**

Ph. platani parasitism rates were calculated by the Girardoz *et al*. formula (2007): parasitism = number of mines with parasitoids/total number of analysed mines (in percent).

The significance of differences in the parasitism of the first, second and third *Ph. platani* generations at the study sites were established using Duncan test.

3. Results

3.1 Parasitoid complex of Ph. platani

Altogether 1 054 adult parasitoids of *Ph. platani* were obtained from the collected *P. acerifolia* leaf samples. 18 species were determined of which 3 species of the family Ichneumonidae and 15 species of the family Eulophidae (Table 1). Among the obtained parasitoids, the most frequent and most abundant species were *Minotetrastichus platanellus*, *Pediobius saulius* and *M. frontalis*. *M. platanellus* and *P. saulius* were dominant parasitoids in the greatest number of samples (*M. platanellus* 58.3 %, *P. saulius* 20.8 %). The domination of *M. platanellus* was often rather high (65 – 85 %). *M. frontalis* occurred frequently, but its abundance was usually not high in the samples from which it was obtained. The rates of its domination in them usually did not exceed 20 %.

In addition to *M. platanellus*, *P. saulius* and *M. frontalis*, *Pnigalio agraules*, *P. pectinicornis* and *Sympiesis gordius* were also somewhat frequent among the identified *Ph. platani* parasitoids, but they were abundant only in individual samples (Table 1). *Neochrysocharis formosa* also occurred frequently, but its abundance was

always low. Other species of identified parasitoids were rare and few. Consequently, their significance as *Ph. platani* parasitoids during the study period was not high.

The dissection of *Ph. platani* larvae and pupae showed the gregariousness and hyper-parasitism in several samples. As the described parasitoid species (Table 1) were not only primary parasitoids, and as *M. platanellus* and *M. frontalis* were also gregarious, the calculated values of their dominance were by all means somewhat increased compared to real values, therefore they should be accepted with reservations.

3.2 Level of parasitism of Ph. platani

In general, the parasitism level of *Ph. platani* in the study samples accounted for 15.0 to 37.8 % (Table 2).

The statistical processing of the study data (Table 2) showed that the parasitism rates of the *Ph. platani* second generation at all sites was statistically significantly higher than the parasitism rates of the first and the third generations and that there were no statistically significant differences in the parasitism of the first and the third generations (Duncan test of significant differences: F– 15.7, P – 0.0012). However, although the parasitism rate of the second generation was higher, the differences in parasitism of the second generation and the other two generations were not really high.

4. Discussion

A list of 21 parasitoid species which can be formed based on our results and Bogavac's results (1959) (see Introduction), shows that *Ph. platani* has a great number of natural enemies among the parasitoids in Serbia. Its parasitoids are wide polyphagous species (Bogavac, 1964; Bouček, 1977; Bouček & Askew, 1968; Vidal & Buszko, 1990; Mey, 1991, 1993; Graham, 1987, 1991; Zverova, 1992) some of which are also recognised as parasitoids of other harmful invasive leaf miners in Serbia (Stojanović & Marković, 2004, 2005). They also include the species which were observed as *Ph. platani* parasitoids for the first time during our research (*Baryscapus nigroviolaceus*, *Cirrospilus viticola*, *Hemiptarsenus unguicellus*, *Itoplectis maculator*, *Scambus calobatus* and *Sympiesis gyorfii*) (Ferrière, 1952; Bouček, 1959; Van Frankenhuyzen, 1983; Vidal & Buszko, 1990; Mey, 1991; Godfray *et al*., 1995; Girardoz *et al*., 2007). Some *Ph. platani* parasitoids identified during our study in Serbia were also identified by the authors of similar studies of *Ph. platani* parasitoids mainly in Germany (Mey, 1991), England (Godfray *et al*., 1995) Bulgaria and Switzerland (Girardoz *et al*., 2007). The most significant *Ph. platani* parasitoids reported in the above studies are *M. platanellus*, *P. saulius* and *M. frontalis,* which were also determined as the most significant parasitoids of *Ph. platani* in our study. In addition, we also identified the following species as significant parasitoids: *P. agraules*, *P. pectinicornis*, *S. gordius* and *N. formosa*. Other species of identified parasitoids were rare and their number was small.

