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Hyperparasitoids of aphids on maize in Opole region in Poland

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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 Opole region, Poland. From the aphid mummies collected at both sites secondary parasitoids of the families Pteromalidae, Cynipidae, Megaspilidae, and Encyrtidae were reared. In spring and early summer of 2004, the most abundant were the species of Pteromalidae, with the eudominating species *Asaphes suspensus* NEES. At the same time of the next year the dominant species were *Dendrocerus carpenteri* (CURTIS) (Megaspilidae) and *Phaenoglyphis villosa* (HARTIG) (Charipidae: Alloxistinae).

In autumn, the secondary parasitoids occurred only in the second year of the study, 2005. The dominant species at both sites was *Phaenoglyphis xanthochroa* (FÖRSTER) (Charipidae: Alloxistinae). In the literature available so far there are no data on secondary parasitoids incidence on maize crop in autumn.

KEY WORDS: maize, aphids, hyperparasitoids, species composition, species dominance.

INTRODUCTION

Cereal aphids feeding on maize crops grown for grain have become an increasingly difficult economic problem recently. Three species are listed that infest maize in Poland, i.e. *Rhopalosiphum padi* L., *Metopolophium dirhodum* (WALK.) and *Sitobion avenae* (P.) H.R.L. The first species is most often the predominating one (KANIA & SOBOTA 1992, KRAWCZYK et al. 2006). Aphids feed on maize plants during the two clearly distinguishable periods: since the beginning of spring till mid-summer and in the autumn (KRAWCZYK et al. 2006).

According to a classical view, insect hyperparasitoids are considered highly detrimental, as they reduce the number of primary parasitoids and are therefore made responsible for massive aphid outbreaks (HAGEN & VAN DEN BOSCH 1968, CARTER et al. 1980). However,

the studies conducted by BENETT (1981) and LUCK et al. (1981) reject the hypothesis of the clearly negative effect of hyperparasitoids. It has been proven that under certain circumstances they may play a positive role in maintaining the balance between the primary parasitoids and their host species (STARY 1970). The presence of hyperparasitoids may therefore enhance the stability of a given pest - primary parasitoid system, transforming it from the system with massive pest incidences to the one in which the pest density is rather constant in time (PANKANIN-FRANCZYK 1995).

The research on hyperparasitoids of aphids feeding on maize is scarce in Poland. The only article within the scope is the one by KANIA & SOBOTA (1992). Most authors focus on the hyperparasitoids of cereal aphids feeding on winter wheat, on oats or on rye (BORGEMEISTER & POEHLING 1990, PANKANIN-FRANCZYK 1987, GABRYŚ & SOBOTA 1991, SOBOTA 1992, SOBOTA & GABRYŚ 1999). As the differences in plant phenology between the maize and the small grains are considerable, one can also expect the differences between the species composition of the parasitoids on these crops.

The aim of the study was to determine the species composition of hyperparasitoids reared from the cereal aphids feeding on maize grown for grain.

MATERIAL AND METHODS

The studies were carried out on the maize crops grown in monoculture in 2004-2005. The two experimental fields, 3 ha each, were located 20 km from one another, at Łosiów and Wronów in Opole region, Poland. The cultivars grown in Łosiów were Ikos (2004) and Eurostar (2005), while in Wronów LG 22.44 (2004) and LG 3226 (2005). In order to determine the species composition of the parasitic wasps, the laboratory rearing was conducted from the mummified aphids. The parasitized aphids were collected every season, starting with the day when the first mummified specimens were found on the plants, until the crop harvest. The plants within the crop field were actively searched for mummies, until the required number of mummies was found (at least 50). Therefore the size of the sample varied considerably as being dependent on the chance of finding the aphid mummies. The specimens were cut out of plants together with the leaf fragments, put in the PVC tubes, and secured with a piece of organdy cloth. In the laboratory, the aphid mummies were transferred to 1 liter glass jars secured with organdy cloth in a similar way as the PVC tubes in the field. The jars were then stored at room temperature. Emerging parasitic wasps were collected from jars using a small aspirator, put in glass probing tubes, and killed with ethyl acetate. The parasitic wasps were identified to species level, using the taxonomic keys by STARY (1981), GRAHAM (1976), and FERGUSSON (1980).

