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PARASITOIDS (HYMENOPTERA: BRACONIDAE, APHIDIINAE) OF THE MEALY PLUM APHID *HYALOPTERUS PRUNI* (GEOFFR.) ON COMMON REED (*PHRAGMITES AUSTRALIS*) IN DIFFERENT TYPES OF HABITAT IN POLAND

T. BARCZAK[1], JANINA BENNEWICZ[1] and P. KAMINSKI[2]

[1] *Department of Zoology, Faculty of Animal Breeding and Biology, University of Technology and Life Sciences Bydgoszcz,* PL 85-225 Bydgoszcz, Poland
[2] *Nicolaus Copernicus University in Toruń, Collegium Medicum in Bydgoszcz, Department of Ecology and Environment Protection,* PL 85-094 Bydgoszcz, Poland

Abstract - The aim of the present work was to determine the parasitoid guild of the mealy plum aphid *Hyalopterus pruni* on common reed (*Phragmites australis*) in different types of habitats in central Poland. The investigations were carried out in selected areas of the Salted Kujawy Region (central-northern Poland). To compare the parasitoid guilds of *H. pruni* from common reed in different types of habitats, species composition, number, domination structure and the percentage of parasitization (effectiveness) were evaluated. The primary parasitoid guild of *H. pruni* on common reed in central Poland comprises three aphidiine braconids, mainly *Praon volucre* and *P. abjectum*. The number of the primary parasitoid species and their effectiveness in the aphid colonies were very low. Hence, common reed did not seem to be a good reservoir of the *H. pruni* parasitoids, but it may play a role as a place of dispersion of these insects, beneficial to orchards. A very low number of the hyperparasitoids were observed in the aphid colonies.

Key words: Common reed, *Phragmites australis*, *Hyalopterus pruni*, aphids, parasitoids

INTRODUCTION

The common reed, *Phragmites australis* (Cav.) Trin. ex Steudel, is a cosmopolitan angiosperm considered by many authors to be the most widely distributed reed species in the world, ranging all over Europe, Asia, Africa, America and Australia (Tewksbury et al., 2002). In Europe, over 170 herbivore species have been reported to feed on *P. australis*, some causing significant damage, e.g. rhizome-feeding species, including the lepidopterous, mainly in North America (Tewksbury et al., 2002). Some stem-boring moths and chloropid flies can have great detrimental impact on *P. australis* as well.

The most abundant and most frequent aphid species that inhabits common reed in Europe, especially in Central Europe, is *Hyalopterus pruni* (Geoff.) (Tewksbury et al., 2002; Kavallieratos et al., 2008; Starý, 1965), but there are no current investigations on its distribution as a feeding species on *P. australis*. The aphid *H. pruni* migrates to its secondary host, common reed, in the late spring and early summer. Reed fields are known to be more heavily infested on the edges compared to the center, as the migrants are attracted to the color of the reed (Starý, 1965). The reeds growing on wet sites are more heavily infested than those on dry sites (Starý, 1965; Mook and Wiegers, 1999). Feeding on *P. australis*, the aphid *H. pru-*

ni can disperse important cereal viruses, for which common reed is a natural host (Ilbaği, 2006).

One of the most important natural enemies of aphids are aphidiines (Braconidae: Aphidiinae), the species number ranging from more than 400 species from all over the world (Aslan et al., 2004; Kavallieratos et al., 2004) to close to 500 species (Dolphine and Quicke 2001). There are no complex and current investigations on the parasitoid guild of the aphid *H. pruni* in Europe. Only Starý (1965), many years ago, elaborated the problem in Czechoslovakia. However, we know from the literature that the parasitoid complex of *H. pruni* comprises several species: *Aphidius transcaspicus* (Telenga), mainly on *Prunus* spp. (Lozier et al., 2008) and on the secondary host plants, as well as, for example, on *P. australis* (Starý, 1965; Aslane et al., 2004; Kavallieratos et al., 2004; Őlmez and Ulusoy, 2003); *Praon volucre* (Hal.). on *Prunus* spp. and *P. australis* (Starý, 1965; Őlmez and Ulusoy, 2003; Kavallieratos et al., 2004), *Ephedrus plagiator* (Nees), on *Prunus* spp. and *P. australis,* and *Lysiphlebus fabarum* (Marsh.), on *P. australis* and *Prunus* spp. (Starý, 1965; Kavallieratos et al., 2004). We found only two host aphid-hyperparasitoid associations in the literature (Basky, 1982; Japoshvili and Noyes (2006) recorded *Syrphophagus aphidivorus* (Mayr) (Hymenoptera: Chalcidoidea, Encyrtidae) ex *H. pruni* in Europe, including Poland.

