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Note

Studies on larval parasitoids of *Paranthrene tabaniformis* (Rott.) (Lepidoptera: Sesiidae) on urban poplars (*Populus* spp.) in Sofia, Bulgaria

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Abstract – Studies on the species composition and structure of the larval parasitoid complex of poplar clearwing moth, *Paranthrene tabaniformis* (Rott.), on urban poplars in Sofia and impact of different species on population density of the pest have been conducted during the period 1996-1999. *P. tabaniformis* larvae within poplar cuttings were collected from one-year-old poplar stumps in five residential areas in Sofia. Parasitoids were collected from pest damaged shoots in a laboratory. Ten larval parasitoids of the host were found: *Bracon (B.) intercessor* Nees, *Macrocentrus (M.) marginator* (Nees), *Apanteles evonymellae* (Bouché) (Hymenoptera: Braconidae), *Liotryphon crassisetus* (Thoms.), *Scambus vesicarius* (Ratz.), *Lissonota culiciformis* Grav., *Dolichomitus* sp., *Pristomerus vulnerator* (Panz.) (Hymenoptera: Ichneumonidae), *Leskia aurea* (Fall.) and *Phytomyptera nigrina* (Meig.) (Diptera: Tachinidae). The most numerous were *A. evonymellae* (70.1%) and *B. intercessor* (16.3%). They attacked young *P. tabaniformis* larvae and emerged at larval stage of the host. In 1996, the level of total parasitism in studied residential areas in Sofia varied from 12.1 to 46.6%, with an average of 32.5%. During the period 1997-1999, mortality of the pest larvae caused by parasitoids reached 38.1–55.6%. *A. evonymellae* was the most important parasitoid; it destroyed 23.8–55.6% of pest larvae.

poplars / *Paranthrene tabaniformis* / parasitoids / host mortality / Bulgaria

Résumé – **Parasitoïdes larvaires de *Paranthrene tabaniformis* (Rott.) (Lepidoptera : Sesiidae) dans les peupliers urbains de Sofia, Bulgarie.** Entre 1996 et 1999, la composition spécifique et la structure du complexe parasitaire des larves de *Paranthrene tabaniformis* (Rott.) ont été étudiées dans les peupliers urbains de Sofia (Bulgarie) de même que l'impact de ces parasitoïdes sur la densité de population du ravageur. Les larves de *P. tabaniformis* et leurs parasitoïdes ont été obtenues à partir de pousses de un an coupées sur des moignons de branches lors de l'abattage de vieux peupliers dans 5 quartiers résidentiels de Sofia (« Slatina », « Druzhba », « Mladost », « Darvenitsa » et « Lyulin »), et placées au laboratoire. Dix parasitoïdes ont été trouvés : *Bracon (B.) intercessor* Nees, *Macrocentrus (M.) marginator* (Nees), *Apanteles evonymellae* (Bouché) (Hymenoptera : Braconidae), *Liotryphon crassisetus* (Thoms.), *Scambus vesicarius* (Ratz.), *Lissonota culiciformis* Grav., *Dolichomitus* sp., *Pristomerus vulnerator* (Panz.) (Hymenoptera : Ichneumonidae), *Leskia aurea* (Fall.) et *Phytomyptera nigrina* (Meig.) (Diptera : Tachinidae). Les parasitoïdes les plus abondants sont *A. evonymellae* (69,1 %), *B. intercessor* (17,3 %), *P. vulnerator* (3,6 %), et *Dolichomitus* sp. (3,6 %). Ce sont des parasitoïdes solitaires, à l'exception de *B. intercessor* qui est grégaire. *B. intercessor*, *L. crassisetus*, *S. vesicarius* et *Dolichomitus* sp. sont des ectoparasitoïdes ; les autres sont des endoparasitoïdes. Ils attaquent les jeunes larves de *P. tabaniformis* et sortent de l'hôte

