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THE NUMBER AND ABUNDANCE OF ICHNEUMONIDAE (HYMENOPTERA, APOCRITA) SUBFAMILIES OCCURRING IN APPLE ORCHARDS AND ON THEIR EDGES

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ABSTRACT

Plant communities which form orchard edges are a vital element of ecological infrastructure enriching these agrocenoses. The research was conducted in an orchard environment made up of apple orchards and their edges in the form of agricultural cultivations, tree clumps and a road lined with trees and shrubberies. The study aim was to determine the impact of the orchard edge plant diversity onto the number and abundance of Ichneumonidae subfamilies in the orchards. The study showed that orchard environments made up of an apple orchard and edge plants of various species create better living conditions for Ichneumonidae parasitoids than the environment of an orchard and neighbouring agricultural cultivations. The diversity of orchard edge plants positively influences the abundance of the Ichneumonidae subfamilies rather than the number of subfamilies in the orchard. In the orchard habitat the following dominant subfamilies were found: Campopleginae, Cryptinae, Orthocentrinae and Pimplinae. These entomophages may control the abundance of pests infesting orchards.

Key words: fruit-growing environment, wild plants, ichneumonid

INTRODUCTION

Parasitoids of the Ichneumonidae family are one of the main biotic factors which control the abundance of phytophages in agrocenoses, also those in orchards. Ichneumonidae larvae are ecto- and endoparasitoids of eggs, larvae and pupae of many plant pests which feed in this habitat. On the other hand imagines of Ichneumonidae feed on pollen and nectar of many plant species [Carreck and Williams 2002, Fitzgerald and Solomon 2004]. Information on these entomophages, occurring in orchards, was presented in papers by e.g. Viggiani [2000], Trandafirescu et al. 2004, Mills [2005], Piekarska-Boniecka et al. [2008], Cole and Walker [2011] and Bąkowski et al. [2013].

The tree clumps and shrubberies which occur in the vicinity of orchards enrich those agrocenoses and create favourable conditions for the development of entomophages, including the parasitoids of the Ichneumonidae family. A positive impact of orchard edge plants onto the occurrence of entomophages in the orchard habitat was proven in the papers by e.g. Piekarska-Boniecka and Suder-Byttner [2002], Debras et al. [2006] and Dib et al. [2012].

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The study aim was to determine the influence of diversity of plant communities occurring on apple orchard edge in the form of agricultural cultivations, shrubberies and a road lined with trees and shrubs onto the number and abundance of Ichneumonidae families in the orchards. The adopted hypothesis was that the habitats characterised by abundant plant life in the vicinity of orchards positively influence the structure of subfamilies of orchard parasitoids.

MATERIAL AND METHODS

Study area

The study was conducted in 2008–2010 in three orchards located in the vicinity of Czempiń in Wielkopolska (Western Poland). They were an orchard located in Głuchowo and two orchards in Gorzyczki. The orchard in Głuchowo was located 15 km from the orchards in Gorzyczki, while orchards in Gorzyczki were away from each other from a distance of 1 km.

The study sites included:

1. Apple orchard, Głuchowo (UTM, XT18; 52.17466°N, 16.71173°E) of 40 ha surface area (A1 = Głuchowo-orchard). The studies were conducted on 3-hectare plots with 15-year-old apple trees of the following cultivars: Gala, Ligol, Cortland, Paulared, Red Delicious and Golden Delicious. The apple tree plot was surrounded with cultivated fields (A2 = Głuchowo-field), where sweet corn was grown in 2008, oats in 2009, and triticale in 2010.

2. Apple orchard I, Gorzyczki (UTM, XT27; 52.10106°N, 16.81199°E) 20 ha in area (B1 = Gorzyczki – orchard I), where studies covered 5-hectare plots with 15-year-old apple trees of: Paulared, Red Delicious, Golden Delicious and Jonagold cultivars. The apple tree plot was surrounded by shrubberies (B2 = Gorzyczki – shrubberies), namely thicket phytocenoses of *Euonymo-Prunetum spinosae* and *Querco-Ulmetum* forest, herbaceous communities and ruderal plant communities. Tree communities were formed mainly by: *Ulmus laevis* Pall., *Quercus robur* L., *Fraxinus excelsior* L., *Acer negundo* L., *Acer platanoides* L. and single *Malus domestica* Borkh. with *Populus ×canadensis* Moench. Herbaceous plants were dominated by *Urtica dioica* L. and *Cirsium arvense* (L.) Scop. In the patches of ruderal shrubberies the following were recorded: *Sambucus nigra* L., *Crataegus monogyna* Jacq., *Lycium barbarum* L., *Rosa canina* L. and *Corylus avellana* L. In shrubberies 18 plant species were found.