The species composition of the parasitic *Hymenoptera* has been described using the following indices: number of species, number of individuals of a given species, species dominance. In order to classify the insect species according to their dominance, the domination index (D) was calculated. The domination classes were adopted after BARCZAK (1993).

RESULTS

From the aphid mummies collected at Łosiów in spring and early summer 2004, 73 hyperparasitoids were reared. They belonged to four families: Pteromalidae, Megaspilidae, Cynipidae and Encyrtidae (Table 1). Pteromalidae were the most numerous group. It was represented by five species: *Asaphes suspensus* NEES, *A. vulgaris* WALK., *Pachyneuron aphidis* BOUCHÉ, *P. concolor* (FÖRSTER), and *Coruna clavata* WALKER. *Dendrocerus carpenteri* (CURTIS) was the only species of Megaspilidae, whereas *Alloxysta victrix* (WESTWOOD) and *A. macrophadna* (HARTIG) represented Charipidae (Alloxistinae). Among the collected mummies were also those that contained *Aphidencyrtus aphidivorus* MAYR., of Encyrtidae family. *A. suspensus*, making up 37% of all the parasitic wasps, was classified as eudominant, *A. vulgaris* and *D. carpenteri* – as dominants, *P. concolor* and *P. aphidis* – as subdominants. Other species occurred incidentally and were therefore classified as recendents.

At the same period in 2004, 68 secondary parasitoids were reared from the aphid mummies collected at Wronów. They belonged to three families: Pteromalidae, Megaspilidae, and Charipidae (Alloxistinae) (Table 1). Pteromalidae family was represented most abundantly, with *A. suspensus* as eudominant, making up 41.2% of all the parasitoids. *P. concolor* (16.2%) was classified as dominant and *A. vulgaris* and *P. aphidis* (14.7% and 7.4%, respectively) as subdominants. *A. victrix* and *Phaenoglyphis villosa* (HARTIG) of the Charipidae (Alloxistinae) family (8.8% and 5.9%, respectively) have been also classified as subdominants, whereas all the other species were counted as recendents. It should be emphasized that *P. villosa*, recorded from the aphid mummies at Wronów, was not found on the maize crop at Łosiów.

In the autumn part of the maize vegetation season 2004, the secondary parasitoids appeared neither at Łosiów nor at Wronów.

In spring and early summer 2005, 170 secondary parasitic wasps were reared from the cereal aphid mummies collected at Łosiów. They represented ten species belonging to four families (Table 2). 50.5% of all the individuals were Charipidae (Alloxistinae). Among them *P. villosa* occurred in the greatest number and was classified as eudominant (36.4%). Other species of this family were less abundant: *A. victrix* (8.8%) was classified as a subdominant whereas *Phenoglyphis xanthochroa* (FÖRSTER) (3.5%) and *A. macrophadna* (1.8%) – as recendents. Species of Megaspilidae made up 30.5% of all the secondary parasitoids and were represented by three species: *D. carpentieri* (29.3%, dominant), *D. aphidum* (RONDANI), and *D. laticeps* HEDICKE. *D. aphidum* and *D. laticeps* occurred sporadically, and each one of them made up 0.6% of all the hyperparasitoids. Two species were identified within Pteromalidae family: *A. suspensus* (8.2%) and *A. vulgaris* (5.5%). Both were classified as subdominants. Apart from that, from the material collected at Łosiów, a number of *A. aphidivorus* specimens (Encyrtidae) were reared with the domination value 5.3%.

Table 1. Hyperparasitoids reared from mummies of aphids feeding on maize in 2004, spring-early summer period.

Family/Species	Łosiów		Wronów	
	No of specimens	**D (%)**	**No of specimens**	**D (%)**
Pteromalidae				
Asaphes suspensus NEES	27	37.0	28	41.2
Asaphes vulgaris WALKER	19	26.0	10	14.7
Pachyneuron aphidis BOUCHÉ	4	5.5	5	7.4
Pachyneuron concolor (FÖRSTER)	7	9.6	11	16.2
Coruna clavata WALKER	1	1.4		
Megaspilidae				
Dendrocerus carpenteri (CURTIS)	11	15.0	2	2.9
Charipidae (Alloxistinae)				
Alloxysta victrix (WESTWOOD)	1	1.4	6	8.8
Alloxysta macrophadna (HARTIG)	2	2.7	2	2.9
Phaenoglyphis villosa (HARTIG)			4	5.9
Encyrtidae				
Aphidencyrtus aphidivorus MAYR	1	1.4		
Total	73	100.0	68	100.0