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alors que celui-ci est encore au stade larvaire. En 1996, le niveau de parasitisme total dans les quartiers résidentiels de Sofia a varié de 12,1 à 46,6 %, avec une moyenne de 32,5 %. En 1997 et en 1999, la mortalité des larves du ravageur, due au parasitisme, a atteint 38,1–55,6 %. *A. evonymellae* a eu l'impact le plus élevé, détruisant de 23,8 à 55,6 % des larves du ravageur.

peupliers / *Paranthrene tabaniformis* / parasitoïdes / mortalité de l'hôte / Bulgarie

1. INTRODUCTION

The poplar clearwing moth, *Paranthrene tabaniformis* (Rottemburg 1775), is one of the most dangerous pests of the poplars (*Populus* spp.) in many regions of the Palaearctic zone [2, 17, 20]. It is associated mainly with the seedlings in nurseries and young trees in poplar plantations. The pest causes serious malformations of the host plants. In Bulgaria damages occur most frequently in the nurseries, where attacks have been reported up to 40% of the poplar seedlings [6].

P. tabaniformis occurs as a pest not only in poplar nurseries and plantations, but also in urban systems. Damage by this insect has been observed periodically on the poplars in the streets and parks of Sofia [9]. The larvae bore galleries in the young shoots and branches of the trees. Infested host plants produce characteristic swellings and deformations, which result in strong aesthetic damages on ornamental trees.

In Bulgaria control of *P. tabaniformis* is usually achieved by treatments with systemic organophosphate insecticides and synthetic pyrethroids [6]. However, they are strongly toxic and their use in urban environment is dangerous. Supplementary control by using biological limiting factors of the pest, such as parasitoid would be helpful to reduce *P. tabaniformis* populations.

Some parasitoids regulate the population densities of the pests at a relatively low number, thus being one of the main factors for the sustainability of the ecosystems. The parasitoid complex of *P. tabaniformis* in Europe includes about 30 species from the families Ichneumonidae, Braconidae, Encyrtidae and Tachinidae which reduce the pest number in some cases up to 65% [2, 3, 17, etc.]. In Bulgaria, 15 species have been found as parasitoids of the pest and ten of them were reported as new records for its parasitoid complex: *Bracon triangularis* Nees (Hymenoptera: Braconidae), *Scambus detritus* Holm., *Pristomerus rufiabdominalis* Uchida, *Dolichomitus messor* (Grav.), *Eriborus* sp. (Hymenoptera: Ichneumonidae), *Megaselia* sp. (Diptera: Phoridae) [12], *Phytomyptera nigrina* (Meig.) (Diptera: Tachinidae) [14], *Scambus vesicarius* (Ratz.), *Liotryphon crassisetus* (Thoms.) (Hymenoptera: Ichneumonidae) [15], and *Lissonota culiciformis* Grav. (Hymenoptera: Ichneumonidae) [10]. Although large numbers of investigations have been carried out, no special studies on parasitoids of *P. tabaniformis* on poplar ornamental trees in urban areas have been made in Bulgaria or other countries.

The paper presents study on the species composition and structure of the larval parasitoid complex of *P. tabaniformis* in Sofia and their impact on pest numbers.

2. MATERIALS AND METHODS

The studies were conducted during the years 1996-1999 in 5 residential areas in Sofia - "Slatina", "Druzhba", "Mladost", "Darvenitsa" and "Lyulin". The biological materials (*P. tabaniformis* larvae within poplar cuttings of approximate 20 cm) were collected from one-year-old poplar stump shoots at the place of cut down old poplars - unknown hybrid clones from euramericana-group, *Populus x* euramericana (Dode) Guinier.

After collection, infested poplar cuttings were transported to the laboratory of the Forest Research Institute in Sofia, where sections were covered with paraffin, and each cutting was kept individually in a glass cylinder closed with cotton stoppers and kept at room temperature (18–22 ºC). In this way the poplar cuttings are kept fresh for a long time, which allows most of the host larvae to complete their development. The samples were observed daily for emergence of adult hosts or parasitoids. The longevity of each individual was reported.