3. Apple orchard II, Gorzyczki (UTM, XT27; 52.10208°N, 16.81451°E) 10 ha in area (C1 = Gorzyczki – orchard II). The studies were conducted on 2-hectar plots with 20-year-old Golden Delicious apple trees. The orchard borders on a road (C2 = Gorzyczki – road) overgrown with plants typical of *Rhamno-Prunetea* class. The road was lined with *Juglans regia* L., *Acer negundo* L., *A. platanoides* L.), *A. pseudoplatanus* L. and *Quercus robur* L., with some *Rosa canina* L., *Crataegus×media* Bechst., *Corylus avellana* L. and *Symphoricarpos albus* Duhamel. Herbaceous plants were dominated by grass, *Urtica dioica* L., *Artemisia absinthium* L., *Achillea millefolium* L. and *Galium aparine* L. On the road 39 plant species were found; this edge was the richest in plants of all the edges in the study area.

In both the studied orchards apple trees grew 1.4 m from each other in rows set 3 m apart. Between the trees fallow land was maintained and the rows of trees were divided by sward. The orchards followed integrated fruit production policy. The apple protection programme was implemented in the same terms and against the same diseases and pests in all orchards. In each of the orchards 5–8 procedures against diseases and 6–8 procedures against pests were performed in the different years of study. The same plant protection substances were applied in all the orchards, namely: Chorus 75 WG, Miedzian 50 WG, Delan 700 WG, Captan 80 WG and Zato 50 WG against illnesses and Calypso 480 SC and Pirimor 500 WG against pests.

Study methods. The study used a commonly used method of trapping Ichneumonidae imagines in the yellow Moericke traps [Moericke 1953]. The trap was made from a yellow plastic pan filled with water and glycol (preservative) and liquid lowering surface pressure, 18 cm in diameter and 11 cm deep. 20 pans were laid out on each site, 1–1.5 m above the ground. The traps were situated in the following manner: 10

of them in the orchard and the other 10 further away, several meters from the orchard's edge. The traps were placed up to 10 m from each other. Specimens were collected in ten-day intervals. Insects caught in one pan during ten days constituted one sample. The traps were placed in the orchard from April to October in each study year.

Subfamilies of Ichneumonidae were identified based of the key by Goulet and Huber [1993].

Statistical analysis. To compare the shape of a curve rather than absolute numbers of species we used rarefaction curves (expected species accumulation curves). Rarefaction allows to estimate the expected species richness for a given number of individual samples [Magurran 2004, Colwell et al. 2012]. This curves show differences in species richness, given the number of individuals detected.

Values of ACE (Abundance Coverage-based Estimator of species richness), Jack1 (First-order jackknife estimator of species richness), Jack2 (Second-order jackknife estimator of species richness), Chao1 and Chao2 (Chao richness estimators) and the dominance index (D) [Colwell et al. 2004, Magurran 2004, Chao et al. 2005, Colwell et al. 2012, Chao et al. 2015] are also calculated. The dominance index for subfamilies was determined as a percentage of specimens of a particular subfamily in the total of specimens caught. The dominant families were assumed to be those with share ≥ 5.1 % [Kasprzyk and Niedbała 1981].

In the next step we used redundancy analysis (RDA) that can be considered as a constrained version of principal components analysis (PCA), wherein canonical axes – built from linear combinations of response variables corresponds to the number of explanatory variables. This is very popular ordination techniques in community ecology and it is based on Euclidean [Mardia et al. 1979, Greenacre and Primicerio 2013].

Next, we compute Bray-Curtis dissimilarity index and we plot the dendrogram based on hierarchical clustering [Greenacre and Primicerio 2013].

In order to compare the multiple groups (e.g. for each habitats and subfamilies) we used ANOVA test. The null hypothesis states that all average values in the groups are the same. Because ANOVA test revealed that the means aren't all equal, then with the help of Tukey's HSD (Honestly Significant Difference) test we asked which means are unequal.

All the calculations were performed in the R platform 3.1.3 [R Core Team 2015] using the vegan [Oksanen et. al. 2017] and stats packages [R Core Team 2015].

RESULTS

In the years 2008–2010 the total of 3,644 samples were taken in the orchard environment of Czempiń vicinity, out of which 1,818 samples came from the orchards and 1,826 were taken from their edges. The total of 16,509 Ichneumonidae specimens of 25 (73.5%) subfamilies out of 34 occurring in Poland were reported (tab. 1).

