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PARASITIC WASPS OF THE *PIMPLINAE* SUBFAMILY (*Hymenoptera, Ichneumonidae*) OF AGRICULTURAL LANDSCAPE REFUGIUM HABITATS IN CENTRAL WIELKOPOLSKA

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Abstract. The research was carried out in the years 1991–1994 in agricultural landscape of medium mosaic degree in the area of Łęczyca. It covered parasitoids of the *Pimplinae* subfamily (*Hymenoptera, Ichneumonidae*), inhabiting refugium habitats such as shrubberies, field borders, roadsides and forest edges. The method used was scooping in order to catch imagos. 48 species were found, which made up 36.1% of this subfamily's domestic fauna and 63.1% of those reported for Wielkopolska. Dominant species were *Endromopoda detrita* (Holmgr.) (*D* = 19.5%), *Itoplectis maculator* (F.) (*D* = 11.5%), *I. alternans* (Grav.) (*D* = 11.3%), *Pimpla contemplator* (Muell.) (*D* = 9.2%) and *Zaglyptus multicolor* (Grav.) (*D* = 7.1%). The greatest species diversity was reported from the forest edge (34 species), while the highest number was found in the shrubberies (268 individuals). The greatest stability of species composition was found in the shrubbery communities. The greatest species similarity between communities was reported for the shrubberies and the forest edge (*SM* = 53.5%). The highest similarity in terms of quantity occurred between the groups on the field border and road edge (*Re* = 64.5%).

Key words: parasitoid, *Pimplinae,* refugium habitats, agricultural landscape, Wielkopolska

INTRODUCTION

Refugium habitats in an agricultural landscape are a basic element increasing agrocenoses' species diversity. In this way they positively influence their stability, frequently deciding on the distribution and development of various beneficial species, also parasitoids. The impact of refugium habitats on parasitoid entomofauna has been the subject of foreign studies [eg. Landris and Haas 1992, Altieri et al. 1993, Marino and Landris 1996, 2000]. Polish resources do not provide many resources on the subject.

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The influence of landscape structure on the occurrence of parasitoids of the *Ichneumonidae* family, which are a decisive factor in biocenose-controlling processes in agrocenoses, was presented in studies by Strawiński [1957], Kościelska [1959], Piekarska-Boniecka [1999, 2005] and Piekarska-Boniecka and Wilkaniec [2001, 2006]. Thus it was decided to start research on parasitic entomofauna infesting agrocenoses of various mosaics degree.

The research was aimed at defining the quality-quantity composition of the *Pimplinae* subfamily parasitoids occurring in refugium habitats, such as woodlots, field borders, roadsides and forest edges, in agricultural landscape of medium mosaic degree in Wielkopolska.

MATERIAL AND METHODS

The research was conducted in the years 1991–1994 in central Wielkopolska, on cultivated fields located between the towns of Puszczykowo and Łęczyca (UTM: XT29), which constituted agricultural landscape of complex type, of medium mosaic degree. The share of non-cultivated habitats was 7.6%. The fields up to 30 ha surface area were situated on the flat top of the so-called Wirska Moraine and bordered with a poor form of Central-European oak-hornbeam complex (*Galio silvatici-Carpinetum*), located in Wielkopolska National Park.

Parasitic wasps were caught from May to October of each year of study using the scooping method. The catch was conducted on the following sites: shrubberies, field borders, roadside and forest edge. 10 samples per month were collected per site. Insects caught in 25 scoop strokes were assumed as one sample.

Phytosociological characteristics of the sites was created on the basis of the study by Matuszkiewicz [2001], while the terminology of vascular plants was adopted according to the list of taxons provided in the study by Mirek et al. [2002].