It is known that parasitoids can have a high impact on the abundance of some leaf miner species (Swan, 1973; Askew & Shaw, 1979; Van Driesche & Taub, 1983; Mey, 1991, 1993; Stojanović & Marković, 2005). Unfortunately, the data on leaf miner parasitism reported in literature are frequently incomparable because of the different methods of parasitism calculation. To avoid this problem, in our study of *Ph. platani* parasitism we applied the method used by Girardoz *et al*. (2007) in their study of *Ph. platani* parasitoids in Bulgaria and Switzerland. Our study results show that *Ph. platani* parasitism in Serbia ranged between 15 and 37.8 % and that there were no great differences in *Ph. platani* parasitism rates in Serbia, Bulgaria (18 – 28 %), Switzerland (1 – 27 %) (Girardoz *et al*., 2007) and England (35 %) (Godfray *et al*., 1995).

Compared to some *Phyllonorycter* species, the study rates of *Ph. platani* parasitism in Serbia (Table 2) were not high. For example, parasitism rate of the species *Ph. robiniella* (Clemens) in Serbia was usually above 50 % (Stojanović & Marković, 2005). On the other hand, the obtained rates of *Ph. platani* parasitism cannot be considered as low, because they accounted for between 20 and 30 % in the majority of samples. Generally, in the species with such parasitism rates, parasitoids do not exert a decisive influence on the development of the host populations. Probably for that reason, *inter alia*, the population density of *Ph. platani* in our parks and tree rows is high at the sites where it is not suppressed.

Along with *Ph. platani,* other invasive leaf miner species (Dimić *et al*., 1998; Stojanović & Marković, 2005; Marković, 2006) have also been introduced to Serbia. Among them, only the species *Cameraria ohridella* Deschka & Dimić (Lepidoptera, Gracillariidae) can be compared with *Ph. platani* by its significance to our parks and tree rows. This horse-chestnut (*Aesculus hippocastanum* Linnaeus) leaf miner, just like *Ph. platani* in Serbia (Freise *et al*., 2002; Stojanović & Marković, 2004), and also in other parts of Europe (Moreth, 2000; Freise *et al*., 2002; Volter & Kenis, 2006; Girardoz *et al*., 2007), has acquired a rich parasitoid fauna. However, compared to *Ph. platani,* the effect of its parasitoids is significantly lower (parasitism 1 - 10 %).

Taking into account all the above mentioned data, it can be concluded that *Ph. platani* is an invasive species which has acquired a great number of parasitoids in Serbia. Unfortunately, their impact on its abundance is not very high.

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Table 1. Recorded species of parasitoids and their status and total number of obtained adult parasitoids and their frequency of occurrence at the investigated sites and in the collected samples

Species	Obtained imagoes		Frequency			
			at the study sites		in the study samples	
	n	%	n	%	n	%
Ichneumonidae						
Itoplectis alternans (Gravenhorst)	5	0.5	3	37.5	3	12,5
Itoplectis maculator (Fabricius)	8	0.8	4	50.0	4	16,7
Scambus calobatus (Gravenhorst)	5	0.5	2	25.0	2	8,3
Eulophidae						
Baryscapus nigroviolaceus (Nees)	1	0.1	1	12.5	1	4,2
Cirrospilus lyncus Walker	3	0.2	1	12.5	1	4,2
Cirrospilus talitzkii Bouček	13	1.3	4	50.0	4	16,7
Cirrospilus viticola (Rondani)	1	0.1	1	12.5	1	4,2
Elachertus inunctus Nees	1	0.1	1	12.5	1	4,2
Hemiptarsenus unguicellus (Zetterstedt)	1	0.1	1	12.5	1	4,2
Minotetrastichus frontalis (Nees)	132	12.5	8	100	16	66,7
Minotetrastichus platanellus (Mercet)	465	44.1	8	100	23	95,8
Neochrysocharis formosa (Westwood)	23	2.2	7	87.5	9	37,5
Pediobius saulius (Walker)	224	21.3	8	100	22	91,7
Pnigalio agraules (Walker)	82	7.8	7	87.5	11	45,8
Pnigalio pectinicornis (Linnaeus)	45	4.3	6	75.0	6	25,0
Sympiesis gordius (Walker)	35	3.3	5	62.5	9	37,5
Sympiesis gyorfii Erdös	2	0.2	1	12.5	1	4,2
Sympiesis sericeicornis (Nees)	8	0.8	4	50.0	5	20,8

Table 2. *Ph. platani* parasitism in the first, second and third generations

Sites	Generation	Number of opened mines	Mines with parasitoids	
			n	%
Beograd – Banjica II	I	100	15	15,0
	II	154	51	33,1
	III	170	38	22,4
Beograd – Topčider	I	112	19	17,0
	II	169	50	29,6
	III	134	26	19,4
Novi Beograd -Siv	I	114	31	27,2
	II	135	51	37,8
	III	153	32	20,9
Zemun - Kalvarija	I	116	24	20,7
	II	102	33	32,4
	III	111	20	18,0

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