The purpose of the present work was to determine the parasitoid guild of the mealy plum aphid *Hyalopterus pruni* on common reed *Phragmites australis* in different types of habitats and the percentage of parasitization (effectiveness) in the aphid colonies in central Poland.

MATERIALS AND METHODS

The field study was carried out in 2005-2007 during spring and summer (April/May – July/August). Samples (leaves with aphid colonies) were taken 2-3 times per month. Each time 2-3 sample series were randomly chosen, but one series was composed of 25 colonies of *H. pruni* from different plants of *P. australis* in each area. One sample was one colony of *H. pruni* with a leaf of common reed. Hence, 175 colonies (i.e. samples) from each research area were taken per year/season.

The hymenopterans isolated from mealy plum aphid in the laboratory (mass rearing of the colonies in glass jars) were determined to the species (primary parasitoids) or generic level (hyperparasitoids).

To compare the parasitoid guilds of *H. pruni* from common reed in different types of habitats, species composition, number and domination structure were evaluated.

The percentage of parasitization was determined as the ratio of the average number of all parasitic Hymenoptera reared from the aphids (the so-called mass-rearing) to the average number of aphids (including mummies) in the colonies on the given research sites (Barczak, 1992).

Significance of differences between the number and values of domination indexes of the particular parasitoid species and other values (the percent of participation of the particular parasitoid guilds in the total number of hymenopterans, the percent of parasitization in the colonies) was evaluated on the basis of an arc-sine-t-test (Sokal and Rohlff, 1981).

The investigations were carried out in selected areas of the Salted Kujawy Region (Central Poland) in the Inowroclaw Region of Ecological Danger (IRED) (Fig. 1) (Niklewska et al., 2000). Hence, the search sites were in environments of various degrees of degradation, mainly linked with acidity and salinity: the Sodium Manufacture in Matwy (Fig. 2), the waste utilization plant in Giebnia (Fig. 3) (very polluted and industrial manufactured areas with anthropogenic impact), and the control (unpolluted) area in Borkowo (Fig. 4). In the localities Matwy, Giebnia and Borkowo, the vegetation cover was varied in a similar way, and commonly occurring plants such species as great burdock (*Arctium lappa* L.) creeping thistle (*Cirsium arvense* L.), common reed (*P. australis*), common chicory (*Cichorium intybus* L.), stinging nettle (*Urtica dioica* L.), common elder

Table 1. Number (N)* of the aphid *Hyalopterus pruni* and percentage of parasitization (P%) in their colonies on leaves of *Phragmites australis* in the given sites and years of investigations.

Year / Research area	2005		2006		2007		2005-2007	
	N	P%	N	P%	N	P%	N (mean)	P% (mean)
Giebnia	214.6	0.15	163.3	0.19	87.7	0.19	155.2	0.18
Matwy	417.2	0.13	193.3	0.13	566.7	0.12	392.4	0.13
Borkowo	384.5	0.13	453.3	0.18	380.0	0.11	405.9	0.14
Mean	338.8	0.14	270.0	0.17	344.8	0.14	317.9	0.15
Total number of samples	525		525		525		1575	

*/ an average aphid number in one of the 175 colonies in the given sites and years of investigations (175 samples per a given site / year)

Table 2. Parasitoids reared ex the *Hyalopterus pruni* colonies on common reed in the particular research areas.

