

SYRPHIDS AND THEIR PARASITOIDS FROM MAIZE CROP

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Abstract: The studies were carried out on the maize crops grown in monoculture in 2004–2005 on two experimental fields at Łosiów and Wronów in the Opole region, Poland. Larvae of these four hoverfly species: *Sphaerophoria scripta* (L.), *S. rueppelli* (Wied.), *S. menthastri* (L.) and *Episyrphus balteatus* (Deg.) were found on maize plants. *S. scripta* was more abundant at both sites in 2004, whereas *S. rueppelli* predominated in 2005. The following parasitoids of syrphid pupae were identified: *Pachyneuron grande* Thomson, *Syrphophagus aeruginosus* (Dalman), *Aphidencyrthus aphidivorus* (Mayr) and *Dendrocerus pupparum* (Graham), as well as ichneumonid wasps. The predominant parasitoid species that attacked the syrphid pupae of all types to the greatest extent, was *P. grande*.

Key words: maize, syrphids, Syrphidae parasitoids, species composition

INTRODUCTION

Aphids (Homoptera: Aphididae) have recently become a steadily increasing threat for maize crops in Poland (Krawczyk *et al.* 2006; Strażyński 2008). On many farms, the aphids are controlled with chemical aphicides. In spite of the growing economical importance of these pests on maize, a wide-ranging research project on the natural enemies of aphids, especially about predatory hoverflies (Diptera: Syrphidae), has still not been done. The only work within the field is the paper by Jasiołek *et al.* (1974), reporting the data collected near Wrocław.

The predatory hoverflies are an important regulating factor of aphid density (Pisarska-Bańkowska 1964; Malinowska 1974; Hurej 1982; Wnuk and Wojciechowska 1993). The majority of predatory syrphid larvae belong to the species of subfamily Syrphinae, as well as to some genera of Cheilosiniinae. They attack mostly aphids, but also prey on other Homoptera, such as scale insects or psyllids (Bańkowska 1963, Wnuk 1978). Apart from that, the hoverfly larvae may feed upon larval stages of Coleoptera or Lepidoptera (Wnuk 1978).

However, hoverflies have their natural enemies too. These are the parasitic wasps of the Pteromalidae, Encyrtidae and Ichneumonidae families (Wnuk 1978). Chambers (1988) reports that the ichneumonid subfamily Diplozontinae is the most abundant group among parasitoids of Syrphidae. Species of this group attack their hosts at the egg stage or the first or the second larval instar. In the latter case, the parasitoid pupation takes place within the host pupa. Rotheray (1981) includes two species of the Figitidae family: *Callaspidie defonscolombi* (Dal-libau) and *Melanips opacus* (Hartig) among the parasitoids of hoverflies, along with Ichneumonidae and Encyrtidae.

The Encyrtidae family is a vast family of parasitic hymenopterans, infesting insects of the orders: Homoptera, Heteroptera, Lepidoptera, Coleoptera, Diptera, Hymenoptera, Neuroptera, Orthoptera, Blattoidea and Megaloptera. These small parasitic wasps effectively suppress many agricultural pests, especially in the tropics and subtropics (Trjapitzin 2008).

Our research was aimed at documenting the abundance and species composition of syrphids and their parasitoids on maize crop grown for grain.

MATERIALS AND METHODS

The insect material (the hoverfly pupae) was sampled in maize crops grown in monoculture in 2004–2005. The two experimental fields, were each 3 ha in size. The fields were located 20 km from one another, at Łosiów and Wronów in the Opole region, in southern Poland. The maize cultivars used at Łosiów were Ikos in 2004 and Eurostar in 2005, whereas the cultivars LG 22.44 and LG 3226 were used in the respective years at Wronów. The laboratory culture of the hoverfly pupae was maintained to obtain adult hoverflies and/or the parasitoids of Syrphidae. The pupae to be reared were collected every season, starting with the day when the first specimens were found on the plants, until the crop harvest. The size of the collected samples varied considerably and were dependent on the finding of syrphid pupae. The specimens were collected together with the leaf fragments, put in the PVC tubes, and secured with a piece of organdy cloth. The pupae were then stored at room temperature until the adult syrphid flies or their parasitoids emerged. The emerging insects were killed with ethyl acetate. In the

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case of the parasitised pupae, where no adult hoverflies were available, the type of pupa indicated the genus in the subfamily Syrphinae. Adult hoverflies were determined to species level according to the key by Bańkowska (1963). The parasitic wasp species were identified using the taxonomic keys by Graham (1976) and Tobjak and Kirijak (1986).