The plant cover of habitats – places of the research was the following:

– shrubberies – 150 m long, made up by *Pruno- Crataegetum*, with nitrophilous edge and ruderal communities on both sides, including plots of *Convolvulo-Agropyretum*,

– field border – 250 m long, overgrown with graminoids (*Convolvulo-Brometm inermis, Convolvulo-Agropyretum* and *Arrhenatheretum medioeuropaeum*) with some species of exothermic grass cover of *Festuco-Brometea* class and thermophilous edges with *Trifolio-Geranietea*,

– midfield roadside – 300 m long, the most numerous plant community was a group of *Convolvulo-Agropyretum.* Under the cover of trees and shrubs edge groupings occurred. Among trees the dominants were the sycamore maple (*Acer pseudoplatanus* L.), norway maple (*Acer platanoides* L.), common ash (*Fraxinus excelsior* L.) and sessile oak (Q*uercus petraea* (Matuschka) Lie),

– forest edge – 300 m long, it was the zone between poor form of central-European oak-hornbeam complex and fields. Along the forest edge ran a dust road overgrown with patches of trampled *Lolio-Plantaginetum* community. In forest complex the pine (*Pinus sylvestris* L.) was dominant. Edge thicket groupings included midfield thickets (*Pruno- Crataegetum*), with quite numerous elder plants (*Sambucus nigra* L.). Also herbaceous vegetation and ruderal groupings were present.

On fields, in direct neighbourhood of shrubberies, winter rye, spring barley, winter rape and winter wheat were cultivated. The field border divided fields on which winter and spring wheat, oats, spring and winter rye were cultivated. Arable lands adjacent to the road edges were earmarked for winter wheat, winter rye, maize, oat and winter rape. The forest edge bordered on fields where winter rape, winter and spring wheat and spring barley were cultivated.

The groupings of parasitoids caught in particular habitats were characterised on the basis of the following biocenotic indices: Shannon's diversity index (*H'*) [Shannon and Weaver 1963], Pielou's evenness index [1966] (*J'*) and Margalef's richness index [1958] (*d*). The stability of species structure of parasitoids communities was analysed on the basis of modified index of community homogeneity in time – Schwerdtfeger's index [1975] (*Kj*). Parasitoid communities were compared in terms of quality with Marczewski-Steinhaus' index (*MS*) [Marczewski and Steinhaus 1959] and in terms of quantity with Renkonen's number [1938] (*Re*).

RESULTS

In refugium habitats of agricultural landscape of Łęczyca area 960 samples were collected in the years 1991–1994. 806 *Pimplinae* specimens of 48 species were caught (Tab. 1, 2). The species reported made up 36.1% of domestic fauna of this subfamily and 63.1% of those reported for Wielkopolska. Eudominants include *Endromopoda detrita* (*D* = 19.5%), *Itoplectis maculator* (*D* = 11.5%) and *I. alternans* (*D* = 11.3%), while dominants were: *Pimpla contemplator* (*D* = 9.2%) and *Zaglyptus multicolor* (*D* = 7.1%).

Species diversity in particular habitats was very similar. On the forest edge, in shrubberies and on the roadside 34 to 31 species were found (Tab. 1, 2). Only on the field border slightly fewer of them were caught: 25. Such shape of diversity was confirmed by the values of Margalef's richness index (*d*) and Shannon's diversity index (*H'*), with the highest value at 14.72 and 2.37 on the forest border, and the lowest at 10.42 and 2.1 on the field border (Tab. 2).

The dominant structure of the *Pimplinae* communities in particular habitats was also very similar. Besides species dominating in all the habitats, taking them as a whole, in shrubberies *Scambus inanis* (*D* = 5.7%) also occurred numerously. Similarly, on the field border *Scambus brevicornis* (*D* = 8.9%) and *Pimpla spuria* (*D* = 8.4%) were also abundant, as was the case on the roadside with *P. rufipes* (*D* = 7.4%) and *P. spuria* (*D* = 7.4%), while on the forest edge the numerous species was *Polysphinca tuberosa* (*D* = 6.9%).

Dominant *Pimplinae* species may control the number of phythophages occurring in agricultural cultivations belonging to genera *Lepidoptera, Coleoptera, Hymenoptera* and *Diptera.* Among particularly important species due to their biocenotic functions are *Endromopoda detrita,* parasitoids of *Cephus pygmaeus* (L.) and species of the *Itoplectis* genus*,* which are listed among polyphages. Among dominants was one species of *Polysphinca tuberosa,* which is a parasitoid of predators of *Arachnida*.