Research area / Species	Matwy					Giebnia					Borkowo					Sum			Σ	%
	2005	2006	2007	Σ	%	2005	2006	2007	Σ	%	2005	2006	2007	Σ	%	2005	2006	2007		
Aphidiinae	87	42	102	231	89.2	30	55	30	115	100,0	55	139	67	261	97,0	172	236	199	607	94,4
Praon abjectum (Hal.)	57	40	57	154	59.5	10	20	5	35	30,4	25	40	10	75	27,9	92	100	72	264	41,1
Praon volucre (Hal.)	30	-	45	75	29.0	20	35	25	80	69,6	30	99	57	186	69,1	80	134	127	341	53,0
Ephedrus plagiator (Nees)	-	2	-	2		-	-	-	-		-	-	-	-		-	2	-	2	0,3
Hyperparasitoids (Alloxystini)	10	3	15	28	10.8	-	-	-	-	0,0	5	-	3	8	3,0	15	3	18	36	5,6
Phaenoglyphis sp.	10	3	9	22	8.5	-	-	-	-		5	-	3	8	3,0	15	3	12	30	4,7
Alloxysta sp.	-	-	6	6	2.3	-	-	-	-		-	-	-	-		-	-	6	6	0,9
Total number of specimens	97	45	117	259	100.0	30	55	30	115	100,0	60	139	70	269	100,0	187 (29,1%)	239 37,2%)	217 (33,7%)	643	100,0
Sum	259 (40.3%)					115 (17.9%)					269 (41.8%)					643 (100.0%)				

(*Sambucus nigra* L.), maples (*Acer* spp.) and tansy (*Tanacetum vulgare* L.) were recorded. The location of individual research areas is presented in three successive figures (Figs. 2-4). Each area was adjoined to wetlands (a pond, swamping, seasonal flooding), or to a watercourse (the canal in Matwy). Therefore, it can be assumed that common reed plants had sufficient and easy access to water.

RESULTS

The numbers of *H. pruni* in colonies on leaves of common reed in each locality and season ranged from several/several dozen specimens in spring (the end of May) to several hundred or more in July, decreasing again from the beginning of August. On average, during the three years of the study, the numbers/abundance of colonies amounted to more than 300 specimens (Table 1). The highest average number of aphids was recorded in the control area in Borkowo (more than 400 aphids). However, it must be added that if it were not for a low mean number of the aphid *H. pruni* in colonies (193.3 specimens) in Matwy in 2006, this area would favor aphid multiplication on leaves of *P. australis* (Table 1), similar to the control area in Borkowo. Colonies in Giebnia, in the most contaminated and degraded area, were distinctly least numerous – on average more than 150 aphids, which is about two times less than on average in colonies for all the period of the study and for all the areas.