At the same period of 2005 at Wronów, 108 hyperparasitoids emerged from the collected mummies. They represented nine species belonging to the same four families as the insects collected at Łosiów (Table 2). Cynipidae made up 40.7% of the material, with *P. villosa* as dominant (25.9%), *P. xanthochroa* was classified as subdominant (13.9%), and *A. victrix* – as subrecendent (0.9%). Two species belonged to Megaspilidae: *D. carpentieri* (26.9%, dominant) and, less abundant, *D. aphidum* (4.6%, recendent). Pteromalidae were represented by *A. suspensus* (14.8%, subdominant), *P. concolor* (3.7%, recendent), and *P. aphidis* (0.9%, subrecendent). *A. aphidivorus*, Encyrtidae, was also subdominant at Wronów as it was at Łosiów the same year.

In autumn 2005 at Łosiów, 65 reared secondary parasitoids represented three families. Within the most abundant Charipidae (Alloxistinae), (63.0%), *P. xanthochroa* superdominated, making up 61.5% of all the wasps (Table. 3). Pteromalidae represented 29.2% of all the hyperparasitoids and the identified species within the family were: *A. suspensus* (13.8%), *P. aphidis* (9.2%), and *A. vulgaris* (6.2%). All the three species were classified as subdominants, along with *A. aphidivorus*, the only species representing Encyrtidae at that season at Łosiów (7.8%).

Table 2. Hyperparasitoids reared from mummies of aphids feeding on maize in 2005, spring-early summer period.

Family/Species	Łosiów		Wronów	
	No of specimens	D (%)	No of specimens	D (%)
Pteromalidae				
Asaphes suspensus NEES	14	8.2	16	14.8
Asaphes vulgaris WALKER	9	5.5		
Pachyneuron aphidis BOUCHÉ			1	0.9
Pachyneuron concolor (FÖRSTER)			4	3.7
Megaspilidae				
Dendrocerus carpenteri (CURTIS)	50	29.3	29	26.9
Dendrocerus aphidium (RONDANI)	1	0.6	5	4.6
Dendrocerus laticeps HEDICKE	1	0.6		
Charipidae (Alloxistinae)				
Alloxysta victrix (WESTWOOD)	15	8.8	1	0.9
Alloxysta macrophadna (HARTIG)	3	1.8		
Phaenoglyphis villosa (HARTIG)	62	36.4	28	25.9
Phaenoglyphis xanthochroa (FÖRSTER)	6	3.5	15	13.9
Encyrtidae				
Aphidencyrtus aphidivorus MAYR	9	5.3	9	8.4
Total	170	100.0	108	100.0

Table 3. Hyperparasitoids reared from mummies of aphids feeding on maize in 2005, autumn period.

Family/Species	Łosiów		Wronów	
	No of specimens	D (%)	No of specimens	D (%)
Pteromalidae				
Asaphes suspensus NEES	9	13.8	20	23.8
Asaphes vulgaris WALKER	4	6.2	5	5.9
Pachyneuron aphidis BOUCHÉ	6	9.2	13	15.5
Megaspilidae				
Dendrocerus carpenteri (CURTIS)			7	8.4
Charipidae (Alloxistinae)				
	1	1.5		
Alloxysta victrix (WESTWOOD)	40	61.5	32	38.0
Phaenoglyphis xanthochroa (FÖRSTER)				
Encyrtidae				
Aphidencyrtus aphidivorus MAYR	5	7.8	7	8.4
Total	65	100.0	84	100.0

Aphid mummies collection in the fall season of 2005 at Wronów yielded 84 hyperparasitoid specimens of four families. The only representative of Charipidae (Alloxistinae), *P. xanthochroa*, was classified as eudominant (Table. 3). The species made up 38.0% of all the secondary parasitoids. Pteromalidae species, namely *A. suspensus* and *P. aphidis*, were dominants (23.8% and 15.5%, respectively), whereas *A. vulgaris* (5.9%) was classified as subdominant. Other collected species belonged to Megaspilidae and Encyrtidae (8.4% and 8.4% of all the hyperparasitoid species, respectively).