The *Pimplinae* communities were characterised with similar mean values of Schwerdtfeger's index (*Kj*) at the same time, describing yearly changes in species composition in four-year long research. The *Kj* index values fluctuated between 42.9% and

Table 1. A list of Pimplinae species caught in refugium habitats of agricultural landscape near Łęczyca in 1991-1994

Tabela 1. Wykaz gatunków Pimplinae odłowionych w środowiskach ostojowych krajobrazu rolniczego okolic Łęczycy w latach 1991-1994

No Nr	Species Gatunek	Shruberies Zakrzewienia		Field order Miedza		Roadside Przydroże		Forest Edg Skraj lasu		Total Ogółem	
		A*	B**	A	B	A	B	A	B	A	B
1	*Acrodactyla degener* (Hal., 1839))	2	0.7	-	-	-	-	-	-	2	0.2
2	*Acropimpla pictipes* (Grav., 1829)	1	0.4	-	-	-	-	1	0.6	2	0.2
3	*Apechthis compunctor* (L., 1758)	-	-	1	0.5	-	-	2	1.2	3	0.4
4	*Apechthis quadridentata* (Thoms., 1877)	10	3.7	-	-	-	-	5	2.9	15	1.9
5	*Apechthis rufata* (Gmel., 1790)	-	-	-	-	1	0.6	7	4.0	8	1.0
6	*Clistopyga incitator* (F., 1793)	-	-	1	0.5	2	1.2	-	-	3	0.4
7	*Dolichomitus agnoscendus* (Roman, 1939)	-	-	2	1.0	1	0.6	8	4.6	11	1.5
8	*Dolichomitus messor* (Grav., 1829)	-	-	-	-	-	-	2	1.2	2	0.2
9	*Dolichomitus* sp.	-	-	-	-	1	0.6	-	-	1	0.1
10	*Endromopoda detrita* (Holmgr., 1860)	28	10.4	46	22.9	39	24.0	44	25.3	157	19.5
11	*Endromopoda nitida* (Brauns, 1898)	1	0.4	-	-	-	-	-	-	1	0.1
12	*Ephialtes manifestator* (L., 1758)	-	-	-	-	-	-	1	0.6	1	0.1
13	*Gregopimpla inquisitor* (Scop., 1763)	4	1.5	1	0.5	2	1.2	6	3.4	13	1.7
14	*Iseropus stercorator* (F., 1793)	1	0.4	1	0.5	-	-	-	-	2	0.2
15	*Itoplectis alternans* (Grav., 1829)	50	18.6	22	10.9	8	4.9	11	6.3	91	11.3
16	*Itoplectis maculator* (F., 1775)	50	18.6	28	14.0	12	7.4	3	1.6	93	11.5
17	*Liotryphon caudatus* (Ratz., 1848)	-	-	1	0.5	1	0.6	-	-	2	0.2
18	*Liotryphon punctulatus* (Ratz., 1848)	-	-	-	-	-	-	2	1.2	2	0.2
19	*Perithous albicinctus* (Grav., 1829)	-	-	-	-	1	0.6	-	-	1	0.1
20	*Perithous divinator* (Rossi, 1790)	1	0.4	-	-	3	1.8	-	-	4	0.5
21	*Perithous scurra* (Panzer, 1804)	5	1.9	2	1.0	6	3.7	-	-	13	1.7
22	*Perithous septemcinctorius* (Thunb., 1822)	3	1.1	1	0.5	1	0.6	-	-	5	0.6
23	*Pimpla contemplator* (Muell., 1776)	25	9.3	24	11.9	13	8.0	12	6.9	74	9.2
24	*Pimpla flavicoxis* Thoms., 1877	1	0.4	3	1.5	5	3.1	9	5.1	18	2.2
25	*Pimpla insignatoria* (Grav., 1807)	6	2.2	1	0.5	2	1.2	5	2.9	14	1.7
26	*Pimpla melanacrias* Perkins, 1941	1	0.4	3	1.5	-	-	-	-	4	0.5
27	*Pimpla rufipes* (Mill., 1759)	8	3.0	4	2.0	12	7.4	5	2.9	29	3.6
28	*Pimpla spuria* Grav., 1829	3	1.1	17	8.4	12	7.4	2	1.2	34	4.2
29	*Pimpla turionellae* (L., 1758)	3	1.1	-	-	1	0.6	1	0.6	5	0.7
30	*Polysphincta boops* Tschek, 1869	-	-	-	-	-	-	2	1.2	2	0.2
31	*Polysphincta tuberosa* Grav., 1829	6	2.2	-	-	4	2.4	12	6.9	22	2.7
32	*Scambus brevicornis* (Grav., 1829)	2	0.7	18	8.9	1	0.6	1	0.6	22	2.7
33	*Scambus buolianae* (Hartig, 1838)	1	0.4	4	2.0	1	0.6	2	1.2	8	1.0
34	*Scambus calobatus* (Grav., 1829)	3	1.1	-	-	2	1.2	3	1.6	8	1.0
35	*Scambus inanis* (Schrank, 1802)	15	5.7	-	-	6	3.7	9	5.1	30	3.7
36	*Scambus nigricans* (Thoms., 1877)	3	1.1	-	-	1	0.6	-	-	4	0.5
37	*Scambus planatus* (Hartig, 1838)	1	0.4	-	-	1	0.6	3	1.6	5	0.7
38	*Scambus pomorum* (Ratz., 1848)	-	-	-	-	-	-	1	0.6	1	0.1
39	*Scambus sagax* (Hartig, 1838)	-	-	-	-	2	1.2	2	1.2	4	0.5
40	*Scambus* sp.	1	0.4	-	-	-	-	-	-	1	0.1
41	*Schizopyga circulator* (Panz., 1801)	-	-	1	0.5	-	-	1	0.6	2	0.2
42	*Schizopyga frigida* Cresson, 1870	-	-	1	0.5	1	0.6	-	-	2	0.2
43	*Tromatobia lineatoria* (Villers, 1789)	2	0.7	4	2.0	1	0.6	1	0.6	8	1.0
44	*Tromatobia ovivora* (Bohem., 1821)	1	0.4	3	1.5	-	-	4	2.3	8	1.0
45	*Zaglyptus multicolor* (Grav., 1829)	27	10.2	8	4.0	20	12.4	2	1.2	57	7.1
46	*Zaglyptus varipes* (Grav., 1829)	-	-	4	2.0	-	-	1	0.6	5	0.7
47	*Zatypota gracilis* (Holmgr., 1860)	2	0.7	-	-	-	-	3	1.6	5	0.7
48	*Zatypota percontatoria* (Muell., 1776)	1	0.4	-	-	-	-	1	0.6	2	0.2
Total number of specimens Ogólna liczba osobników		268	100.0	201	100.0	163	100.0	174	100.0	806	100.0
Total number of species Ogólna liczba gatunków		32		25		30		34		48	