RESULTS

Species composition of Syrphidae

Out of the 128 pupae collected from maize at Łosiów in 2004, only 15 adult hoverflies emerged (11.7%) (Table 1). The emerging insects belonged to three aphidivorous species: *Sphaerophoria scripta* (L.) – (8 individuals, 53.3% of all emerged hoverflies), *Sphaerophoria rueppelli* (Wied.) – (4 indiv., 26.7%), and *Episyrphus balteatus* (Deg.) – (3 indiv., 20.0%) (Table 2). Of the remaining pupae, 108 (84.4%), were parasitised (Table 1). Another 5 pupae were infected by entomopathogenic fungi or desiccated, and no imagines emerged from them. Only 38 pupae were collected at Wronów in 2004 (Table 1). Twenty-six pupae (68.5%),

were parasitised, 3 pupae were desiccated or infected by fungi, and out of the remaining ones, 9 adult hoverflies emerged, with *Sphaerophoria* sp. as the best represented genus (Table 2).

Out of 64 pupae collected at Łosiów in 2005, 21 (32.8%) were parasitized, 19 were infected by fungi or desiccated, and adult hoverflies emerged from 24 (37.5%) pupae (Table 1). Among the 24 emerging hoverflies, again, the most abundant was the *Sphaerophoria* spp., with the predominating species being *S. rueppelli* – 9 indiv., (37.5%) (Table 2). The two other *Sphaerophoria* species were less abundant: *S. scripta* – 6 indiv., (25.0%), and *S. menthastri* (L.) – 2 indiv., (8.3%). Apart from the above species, 4 individuals (16.7%) of *E. balteatus* emerged from the remaining pupae. At Wronów, 39 pupae were collected in 2005 (Table 1). Parasitoids of *Syrphidae* were identified in 14 (35.9%) of them. Like in the sample from Łosiów, the pupae from Wronów were largely infected by the entomopathogenic fungi or desiccated – 15 indiv., (38.5%). Adult Syrphidae emerged from 10 pupae (25.6%). Their species list was similar to that of Łosiów, with 4 species (Table 2). The most represented one was *S. rueppelli* – 4 indiv. (40%).

Table 1. Emergence of imagines from the pupae of Syrphidae collected in maize in 2004–2005

Sampling site	Sampling period	Total pupae reared	Pupae from which parasitoids emerged		Pupae infected with entomopathogenic fungi or desiccated		Parasitised pupae		Pupae from which adult Syrphidae emerged	
		No.	No.	[%]	No.	[%]	No.	[%]	No.	[%]
2004										
Łosiów	22.07–11.08	128	123	96.1	5	3.9	108	84.4	15	11.7
Wronów	21.07–04.08	38	35	92.1	3	7.9	26	68.5	9	23.6
2005										
Łosiów	14.07–08.08	64	45	70.3	19	29.7	21	32.8	24	37.5
Wronów	18.07–01.07	39	24	61.5	15	38.5	14	35.9	10	25.6

Table 2. Species composition of Syrphidae reared from the pupae collected in maize crop in 2004–2005

Sampling site	Species	No.	[%]
2004			
Łosiów	<i>Episyrphus balteatus</i> (De Geer)	3	20.0
	<i>Sphaerophoria scripta</i> (Linnaeus)	8	53.3
	<i>S. rueppelli</i> Wiedemann	4	26.7
Wronów	<i>E. balteatus</i> (De Geer)	1	11.2
	<i>S. scripta</i> (Linnaeus)	3	33.3
	<i>S. rueppelli</i> Wiedemann	1	11.1
	<i>S. menthastri</i> (Linnaeus)	1	11.1
	<i>Sphaerophoria</i> sp.	3	33.3
2005			
Łosiów	<i>E. balteatus</i> (De Geer)	4	16.7
	<i>S. scripta</i> (Linnaeus)	6	25.0
	<i>S. rueppelli</i> Wiedemann	9	37.5
	<i>S. menthastri</i> (Linnaeus)	2	8.3
	<i>Sphaerophoria</i> sp.	3	12.5
Wronów	<i>E. balteatus</i> (DeGeer)	2	20.0
	<i>S. scripta</i> (Linnaeus)	3	30.0
	<i>S. rueppelli</i> Wiedemann	4	40.0
	<i>S. menthastri</i> (Linnaeus)	1	10.0