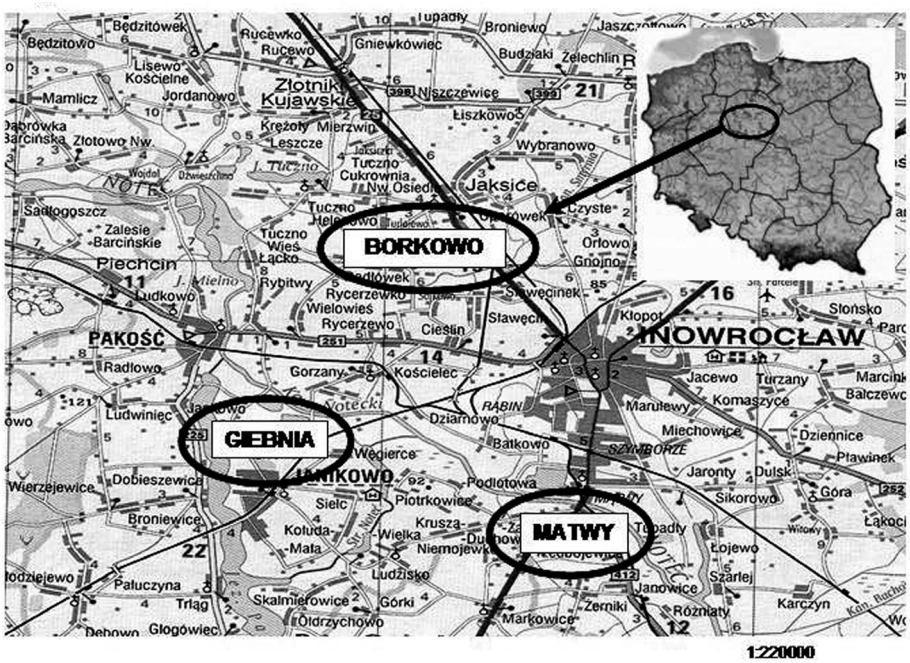

Fig. 1. Search sites in the Kuyavia Region.

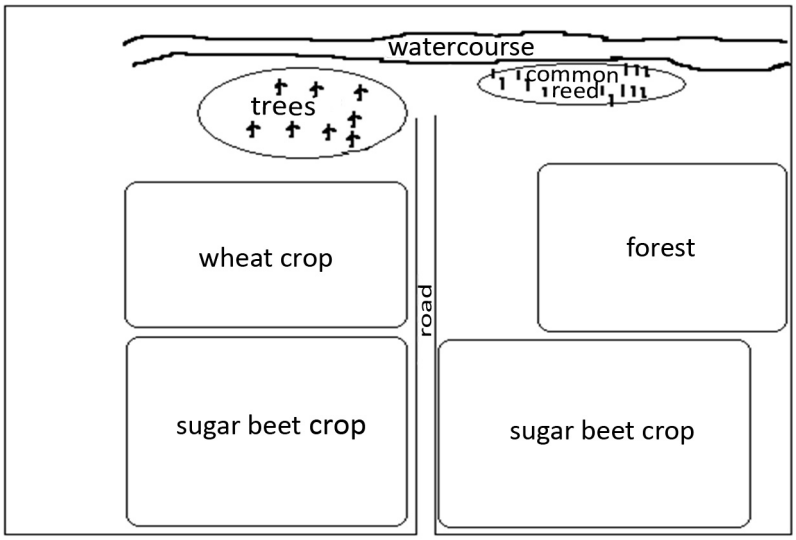

Fig. 2. Giebnia – the area with the waste utilization plant.

Taking into consideration the three-year study, the qualitative and quantitative structures of guilds of parasitic Hymenoptera, which are associated with colonies of the aphid *H. pruni* on leaves *P. australis* in the individual research areas, were estimated (Table 2).

In general, throughout the study period, only about 650 specimens of Hymenoptera were collected from all the areas. These were mainly primary parasitoids (about 95%) and their number in individual years was usually not less than 90% (Table 2).

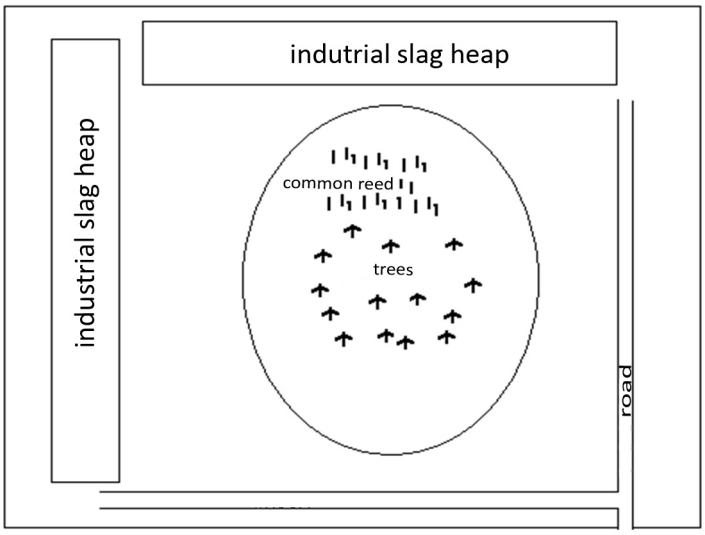

Fig. 3. Matwy – the area near sodium manufacture.