In the orchard environment made up of orchards and neighbouring edges with abundant plant life (B1-B2 i C1-C2) more Ichneumonidae subfamilies (24) and higher abundances were found (5,823 and 6,233 specimens) than in the orchard and the neighbouring agricultural cultivations (A1-A2). In the latter 22 subfamilies and 4,453 specimens of parasitoids were found (tab. 1).

In the apple orchard (B1) neighbouring on shrubberies slightly more (24) Ichneumonidae subfamilies were found than in the orchard (A1) neighbouring with agricultural cultivations (22). In that orchard more parasitoid specimens (3,223) were found than in other orchards (1,818 and 2,207).

On orchard edges (B2 and C2) in the form of shrubberies and a road lined with trees and shrubs slightly more subfamilies were found (22 and 24) and definitely higher abundances (4415 and 3616) of parasitoid subfamilies also on edges (A2) in the form of agricultural cultivations. There were found 21 subfamilies and 1,230 specimens.

Table 1. The number of specimens (N) and the dominance index (D) of Ichneumonidae subfamilies in the orchard environment near Czempiń in 2008–2010

	Subfamily	Habitats											
		Głuchowo				Gorzyczki I				Gorzyczki II			
		orchard (A1)		field (A2)		orchard (B1)		shrubberies (B2)		orchard (C1)		road (C2)	
		N	D (%)	N	D (%)	N	D (%)	N	D (%)	N	D (%)	N	D (%)
S1	Adelognathinae	15	0.47	10	0.81	8	0.44	28	0.63	13	0.59	23	0.64
S2	Anomaloninae	10	0.31	9	0.73	4	0.22	5	0.11	9	0.41	1	0.03
S3	Banchinae	100	3.10	22	1.79	76	4.18	122	2.76	67	3.04	107	2.96
S4	Brachycyrtinae	1	0.03	3	0.24	2	0.11	5	0.11	10	0.45	6	0.17
S5	Campopleginae	504	15.64	250	20.33	288	15.84	436	9.88	191	8.65	327	9.04
S6	Cremastinae	14	0.43	11	0.89	15	0.83	37	0.84	19	0.86	25	0.69
S7	Cryptinae	632	19.61	338	27.48	482	26.51	1240	28.09	623	28.23	1033	28.57
S8	Ctenopelmatinae	59	1.83	46	3.74	36	1.98	110	2.49	79	3.58	93	2.57
S9	Cylloceriinae	1	0.03	3	0.24	2	0.11	5	0.11	-	-	-	-
S10	Diplazontinae	86	2.67	79	6.42	66	3.63	164	3.71	108	4.89	201	5.56
S11	Ichneumoninae	128	3.97	88	7.15	128	7.04	282	6.39	119	5.39	268	7.41
S12	Mesochorinae	247	7.66	26	2.11	36	1.98	148	3.35	36	1.63	81	2.24
S13	Metopiinae	68	2.11	5	0.41	12	0.66	23	0.52	8	0.36	13	0.36
S14	Microleptinae	41	1.27	7	0.57	19	1.05	41	0.93	107	4.85	84	2.32
S15	Ophioninae	9	0.28	4	0.33	5	0.28	4	0.09	1	0.05	2	0.06
S16	Orthocentrinae	815	25.29	174	14.15	164	9.02	874	19.80	215	9.74	701	19.39
S17	Orthopelmatinae	28	0.87	14	1.14	28	1.54	129	2.92	52	2.36	56	1.55
S18	Oxytorinae	38	1.18	18	1.46	23	1.27	56	1.27	31	1.4	74	2.05
S19	Phrudinae	-	-	-	-	-	-	-	-	-	-	1	0.03
S20	Pimplinae	268	8.32	93	7.56	255	14.03	271	6.14	454	20.57	298	8.24
S21	Rhyssinae	-	-	-	-	1	0.06	-	-	-	-	2	0.06
S22	Stilbopinae	-	-	-	-	1	0.06	-	-	1	0.05	1	0.03
S23	Tersilochinae	51	1.58	12	0.98	119	6.55	276	6.25	23	1.04	50	1.38
S24	Tryphoninae	104	3.23	18	1.46	45	2.48	149	3.37	38	1.72	126	3.48
S25	Xoridinae	4	0.12	–	–	3	0.17	10	0.23	3	0.14	43	1.19
Total number of specimens		3223	100.00	1230	100.00	1818	100.00	4415	100.00	2207	100.00	3616	100.00
		4453				6233				5823			
Total number of subfamilies		22		21		24		22		22		24	
		22				24				24			