Syrphidae parasitoids

The emergence of the parasitic wasps from the hoverfly pupae in the material collected at Łosiów in 2004 was observed between the 30th July and the 18th August (Table 3). During that time, the parasitisation was recorded in three genera of Syrphidae: *Episyrphus*, *Sphaerophoria*, and *Melanostoma*. The highest number of the parasitised pupae was found in *Sphaerophoria*. Out of 75 parasitised *Sphaerophoria* pupae, 493 individuals of *Pachyneuron grande* Thomson (Pteromalidae) were reared. Furthermore, a few individuals of *Syrphophagus aeruginosus* (Dalmán) (Encyrtidae), and a small number of ichneumonids were identified from the same material. In the same year and sampling site, 30 parasitised pupae of *Episyrphus* were collected, from which 427 individuals of *P. grande* and 1 specimen of *Dendrocerus pupparum* (Graham) (Megasplilidae) emerged. The pupae of *Melanostoma* were scarcely parasitised, but those that were, were again parasitised mostly by *P. grande*.

The parasitoid emergence at Wronów in 2004 was observed between the 28th July and 12th August (Table 3). All of the 6 collected *Episyrphus* pupae were attacked by

P. grande; altogether 111 parasitoids emerged from them. Likewise, of the 20 sampled *Sphaerophoria* pupae, only one was not parasitised by *P. grande*. Instead, 20 individuals of *S. aeruginosus* emerged from it. From the remaining 19 pupae, 161 individuals of *P. grande* were cultured, as well as 2 ichneumonid wasps.

In 2005, the parasitoid appearance in the material collected at Łosiów was observed between the 1st and the 12th of August (Table 4). As in the previous year, the pupae of *Sphaerophoria* spp. were the most parasitized. From 17 pupae of *Sphaerophoria*, 52 wasps of *P. grande* emerged, along with 34 of *Aphidencyrthus aphidivorus* (Mayr) (Encyrtidae), and some specimens of Ichneumonidae. Moreover, 4 parasitised pupae of *Episyrphus* spp. were recorded, from which 15 individuals of *P. grande* and 2 ichneumonids were identified.

In the same year at Wronów, the pupae of *Sphaerophoria* sp. were also the most parasitised, (Table 4). From 10 pupae of the genus, 33 specimens of *P. grande* emerged and 21 of *A. aphidivorus*. *Episyrphus* pupae were attacked only by *P. grande*. The emergence of the parasitoids was observed between the 28th July and the 10th August.

Table 3. Species composition of the parasitoids of the pupae of Syrphidae, collected from maize plants in 2004

Sampling site	Emergence date	Pupae type:								
		<i>Episyrphus</i>			<i>Sphaerophoria</i>			<i>Melanostoma</i>		
		parasitised pupae [No.]	<i>Pachyneuron grande</i>	<i>Dendrocerus pupparum</i>	parasitised pupae [No.]	<i>Pachyneuron grande</i>	<i>Syrphophagus aeruginosus</i>	Ichneumonidae	parasitised pupae [No.]	<i>Pachyneuron grande</i>
Łosiów	30.07	5	97		1	6				
	02.08	12	195		10	107				
	04.08	2	15		11	114				
	05.08	4	58		5	58			1	6
	10.08	6	47	1	22	129	19	1		
	12.08	1	15		4	13			1	10
	18.08				22	66		1	1	12
Total		30	427	1	75	493	19	2	3	28
Wronów	28.07				1	16				
	29.07	2	25		1	5				
	02.08				3	26		1		
	04.08	1	25		2	28		1		
	05.08				5	36				
	10.08	3	61		7	50				
	12.08				1		20			
Total		6	111		20	161	20	2		

Table 4. Species composition of the parasitoids of the pupae of Syrphidae, collected from maize plants in 2005