In 1996, population density of *P. tabaniformis* was relatively high (0.1 – 0.7 larvae/m), and seven collections of the pest larvae were made from March 3 to April 21. During the period 1997-1999, the populations of *P. tabaniformis* were very low (0.01 – 0.05 larvae/m), and only 18 - 21 larvae were collected annually in March from one residential area. However, more damaged poplar shoots with *P. tabaniformis* larvae were collected and analysed during the period of study, but only in 370 cases parasitoids and hosts were observed - 311 in 1996, 18 in 1997, 21 in 1998, and 20 in 1999. In the rest of the samples the larvae died because the cuttings dried out. In this study the parasitism was calculated only on the bases of emerged parasitoids and hosts.

At the end of the observation period, the poplar cuttings were opened and their contents analyzed in detail

in order to determine the cause of mortality of the host and to establish some bioecological characteristics of the parasitoids. Emerged parasitoids were killed with ethyl acetate, identified and deposited in the author's collection.

3. RESULTS

3.1. Species composition and structure of the parasitoid complex

Ten hymenopteran and dipteran larval parasitoids of *P. tabaniformis* were recorded in Sofia (*table I*). They belong to the two orders and three families as follows: *Bracon (Bracon) intercessor* Nees 1834, *Macrocentrus (Macrocentrus) marginator* (Nees 1812), *Apanteles evonymellae* (Bouché 1834) (Hymenoptera, Braconidae), *Liotryphon crassisetus* (Thomson 1877), *Scambus vesicarius* (Ratzeburg 1844), *Lissonota culiciformis* Gravenhorst 1829, *Dolichomitus* sp., *Pristomerus vulnerator* (Panzer 1799) (Hymenoptera, Ichneumonidae), *Leskia aurea* (Fallén 1820) and *Phytomyptera nigrina* (Meigen 1824) (Diptera, Tachinidae). *M. marginator* was described as new parasitoid of *P. tabaniformis*, and *L. aurea* and *B. intercessor* were reared for the first time from this host in Bulgaria (*table I*).

Most of the parasitoids were recorded in 1996 during an outbreak of *P. tabaniformis*. During the period 1997–1999 the pest density was low and resulted in the collection few partasitoids.

The relative abundance (%) of all braconids in the parasitoid complex of *P. tabaniformis* was 87.1%. Ichneumonids made up 11.5%, while tachinids were 1.4%. The most abundant were two braconids - *A. evonymellae* (70.1%) and *B. intercessor* (16.3%), followed by the ichneumonids *P. vulnerator* (3.4%) and *Dolichomitus* sp. (3.4%), while the other species are presented by 0.7 – 2.7% (*table I*).

Structure of the parasitoid complex of *P. tabaniformis* in Sofia varied greatly from year to year and between different residential areas. Only *A. evonymellae* was recorded all four years and it was the dominant in the parasitoid complex of the pest with 62.5 – 100%. In 1996 dominant species was *B. intercessor* (19.8%) as well, but this status is due to the gregarious mode of its parasitism on the host. In the same year three species were subdominant (*P. vulnerator* – 4.1%, *Dolichomitus* sp. – 4.1% and *S. vesicarius* – 3.3%); the remaining parasitoids were not numerous.

Only separate parasitoid individuals were recovered in 1997 (n = 10), 1998 (n = 8) and 1999 (n = 8) and that is why it is not correct to analyze the species composition and structure of the parasitoid complexes.

Table I. Species composition, structure and impact of the parasitoids of *P. tabaniformis* in Sofia during the period 1996–1999.