*A – Number of specimens – Liczba osobników (*N*)

**B – Dominanty index – Współczynnik dominacji (*D*), %

Table 2. Biocenotic indices characterising communities of *Pimplinae* caught in refugium habitats of agricultural landscape near Łęczyca in 1991-1994

Tabela 2. Wskaźniki biocenotyczne charakteryzujące zgrupowania *Pimplinae* odłowionych w środowiskach ostojowych krajobrazu rolniczego okolic Łęczycy w latach 1991-1994

Environment Środowisko	Number of samples Liczba prób (*n*)	Number of specimens Liczba osobników (*N*)	Number of species Liczba gatunków (*S*)	D^{*}	H'^{**}	J'^{***}
Shruberies – Zakrzewienia	240	268	32	12.77	2.15	0.43
Field order – Miedza	240	201	25	10.42	2.1	0.45
Roadside – Przydroże	240	163	30	13.56	2.55	0.51
Forest Edg – Skraj lasu	240	174	34	14.72	2.37	0.46
Total – Ogółem	960	806	48	-	-	-

$^{*}d$ – Margalef's index (Margalef 1958)
$^{**}H'$ – Shannon's index (Shannon, Weaver 1963)
$^{***}J'$ – Pielou's index (Pielou 1966)

Table 3. Homogenity of *Pimplinae* communities in time in refugium habitats of agricultural landscape near Łęczyca in 1991-1994

Table 3. Jednorodność zgrupowań *Pimplinae* w czasie w środowiskach ostojowych krajobrazu rolniczego okolic Łęczycy w latach 1991-1994