Sampling site	Emergence date	Pupae type:						
		<i>Episyrphus</i>			<i>Sphaerophoria</i>			
		parasitised pupae [No.]	<i>Pachyneuron grande</i>	<i>Ichneumonidae</i>	parasitised pupae [No.]	<i>Pachyneuron grande</i>	<i>Aphidicyrtus aphidivorus</i>	<i>Ichneumonidae</i>
Łosiów	01.08	3	10	2	4	6		3
	03.08				2	12		
	05.08				3	9	17	1
	08.08				2	5	15	
	10.08				3	15	2	
	12.08	1	5		3	5		1
Total		4	15	2	17	52	34	5
Wronów	28.07	2	7		3	5		
	01.08	1	5		2	7	5	
	05.08				3	9	8	
	10.08	1	6		2	12	8	
Total		4	18		10	33	21	

DISCUSSION

Sphaerophoria spp. was the best represented genus among the Syrphidae, identified in the material collected in 2004–2005. At both sampling sites in 2004 the dominant species was *S. scripta* (L.), whereas in 2005 – *S. rueppelli* (Wied.). *E. balteatus* (Deg.) was less abundant. Nevertheless, *E. balteatus* was found at both sites in both seasons of the study. Similarly, Jasiołek *et al.* (1974), while investigating hoverfly incidence on maize near Wrocław, found both *S. scripta* and *E. balteatus* on the crop plants, but they recorded higher abundance of the second species and only the occasional presence of *S. scripta*. The other study carried out near Wrocław by Sobota and Gabryś (2001) confirmed the dominance of *E. balteatus* on a number of different crops other than maize. According to Dušek and Laška (1966) and Wnuk (1972), both of the species are polyphagous predators, preying on many different aphid species.

A considerable number of the collected syrphid pupae were parasitised. The percentage of parasitism ranged from 32.8 at Łosiów in 2005 to 84.4 at Łosiów in 2004. Pupae of the *Sphaerophoria* spp. were found parasitised more often than those of *Episyrphus* or *Melanostoma*. The species of *Sphaerophoria* at Łosiów and at Wronów in 2004 were parasitised mainly by *Pachyneuron grande* (Thomson) (Pteromalidae). This species was clearly a dominant one among the parasitoids of hoverflies. In the same year, few individuals of *Syrphophagus aeruginosus* (Dalman) (Encyrtidae) were identified. According to Trjapitzin (2008), *S. aeruginosus* is probably a secondary parasite. Another fairly abundant parasitoid, *Aphidicyrtus aphidivorus* Mayr (Encyrtidae) was identified along with *P. grande* in 2005. *A. aphidivorus* is known as the endohyperparasitoid of many aphidiid primary parasitoids (Völkl and Barczak 1990). The parasitisation of the hoverfly pupae collected from maize crop by Pteromalidae wasps was also demonstrated by Jasiołek *et al.* (1974). However, the percentage

of parasitism reported by these authors did not exceed 32% and the dominant parasitoid species was *Pachyneuron umbratum* Del.

CONCLUSIONS

1. The predatory larvae of the following hoverfly species were found on maize plants: *S. scripta* (L.), *S. rueppelli* (Wied.), *S. menthastri* (L.) and *E. balteatus* (Deg.). *S. scripta* was more abundant at both sites in 2004, whereas *S. rueppelli* predominated in 2005.
2. The abundance of the aphidivorous Syrphidae was substantially reduced by their parasitoids. The maximum of parasitism was 84.4 per cent.
3. The following parasitoids of syrphid pupae were identified: *P. grande* Thomson, *S. aeruginosus* (Dalman), *A. aphidivorus* (Mayr) and *D. pupparum* (Graham), as well as ichneumonid wasps. *P. grande* was the predominant parasitoid species, which attacked the syrphid pupae of all types to the greatest extent.

REFERENCES

- Bańkowska R. 1963. Klucze do oznaczania owadów Polski. Część XXVIII Muchówki (Diptera), z. 34, Syrphidae. PWN Warszawa, 236 pp.
- Chambers R.J. 1988. Syrphidae. p. 259–267. In: "Aphids Their Biology, Natural Enemies and Control" (A.K. Minks, P. Harrewijn, eds). Elsevier Science Publishers B.V. Amsterdam, 2B, 310 pp.
- Dušek J., Laška P. 1966. Occurrence of syrphid larvae on some aphids. p. 37–38. In: "Ecology of Aphidophagous Insects" (I. Hodek, ed.). Academia, Prague, 360 pp.
- Graham M.W.R. de V. 1976. The British species of Aphelinus with notes and descriptions of other European Aphelinidae (Hymenoptera). Syst. Entomol. 1: 123–146.