DISCUSSION

Out of all reared secondary parasitoids, species that represented four families: Pteromalidae, Megaspilidae, Charipidae (Alloxistinae) and Encyrtidae, were identified. The number of species within particular families varied. In 2004, at both localities, the most abundant family was Pteromalidae, with the eudominant species *Asaphes suspensus* NEES. This parasitoid is a polyphagous species with wide host range and, according to POWELL (1982), it is less common than *Asaphes vulgaris* WALK. Our results from Opole region in Poland indicate the contrary. Other Pteromalidae: *Pachyneuron aphidis* BOUCHÉ and *P. concolor* (FÖRSTER), occurred abundantly as well. Their presence on winter wheat and on maize plants near Wrocław has been already demonstrated by KANIA & SOBOTA (1992), whereas the records of these species were practically absent in other European entomological literature. *Dendrocerus carpenteri* (CURTIS) (Megaspilidae) appeared in the collected material in both years of the study. In 2004, depending on the collection site, it was classified as dominant or recendent species, in 2005 appeared as dominant at both places. The obtained results largely correspond to the data demonstrated by German authors: BORGEMEISTER & POEHLING (1988, 1990), who describe *D. carpenteri* as the most abundant parasitoid. GABRYŚ & SOBOTA (1991) demonstrated it clearly too, that *D. carpenteri* was a dominant species on winter wheat near Wrocław. These findings were later confirmed in the studies by SOBOTA (1992), SOBOTA et al. (1998), SOBOTA & GABRYŚ (1999). Among the Cynipidae wasps, BORGEMEISTER & POEHLING (1988) most frequently reported *Alloxysta leunisii* (HARTIG), which was recorded neither from Łosiów or Wronów in the course of our study. On the contrary, *P. villosa* occurred only incidentally in the research reported by BORGEMEISTER & POEHLING (1988) and this does not agree with our results. In spring and in the early summer, sporadical occurrence of *Aphidencyrtus aphidivorus* MAYR. (Encyrtidae) was noticed, which seems interesting as this species is rarely reported in literature as a secondary parasitoid found in cereal aphids (GABRYŚ & SOBOTA 1991, KANIA & SOBOTA 1992).

Only in 2005, the hyperparasitoids appeared on maize crop in autumn. The dominant species at that time at both Łosiów and Wronów, was *Phenoglyphis xanthochroa* (FÖRSTER) (Charipidae: Alloxistinae). Pteromalidae occurred in a relatively high number, too. They were namely *A. suspensus*, *A. vulgaris* and *Pachyneuron aphidis* BOUCHÉ, as well as

A. aphidivorus. The species of the genus *Dendrocerus* were not abundant and they were recorded only from the crop at Wronów. In the literature available so far there are no data on secondary parsitoids incidence on maize crop in autumn.

CONCLUSION

1. The parasitoids of the cereal aphids feeding on maize crop were the hosts to the secondary parasitoids of the families Pteromalidae, Charipidae (Alloxistinae), Megaspilidae, and Encyrtidae. In spring and early summer of 2004, the most abundant at both study sites were the species of Pteromalidae, with the eudominating species *Asaphes suspensus* NEES. At the same time of the next year, 2005, the dominant species were *Dendrocerus carpenteri* (CURTIS) (Megaspilidae) and *Phaenoglyphis villosa* (HARTIG) (Charipidae: Alloxistinae).
2. In autumn, the secondary parasitoids occurred only in the second year of the study, 2005. The dominant species at both sites was *Phaenoglyphis xanthochroa* (FÖRSTER) (Charipidae: Alloxistinae). In the available literature there are no data on the incidence of cereal aphids` secondary parsitoids in autumn.

REFERENCES

CARTER N., MCLEAN I.F., WATT A.D., DIXON A.F.G. 1980. Cereal aphids: a case study and review. Applied Biology. **5**: 271-348.

BARCZAK T. 1993. Ekologiczne aspekty wykorzystania parazytoidów w zwalczaniu mszycy burakowej *Aphis fabae* Scop. Zesz. Nauk. ATR w Bydgoszczy, Rozprawy **57**: 1-88.