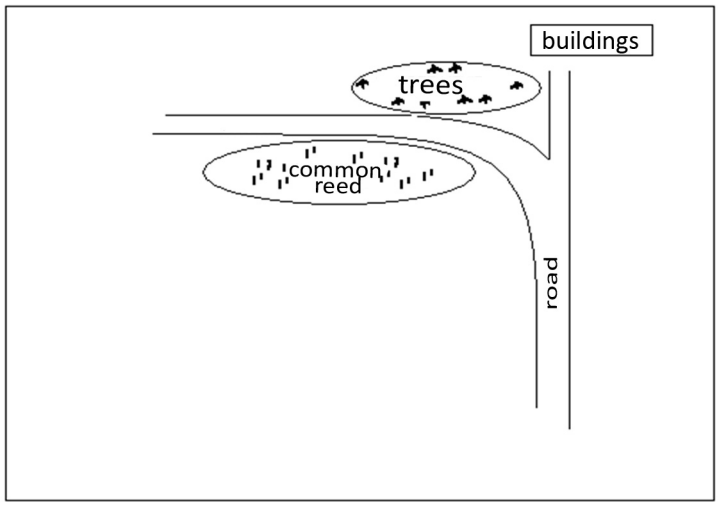

Fig. 4. Borkowo – the control (unpolluted) area.

The numbers of parasitic Hymenoptera in individual years were relatively different, but a statistically significant difference ($p<0.01$) occurred only between the years 2005 (the least individuals) and 2006 (the most hymenopterans) (Table 2). The following results were obtained in the individual research areas. Comparable numbers of parasitic Hymenoptera (the most individuals) were found in the control areas in Borkowo and in Matwy, about 260 individuals in each (differences between them were insignificant, see Table 2). Significantly the fewest parasitoids in turn were found in the most anthropogenically transformed area in Giebnia – more than two times less ($P<0.001$) (Table 2). In all the localities, primary parasitoids were represented by only one family (Braconidae: Aphidiinae). Its numbers ranged in individual years from 87.1-93.3% in Matwy, 100% in Giebnia and 91.6-100% in Borkowo, and in total (for three years), respectively, from 89.2% in Matwy, to 100% in Giebnia and 97% in Borkowo

(Table 2). There were few hyperparasitoids among all the isolated hymenopterans; in total only 5.6% (36 specimens) were isolated (Table 2). They belonged to one taxon Alloxystini (Cynipoidea: Figitidae, Charipinae) (classification after Paretaz-Martinez et al., 2007), and the *Phaenoglyphis* genus prevailed (83.3%). Hyperparasitoids were not found in guilds of parasitic Hymenoptera in Giebnia, and there were few of them in Borkowo (Table 2).

When characterizing in detail the guilds of primary parasitoids (Aphidiinae), a small number of species is noticeable – there were only three, including two more numerous in the whole period of the study, belonging to the genus *Praon,* as well as the small *Ephedrus plagiator* (Nees), which occurred only in Matwy. *Praon volucre* (Hal.) (the most numerous), prevailed in Giebnia and Borkowo, whereas *P. abjectum* (Hal.) was detected in Matwy, where in 2006 no *P. volucre* were observed. The differences were highly significant both in the general comparison of numbers of both species ($P<0.001$) (Table 1) and even more in guilds in the individual research areas ($P<0.001$). *P. volucre* occurred most numerously in the control area, which could be regarded as a reservoir of this species of parasitoid in salinified areas near Inowroclaw (significant differences in the domination index value for the same species were $P<0.001$ in relation to Matwy and $P<0.05$ in relation to Giebnia) (Table 2). In the case of *P. abjectum,* highly significantly larger ($P<0.001$) numbers and the value of domination index for this species were found in Matwy, in relation to the other areas (Table 2). Hence, this area can be a reservoir of this aphidophage.