Family, species	Number of parasitoids males	females	Emergence date	Percentage in the complex	Host mortality %
Braconidae	**68**	**60**	**87.1**		
** *B. intercessor*	15	9	11-18.04.1996	16.3	1.3
* *M. marginator*	-	1	12.04.1998	0.7	4.8
	44	37	22.03-03.05.1996		26.1
A. evonymellae	6	4	25-29.03.1997	70.1	55.6
	2	3	20-25.03.1998		23.8
	1	6	07-13.04.1999		35.0
Ichneumonidae	**11**	**6**		**11.5**	
L. crassisetus	-	1	02.04.1996	0.7	0.3
S. vesicarius	4	-	29.03-16.04.1996	2.7	1.3
L. culiciformis	-	2	18.05.1998	1.3	9.5
Dolichomitus sp.	5	-	28.03-29.04.1996	3.4	1.6
P. vulnerator	2	3	13-16.05.1996	3.4	1.6
Tachinidae	**2**	-		**1.4**	
P. nigrina	1	-	09.05.1996	0.7	0.3
** *L. aurea*	1	-	21.04.1999	0.7	5.0
Total	**81**	**66**		**100.0**	

* - New species for parasitoid complex of *P. tabaniformis.*
** - New parasitoid of the host in Bulgaria.

3.2. Biological characteristics of the parasitoids

All of the parasitoids attacked the larvae of *P. tabaniformis* were larval while no pupal parasitoids were recorded in this study. Analyses of dead hosts showed that parasitoid adults emerged from third - fifth larval instars prior to pupating.

B. intercessor was gregarious; an average 6.0 ± 1.83 (n = 4) adults were obtained per host. From the remaining hosts solitary parasitoids were recovered. Four species - *B. intercessor*, *L. crassisetus*, *S. vesicarius* and *Dolichomitus* sp. developed as ectoparasitoids, and the other species were internal parasitoids.

With the exception of *L. culiciformis* which emerged almost at the same time as the host, the remaining parasitoids emerged in laboratory 24–33 days prior to the emergence of *P. tabaniformis* and lived without additional feeding 1–8 days.

3.3. Impact of the parasitoids

The total mortality of *P. tabaniformis* from larval parasitoid attacks in the studied areas ranged between 12.1 and 55.6%.

In 1996, total parasitism in studied residential areas in Sofia varied from 12.1 to 46.6%, and the average was 32.5%. In 1997 total parasitism of *P. tabaniformis* was 55.6%, and in 1998 and 1999 – 38.1 and 40.0%, respectively.

During all four years, *A. evonymellae* was the most important parasitoid of *P. tabaniformis*, killing 23.8–55.6% of the pest larvae (*table I*).

The remaining parasitoids occurred in relatively low number and they were not important as regulating agents of the pest.

4. DISCUSSION

In many regions of Bulgaria *P. tabaniformis* develops one generation per year and overwinters as a larva in third – sixth (mostly in fifth) stage [7]. In the Sofia region *P. tabaniformis* usually overwinters in second – fourth stage (Georgiev, unpublished). The samples were taken from the beginning of March until the end of April and, therefore, the parasitoids of the young and middle-stage larvae of *P. tabaniformis* were studied in this investigation.

In Bulgaria *A. evonymellae* is the most common and most effective parasitoid of *P. tabaniformis*, which has been confirmed from this and other investigations [5, 12]. It occurs in all areas studied in Bulgaria [12]. In poplar nurseries it reduced the pest population by up to 35% [5]. *A. evonymellae* overwinters as a larva in the host. It is bivoltine, but only the second (overwintering) generation is associated with *P. tabaniformis*; in the spring the emergence of *A. evonymellae* is not synchronized with *P. tabaniformis* larval population and its premier generation develops in alternate hosts [8]. In the Netherlands this parasitoid has been reported to kill up to 55% of the *P. tabaniformis* larvae [16].