Environment Środowisko	Number of species – Liczba gatunków (*S*)					Schwerdtfeger's index Wskaźnik Schwerdtfegera (K_j) %
	1991	1992	1993	1994	1991-1994	
Shrubberies – Zakrzewienia	23	20	29	33	32	51.6
Field border – Miedza	13	11	9	22	25	48.0
Roadside – Przydroże	11	8	13	18	30	45.0
Forest edge – Skraj lasu	18	20	23	28	34	42.9

Table 4. The values of Marczewski-Steinhaus index (1959) (*MS*) and Renkonen number (1938) (*Re*) for *Pimplinae* communities caught in refugium habitats of agricultural landscape near Łęczyca in 1991-1994

Tabela 4. Wartości wskaźnika Marczewskiego-Steinhausa (1959) (*MS*) i liczby Renkonena (1938) (*Re*) dla zgrupowań *Pimplinae* odłowionych w środowiskach ostojowych krajobrazu rolniczego okolic Łęczycy w latach 1991-1994

Environment Srodowisko	Field border – Miedza		Roadside – Przydroże		Forest Edg – Skraj lasu	
	Marczewski-Steinhaus index Wskaźnik Marczewskiego-Steinhausa (*MS*) %	Renkonen number Liczba Renkonena (*Re*) %	Marczewski-Steinhaus index Wskaźnik Marczewskiego-Steinhausa (*MS*) %	Renkonen number Liczba Renkonena (*Re*) %	Marczewski-Steinhaus index Wskaźnik Marczewskiego-Steinhausa (*MS*) %	Renkonen number Liczba Renkonena (*Re*) %
Shrubberies Zakrzewienia	46.1	57.6	55.0	60.9	53.5	50.3
Field border Miedza	-	-	52.8	64.5	43.0	51.1
Roadside Przydroże	-	-	-	-	48.8	62.0

51.6% (Tab. 3). This means that the communities quality composition reported each year in particular habitats was generally identical in about 50% in the research periods. It was the most stable in shrubberies and the most fluctuating on forest edge.

Species composition of *Pimplinae* communities reported in particular refugium habitats did not show significant similarity, as Marczewski-Steinhaus index (*SM*) achieved values from 43.9% to 53.5% (Tab. 4). The highest species similarity was be-

tween the communities in shrubberies and on the forest edge (*SM* = 53.5%), while the lowest between *Pimplinae* found on field border and forest edge (*SM* = 43.9%).

The number of *Pimplinae* specimens found in particular habitats was clearly diversified (Tab. 1, 2). Definitely the most specimens were caught in shrubberies, where 268 specimens were found. The lowest number was found on the road edge, where 163 specimens were caught. The road and forest edges were habitats with the lowest number of *Pimplinae* specimens caught.

The distribution of *Pimplinae* occurrence in particular habitats was even. The values of Pielou's index (*J'*) were similar and at the same time mean and obtained the values between 0.46 and 0.51 (Tab. 2). Such a level of *J'* values proves that the quantity structure of communities was fully developed. The communities had species with gradually diminishing number and a large number of species with very low number.

The quantity composition of *Pimplinae* communities in particular habitats was varied. Renkonnen's number (*Re*) showed values from 50.3% to 64.5% (Tab. 4). The communities most similar in terms of number were found on the field border and roadside (*Re* = 64.5%), while the biggest differences were found in shrubberies and on the forest edge (*Re* = 50.3%).

DISCUSSION

In the years 1991–1994 in agricultural landscape of medium mosaic degree of in central Wielkopolska 48 *Pimplinae* species were found, which constitute 63.1% of species reported for the area. This proves that refugium habitats in agricultural landscape are places of occurrence of parasitic wasps of *Pimplinae* subfamily, and that is why they can control the number of phytophagous species connected with agricultural cultivations. Those biocenotic relations corroborated research results in Wielkopolska as presented in the studies by Piekarska-Boniecka [2005] and Piekarska-Boniecka and Wilkaniec [2006]. Positive influence of varied structure of agricultural landscape of western Wielkopolska on the occurrence of entomofages, including parasitoids of *Ichneumonidae* subfamily, was also confirmed in the study by Karg [1989]. Positive impact of refugium habitats in agricultural landscape on species diversity and number of parasitic wasps was also presented in studies by Bilewicz-Pawińska and Pankanin-Franczyk [1995] as well as Barczak et al. [2000, 2002].