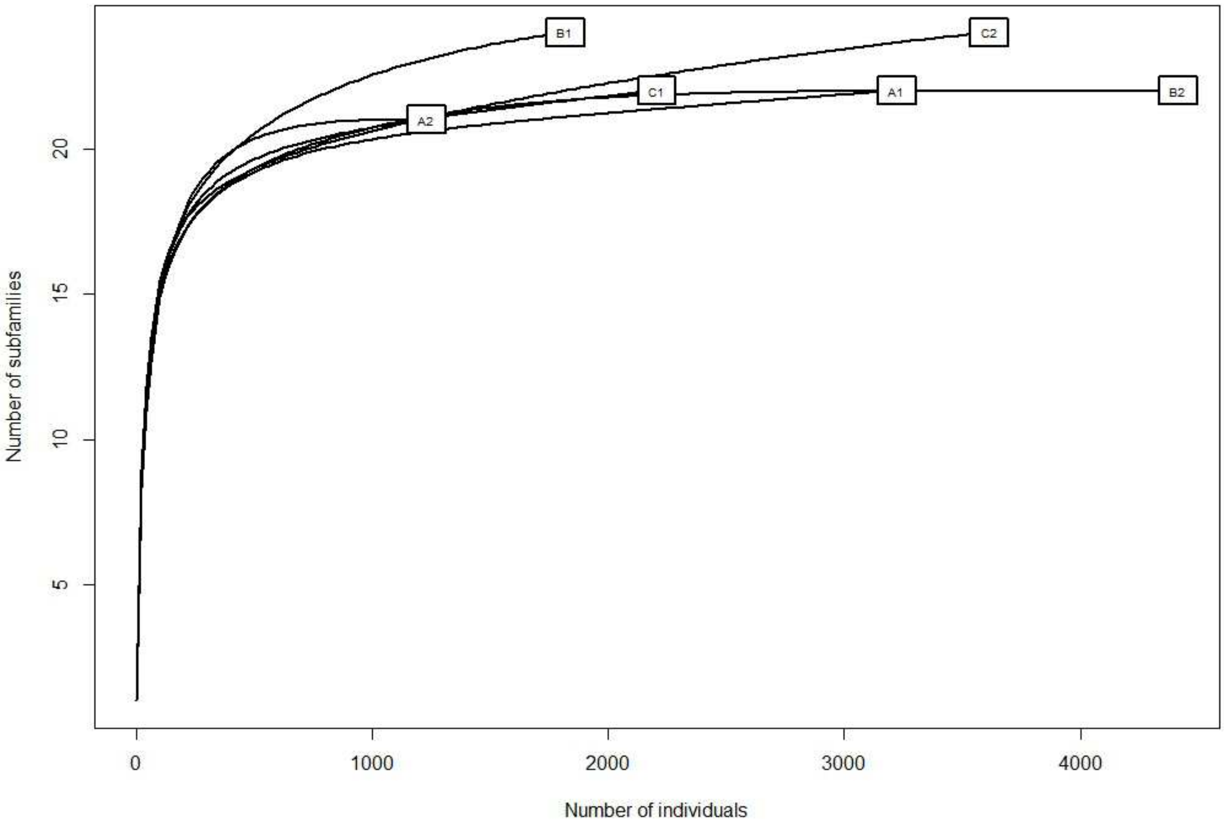

Fig. 1. Expected species accumulation curves of subfamilies richness of Ichneumonidae in the orchard environment near Czempiń in 2008–2010 (A1 – Głuchowo, orchard; A2 – Głuchowo, field; B1 – Gorzyczki, orchard I; B2 – Gorzyczki, shrubberies; C1 – Gorzyczki, orchard II; C2 – Gorzyczki, road)

Table 2. Value of the estimated numbers of Ichneumonidae subfamilies (ACE, Chao1, Jack 1 and Jack 2) in the orchard environment near Czempiń in 2008–2010

Habitat	Number of subfamily	ACE	Chao1	Jack 1	Jack 2
Głuchowo – orchard (A1)	22	23	24	25	27
Głuchowo – field (A2)	21	22	22	22	22
Gorzyczki – orchard I (B1)	24	24	24	25	24
Gorzyczki – shrubberies (B2)	22	23	23	24	25
Gorzyczki – orchard II (C1)	22	23	24	25	27
Gorzyczki – road (C2)	24	26	28	27	29
Głuchowo (A1–A2)	22	23	23	23	23
Gorzyczki (B1–B2)	24	24	24	25	26
Gorzyczki C1–C2)	24	25	25	25	25