Eriborus terebrans (Grav.) (Hymenoptera: Ichneumonidae) parasitizes up to 39% of *P. tabaniformis* young larvae in some localities in Bulgaria, thus occupying a secondary position as a limiting biocontrol agent among the parasitoids [5]. It is known mainly as a parasitoid of European corn borer, *Ostrinia nubilalis* (Hb.) (Lepidoptera: Pyralidae) [21]. However, *E. terebrans* was not observed in Sofia, probably because of absence of its main host.

P. vulnerator kills up to 15% of *P. tabaniformis* larvae in the poplar nurseries in Bulgaria [5]. This parasitoid completes two generations per year in the larvae of *Gypsonoma aceriana* (Dup.) (Lepidoptera: Tortricidae) [11]. However, only the overwintering generation of *P. vulnerator* is connected with *P. tabaniformis* [5, 6, 12]; in the spring parasitoid adults appear about 20–25 days prior to emergence of *P. tabaniformis* and cannot attack its neonate larvae.

The new species for parasitoid complex of *P. tabaniformis*, *M. marginator* is known as a parasitoid of many lepidopteran hosts including clearwing moth species of *Synanthedon* genus: *S. culiciformis* (L.), *S. vespiformis* (L.), *S. cephiformis* (O.), *S. formicaeformis* (Esp.), *S. myopaeformis* (Borkh.), *S. spheciformis* (Den. & Schiff.), *S. tipuliformis* (Cl.) [22]. *L. crassisetus* also parasitizes some representatives of this genus: *S. flaviventris* (Staud.), *S. scoliaeformis* (Borkh.), *S. myopaeformis*, *S. culiciformis* [4] and *S. typuliformis* [1].

B. intercessor (syn. *B. fulvus* Szepl.) has been previously recorded as a parasitoid of *P. tabaniformis* in Hungary [18, 19].

P. nigrina has been found as a parasitoid of *P. tabaniformis* only in Bulgaria [14]. The other species of Tachinidae family – *L. aurea* parasitizes species of *Synanthedon* genus – *S. vespiformis*, *S. scoliaeformis*, *S. formicaeformis*, *S. typhiaeformis* (Borkh.) [13] and *S. myopaeformis* [23]. This parasitoid has been recorded previously from other *P. tabaniformis* populations in Europe [17, 20]. It is bivoltine [23]; in this study its overwintering generation was associated with *P. tabaniformis*.

During the years of investigation, parasitoids destroyed a significant portion (32.5–55.6%) of overwintering larvae of *P. tabaniformis* in Sofia. No studies have been conducted on the parasitoids during the summer months, but in other habitats of the host in Bulgaria three species - *Bracon mediator* Nees, *B. triangularis* and *E. terebrans* reduced the number of the pest during the vegetation period up to 14% [5]. Therefore, it is possible that the mortality of *P. tabaniformis* caused by parasitoids in Sofia is actually higher.

Parasitoids of *P. tabaniformis* appear to be the major factor in maintaining a low pest population density in Bulgaria. They can be a promising tool in devising a strategy for management of the pest. Some its biological characteristics, such as freedom from any hyperparasitoids, appearance before the host, etc., can find a place for increasing of the beneficial impact of the parasitoids in poplar plantations. For example, it is well known that the most important parasitoids emerge about one month before *P. tabaniformis* in Bulgaria and if some pest control against other pests in this period is needed, it would be is advisable to use selective larval insecticides. In this way, the flying adult parasitoids will not be affected and can exert an additional impact on the pest. In the poplar nurseries the infested by xylophagous insects control is accomplished by burning the seedlings. However it would be better from a pest control perspective to preserve the cuttings with *P. tabaniformis* larvae in containers covered with plastic net which has mesh-openings 5×5 mm. The net will stop the pest moths from escaping but will let the parasitoid adults through. These measures might increase of the sustainability of the poplar stands.

In urban areas in Sofia the parasitoids are obviously important biological component in reducing the number of *P. tabaniformis*. Some of them are probably responsible for maintaining the pest populations at relatively low levels, thus being a contributing factor towards the improvement of the decorative value of young poplar ornamental trees.

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