BENNETT F.D. 1981. Hyperparasitism in the practice of biological control [in:] D. ROSEN (ed.), The Role of Hyperparasitism in Biological Control: A Symposium. Division of Agricultural Sciences, University of California Publications, **4103**: 43-49.

BORGEMEISTER C., POEHLING H.M. 1988. Seasonal abundance and species composition of cereal aphid primary and secondary parasitoids. Med. Fac. Landbouww. Rijksuniv. Gent, 53/3a: 1055-1062.

BORGEMEISTER C., POEHLING H.M. 1990. Einfluss von Primär- und Hyperparazitoiden auf die Populationsdynamik von Getreideblattäusen. Ergebnise zwei jähriger Untersuchungen im Raum Hannover. Mitt. Deutsch. Ges. Allg. Angew. Ent., **7**: 555-562.

FERGUSSON N.D.M. 1980. A revision of the British species of *Dendrocerus* Ratzeburg (*Hymenoptera, Ceraphronidae*) with a review of their biology as aphid hyperparasites. Bull. Brit. Mus. (Nat. Hist.) Entomology, **41**: 255-314.

GABRYŚ B., SOBOTA G. 1991. Porównanie składu gatunkowego hiperparazytoidów mszyc żerujących na sąsiadujących ze sobą uprawach gorczycy i pszenicy ozimej. [in:] E. CICHOCKA E. & W. GOSZCZYŃSKI (eds.) Mszyce – ich bionomia, szkodliwość i wrogowie naturalni. Warszawa: 115-118.

GRAHAM M. W.R. de V. 1976. The British species of Aphelinus with notes and descriptions of other European Aphelinidae (Hymenoptera). Syst. Entom. **1**: 123-146.

HAGEN K.S., Van den BOSCH R. 1968. Impact of patogens, parasites and, predators on aphids. Ann. Rev. Ent. **13**: 325-384.

KANIA C., SOBOTA G. 1992. Parasite spectrum and relative abundance of cereal aphids parasite on maize in the Wrocław district. Hungarian Natural History Museum, Budapest. **1**: 324-328.

KRAWCZYK A., HUREJ M., SOBOTA G. 2006. Aphids and their natural enemies infesting maize in Opole province. Aphids and other homopterous insects (monograph), **12**: 125-134.

LUCK R., MESSENGER P.S., BARBIERI J.F. 1981. The influence of hyperparasitism on the performance of biological control agents. [in:] D. Rosen (ed.), The role of hyperparasitism in biological control: A Symposium. Division of Agricultural Sciences, University of California Publications, **4103**: 34-42.

PANKANIN-FRANCZYK M. 1987. Occurrence of aphids and their parasitoids on rye crops differently surrounded. Pol. Ecol. Stud. **13**: 215-226.

PANKANIN-FRANCZYK M. 1995. Ekologiczne aspekty funkcjonowania parazytoidów mszyc. Referat z Międzynarod. Konf.: Szkodliwość i zwalczanie mszyc na uprawach ogrodniczych, rolniczych i leśnych. Skierniewice (26-27.10.1995), pp. 1-12.

POWELL W. 1982. The identification of hymenopterous parasitoids attacking cereal aphids in Britain, Syst. Entomol. **7**: 465-473.

SOBOTA G. 1992. Parasitoids of cereal aphids on winter wheat in the vicinity of Wrocław, Poland. Aphids and other homopterous insects, **3**: 83-88.

SOBOTA G., GABRYŚ B. 1999. Parasitoids and hyperparasitoids of aphids caught in yellow traps in selected field crops. Aphids and other homopterous insects, **7**: 297-303.

SOBOTA G., PANKANIN-FRANCZYK M., GABRYŚ B., GADOMSKI H., HALAREWICZ-PACAN A. 1998. The role of hyperparasitoids in limiting populations of *Aphidiidae* in field crops. Aphids and other homopterous insects, **6**: 111-116.

STARY P. 1970. Biology of aphid parasites (*Hymenoptera, Aphidiidae*) with respect of integrated control. W. JUNK (ed.), The Haque. The Netherlands, 643 pp.

STARY P. 1981. Biosystematic synopsis of parasitoids on cereal aphids in the western Palaearctic (Hymenoptera, Aphidiidae, Homoptera Aphidoidea). Acta ent. Bohemoslov. **78**: 382-396.

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