- Hurej M. 1982. Naturalna redukcja liczebności populacji mszycy trzmielinowo-burakowej - *Aphis fabae* Scop. przez Syrphidae (Diptera) w uprawie buraka cukrowego. Pol. Pismo Entomol. 52 (3-4): 287-294.
- Jasiołek Z., Kania C., Sobota G. 1974. Bzygowate (Syrphidae, Diptera) niszczące mszycę na kukurydzy. Pol. Pismo Entomol. 44 (2): 425-430.
- Krawczyk A., Hurej M., Sobota G. 2006. Aphids and their natural enemies infesting corn in Opole province. Aphids and Other Homopterous Insects 12: 125-134.
- Malinowska D. 1974. Ochrona mszycożernych bzygowatych przed ujemnym wpływem pestycydów stosowanych do zwalczania mszycy burakowej. Ochrona Roślin 5: 6-9.
- Pisarska-Bańkowska R. 1964. Bzygowate. Zesz. Probl. Post. Nauk Rol. 45: 121-125.
- Rotheray G.E. 1981. Host searching and behaviour of some parasitoids of aphidophagous Syrphidae. Department of Zoology. University College, Cardiff 6: 79-97.
- Sobota G., Gabryś B. 2001. Hoverflies (Diptera, Syrphidae) on selected field crops. Aphids and Other Homopterous Insects 8: 403-409.
- Strażyński P. 2008. Aphid fauna /Hemiptera, Aphidoidea/ on corn crops in Wielkopolska - species composition and increase in numbers. Aphids and Other Homopterous Insects 14: 123-128.
- Tobias W.I., Kirijak I.G. 1986. Aphidiidae. p. 232-295. In: „Opredelitel Nasiekomykh Jewropiejskoj Czasti SSSR” (G. S. Niedwiediew, ed.). Nauka, Leningrad, 295 pp.
- Trjapitzin V.A. 2008. A review of Encyrtid wasps (Hymenoptera, Chalcidoidea, Encyrtidae) of Macaronesia. Entomol. Rev. 88 (2): 218-232.
- Völkl W., Barczak T. 1990. Habitat selection by the aphid hyperparasitoid *Aphidencyrthus aphidivorus* Mayr (Hymenoptera, Encyrtidae). Pol. Pismo Entomol. 60 (1-2): 129-135.
- Wnuk A., 1972. Badania nad składem gatunkowym drapieżnych bzygowatych (Syrphidae, Diptera) występujących w koloniach mszyc na drzewach i krzewach ozdobnych. Pol. Pismo Entomol. 42 (1): 235-247.
- Wnuk A. 1978. Drapieżne muchówki. p. 267-285. In: „Biologiczne metody walki ze szkodnikami roślin” (J. Boczek, J.J. Lipa, eds.). PWN, Warszawa, 594 pp.
- Wnuk A., Wojciechowska E. 1993. Drapieżne bzygowate (Diptera, Syrphidae) występujące w koloniach mszycy kapuścianej *Brevicoryne brassicae* (L.) na kapuście i kalafiorze. Pol. Pismo Entomol. 62 (1-4): 215-229.

POLISH SUMMARY

BZYGOWATE ORAZ ICH PARAZYTOIDY WYSTĘPUJĄCE W UPRAWIE KUKURYDZY

Badania przeprowadzono na polach kukurydzy uprawianej w monokulturze w Łosiu i we Wronowie województwo opolskie, w latach 2004-2005. Na roślinach kukurydzy występowały larwy 4 gatunków bzygów, tj.: *Sphaerophoria scripta* (L.), *S. rueppelli* (Wied.), *S. menthastri* (L.) i *Episyrphus balteatus* (Deg.). *S. scripta* była najliczniejszym gatunkiem w 2004 roku, podczas gdy *S. rueppelli* dominowała w 2005 roku. Oznaczono następujące gatunki parazytoidów porażających poczwarki bzygów: *Pachyneuron grande* Thomson, *Syrphophagus aeruginosus* (Dalman), *Aphidencyrthus aphidivorus* (Mayr) i *Dendrocercus pupparum* (Graham). Najliczniejszym gatunkiem okazał się *P. grande*. Owady tego gatunku w największym procencie porażały wszystkie typy poczwerek bzygów.