Research confirmed the dominant structure of *Pimplinae* caught in all the refugium habitats taken as a whole, as those species had previously been reported as dominant in those habitats by Piekarska-Boniecką [2005] and Piekarska-Boniecka and Wilkaniec [2006].

The research showed that the species stability of *Pimplinae* communities was lower on particular sites than reported in the study by Piekarska-Boniecka [2005]. Schwerdtfeger's index (*Kj*) showed lower values. This proves that species composition of the groupings undergoes clear changes in subsequent years of study.

The research presented the largest species diversity of *Pimplinae* on the forest edge, and the highest number in shrubberies. This was not confirmed by research by Piekarska-Boniecka [2005], who proved that on the field border and roadside the *Pimplinae* community was the most diversified in terms of species, while on the forest edge para-

sitic wasps were the most numerous. This proves that parasitoids move in consequent years within those habitats.

The research proved the largest species similarity of *Pimplinae* communities found in shrubberies and on the road edge. It corroborated the value of Marczewskie-Steinhaus index (*SM*) for those groupings, as previous studies by Piekarska-Boniecka [2005] defined it at the same level.

CONCLUSIONS

Refugium habitats in agricultural landscape of medium mosaics degree of in central Wielkopolska, with 7.6% share of non-arable habitats, constitute attractive habitats for parasitoids of the *Pimplinae* subfamily (*Hymenoptera, Ichneumonidae*). The forest edge is the habitat attracting the most species of parasitic wasps, while in midfield thickets the number is the greatest. Agrocenoses should be organised in such a way that the share of refugium habitats for beneficial entomofauna in the form of shrubberies, field borders, roadside and forest edges is about 10% of all the agricultural area. Such a structure of agricultural landscape ensures parasitoids appropriate conditions for living, shelter, breeding and enables their dispersion onto neighbouring cultivations.

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PASOŻYTNICZE BŁONKÓWKI Z PODRODZINY *Pimplinae* (*Hymenoptera, Ichneumonidae*) ŚRODOWISK OSTOJOWYCH KRAJOBRAZU ROLNICZEGO ŚRODKOWEJ WIELKOPOLSKI

Streszczenie. Badania prowadzono w latach 1991–1994 w krajobrazie rolniczym o średnim stopniu mozaikowatości w okolicach Łęczycy. Badaniami objęto parazytoidy z podrodziny *Pimplinae* (*Hymenoptera, Ichneumonidae*), zasiedlające środowiska ostojowe w postaci zakrzewień, miedz, przydroży i skrajów lasu. Wykorzystano metodę czerpakowania w celu odłowu imagines. Stwierdzono występowanie 48 gatunków, które stanowiły 36,1% fauny krajowej tej podrodziny i 63,1% wykazanych z Wielkopolski. Gatunkami dominującymi były *Endromopoda detrita* (Holmgr.) (*D* = 19,5%), *Itoplectis maculator* (F.) (*D* = 11,5%), *I. alternans* (Grav.) (*D* = 11,3%), *Pimpla contemplator* (Muell.) (*D* = 9,2%) i *Zaglyptus multicolor* (Grav.) (*D* = 7,1%). Wykazano najwyższe zróżnicowanie gatunkowe na skraju lasu (34 gatunki), i najwyższą liczebność w zakrzewieniach (268 osobników). Stwierdzono największą stabilność składu gatunkowego zgrupowań występujących w zakrzewieniach. Wykazano największe podobieństwo gatunkowe pomiędzy zgrupowaniami stwierdzonymi w zakrzewieniach i na skraju lasu (*SM* = 53,5%). Stwierdzono największe podobieństwo w kategoriach ilościowych pomiędzy zgrupowaniami występującymi na miedzy i przydrożu (*Re* = 64,5%).

Key words: parazytoid, *Pimplinae,* środowiska ostojowe, krajobraz rolniczy, Wielkopolska

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