On account of the small number of parasitic Hymenoptera isolated from colonies of the aphids *H. pruni,* their very low effectiveness (degree of parasitization) observed in the research areas is not surprising (Table 1). This is so low that in fact there is little sense in comparing this parameter of parasitoid activity between the research areas. Therefore, the statistical analysis did not show significance of differences between the compared areas. It is notable, however, that the highest average value of the degree of parasitization of *H. pruni* colonies for all the period of the study, as well as in individual years, occurred in Giebnia, where aphid colonies were in turn the least numerous (Table 1). On the one hand, the smallest number of primary parasitoids was collected in this locality (for all the period of the study and in almost all seasons), on the other, hyperparasitoids were not recorded at all (Table 2).

Taking into consideration the research areas, a low activity of parasitoids in colonies of the aphid *H. pruni* can be observed – a small number of species and their numbers in guilds, as well as a low degree of parasitization, and also a very small pressure of hyperparasitoids. In this respect, the analyzed guilds of parasitic Hymenoptera were similar. On the other hand, differences between the research areas were proved as far as the domination structure of primary parasitoids and the numbers of hymenopteran guilds are concerned.

DISCUSSION

Many of the insect species recorded from *P. australis* have been studied extensively in Europe, where they are well-known pests of reed beds (Tewksbury et al., 2002). Of them, two pest aphids from *Hyalopterus* genus were recorded as feeding on leaves of common reed, mainly *H. pruni*; (Starý, 1965; Kavallieratos et al., 2004; Kavallieratos et al., 2007; Tewksburry et al., 2002; Aslan et al., 2004; Őlmez and Ulusoy, 2003). Additionally, another aphid species collected from the leaves of *P. australis* was *Hyalopterus amygdali* (Blanchard) (Europe, Asia) (Tewksbury et al., 2002; Wei et al., 2005), but it was not of high economic importance.

There are not many current literature data on parasitic Hymenoptera as a component of the host plant (*P. australis*)–aphid–parasitoid (hyperparasitoid) associations, especially outside Europe. We determined three primary parasitoid species of *H. pruni* from the Aphidiinae subfamily (see Table 2), and probably (under current evaluation) two hyperparasitoid species (Cynipoidea: Figitidae, Charipinae-Alloxystini). In the literature, we found mainly *P. volucre* and *E.*

plagiator as directly recorded as reared from *H. pruni* on *P. australis* (Starý, 1965; Kavallieratos et al., 2004). This parasitoid species and the other aphidiines were reared from *H. pruni* on other aphid host-plant species such as *Prunus* spp. (Starý, 1965; Kavallieratos et al., 2004; Őlmez and Ulusoy, 2003). However, we did not collect *A. transcaspicus* and *L. fabarum* ex mealy plum aphid on common reed. *A. transcaspicus* was recorded in Southern Europe, Asia Minor and Central Asia as reared from *H. amygdali* on *Prunus* spp. and *Amygdalis communis* (Stary, 1965; Kavallieratos et al., 2004; Aslant et al., 2004; Őlmez and Ulusoy, 2003). *L. fabarum* was collected from the colonies of *H. pruni* on *Prunus* spp. (Kavallieratos et al., 2004).

According to Starý (1965), there were no differences between the primary parasitoid complexes (guilds) on the primary (mainly *Prunus* spp.) and secondary (*P. australis*) host species of *H. pruni*. The dominant species in both cases are *E. plagiator* and *P. volucre*, but their effectiveness was usually low (Starý, 1965).

The parasitoid complex of *H. amygdali* feeding on *P. australis* is rather poorly known, but similar to that of *H. pruni:* these are *E. plagiator*, *P. volucre* and *A. transcaspicus* (Starý, 1965). We found only one current record in China (Wei et al., 2005), where *H. amygdali* was parasitized on common reed by another species, *Aphidius phragmitei* Lin et Ji, but on the other *H. amygdali* host plant species, its parasitoid guild constituted *A. transcaspicus* and *P. volucre* on *Prunus* spp. (Starý, 1965; Kavallieratos et al., 2004), or *A. transcaspicus* and *E. persicae* on *Amygdalis communis* (Aslan et al., 2004; Őlmez and Ulusoy, 2003), and *E. persicae* on hibiscus and peach (Wei et al., 2005).

As for a hyperparasitoid subguild of *H. pruni*, there is a lack of data worldwide. Only Japoshvili and Noyes (2006) recorded *Syrphophagus aphidivorus* (Chalcidoidea, Encyrtidae) as reared from *H. pruni*; we knew exactly from what host-plant species this material was collected. *S. aphidivorus* is a widely distributed species, not only for an aphid hyperparasitoid (Japoshvili and Noyes, 2006).

A separate question is a possibility of using some of the above-mentioned primary parasitoid species to reduce, regionally, the population number of the pest aphid *H. pruni*. First steps to include parasitoids, mainly of *A. transcaspicus,* into the biological control of mealy plum aphid, have been done, e.g. as genetic analyses of its regional populations (Lozier et al., 2008). But more investigations based on genetic experiments are needed. Previously, Starý (1965) stated that the natural limitation of *H.* pruni by the indigenous parasitoid species in Europe (*E. plagiator* and *P. volucre*) is low. However, in Europe, the parasitoid species *A. transcaspicus* controlling the aphid colonies, and introduced, often successfully, on peach trees and *Phragmites,* could be more effective. I think the problem has been and will be in the near future important to orchards with *Prunus* spp., both in southern and northern Europe (e.g. Stary, 1965; Kavallieratos et al., 2007; Mook and Wiegers, 1999), including Poland (Cichocka, 1980).

It appears that in Europe aphid control using introduced *A. transcaspicus* is more possible in the case of *Phragmites* (*P. australis* mainly) and non-treated small orchards than in big orchards (so-called regular orchards). In "regular" orchards, the parasitoids of *H. pruni* should be taken into consideration in the integrated control system (IPM) of the aphid, as proposed by Starý (1965) many years ago.

One more question for discussion is if and how the type of environment, with or without salinity and other wastes, has influenced the number and/or species composition (dominance structure) of the primary parasitoid guilds of *H. pruni* on *P. australis*. The species composition and the dominance structure of the primary parasitoid guilds were rather similar excluding Matwy, where *P. abjectum* prevailed (Table 2). It could be supposed that in this case some other factors might have influenced the number and dominance index of that parasitoid species, perhaps ant- or not ant-attendance of the aphid colonies (e.g. Voelkl, 1994 and many others). Similarly, the effectiveness (percent of parasitization – Table 1) of the parasitoid guilds was very low

and on the same level (statistically not significant) in all the research areas. However, we observed differences (statistically proven) between the most anthropogenic influenced area in Giebnia and the two other sites as regards the total number of hymenopterans (although this was not of a high value) and particular parasitoid species number. Hence, we are of the opinion that in the investigated model we did not observe the direct environmental effect on parasitic Hymenoptera as the natural enemies of *H. pruni* on *P. australis*.

CONCLUSIONS

The primary parasitoid guild of the mealy plum aphid, *Hyalopterus pruni*, on common reed (*Phragmites australis*) in central Poland comprises three aphidiine braconids: mainly *Praon volucre* (Hal.) and *P. abjectum* (Hal.), and, in a small number only, *Ephedrus plagiator* (Nees). The number of the primary parasitoid species (Hymenoptera: Braconidae, Aphidiinae) and their effectiveness (percentage of parasitization) in the aphid colonies was very low. Hence, the common reed (*P. australis*) did not seem to be a good reservoir of the *H. pruni* parasitoids; however, it may play a role as a place of dispersion of this beneficial insect to orchards. A very low number of the hyperparasitoids, mainly of *Phaenoglyphis* genus (Cynipoidea, Figitidae: Charipinae-Alloxystini) were observed in the colonies of *H. pruni* on *P. australis* in central Poland.

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