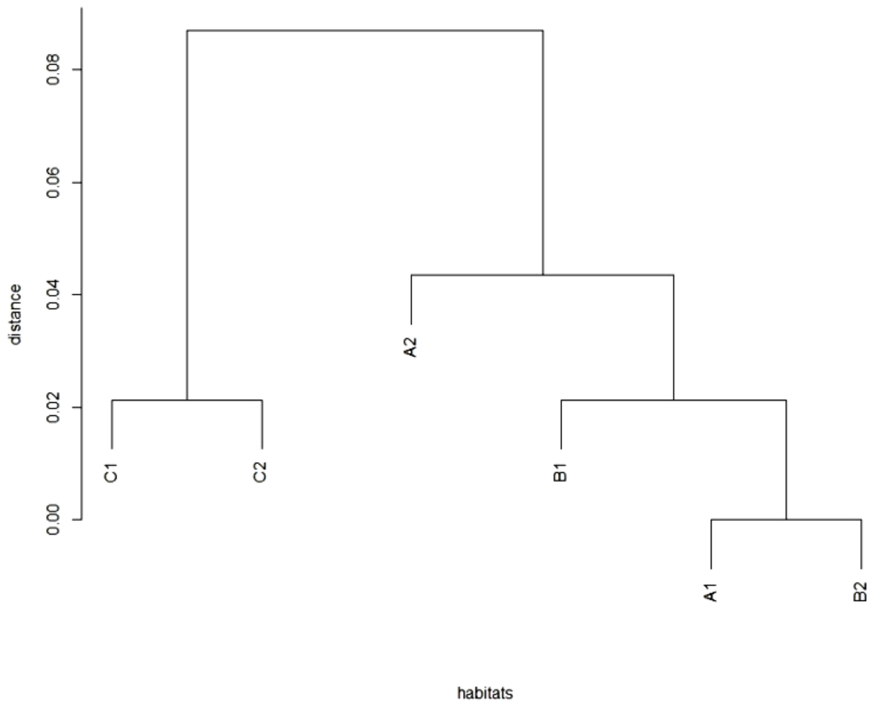

Fig. 2. Dendrogram of habitats with group single linking as the cluster method based on Bray-Curtis dissimilarity index (A1 – Głuchowo, orchard; A2 – Głuchowo, field; B1 – Gorzyczki, orchard I; B2 – Gorzyczki, shrubberies; C1 – Gorzyczki, orchard II; C2 – Gorzyczki, road)

Table 3. ANOVA test for subfamilies and habitats

Source	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Subfamilies	24	4394902	183121	18.415	< 0.0001
Habitats	5	291395	58279	5.861	< 0.0001
Residuals	120	1193281	9944		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

The trends of changes in the number and abundance of Ichneumonidae subfamilies infesting particular habitats are presented in Figure 1. Along with the increase in the number of specimens caught the number of subfamilies recorded for particular habitats increased, too. In orchard (B1), bordering on shrubberies, the number of subfamilies was significantly higher with a lower abundance of specimens than the number and abundance of subfamilies caught in most other habitats (A1, B2, C1 i C2).

In all the habitats of orchard environment 4 subfamilies were dominant, namely: Campopleginae (9.04%–20.33%), Cryptinae (19.61%–28.57%), Orthocentrinae (9.02%–19.8%) and Pimplinae (6.14%–20.57%). Other dominant subfamily was Ichneumoninae, which occurred numerously in orchards (B1 and C1) (7.04% and 5.39%) and on edges (B2 and C2) with abundant plant life (6.39% ansd 7.41%). The subfamily Diplazontinae dominated on the road (C2) (5.57%), while Tersilochinae in the orchard (B1) (6.55%) and in shrubberies (B2) (6.25%). Thus it was proven that the most dominant subfamilies of parasitoids occurred in the orchard environment made up from an orchard and shrubberies (B1-B2) and on the road (C2) bordering on the orchard (tab. 1).

The number of Ichneumonidae subfamilies reported from particular habitats was very similar to the number of subfamilies indicated with ACE, Chao 1 and Jack 1 and Jack 2 estimators for some habitats (tab. 2). It was identical as the number of subfamilies caught in the orchard (B1) neighbouring with shrubberies. For the other habitats the estimators indicated from 1 to 2 subfamilies more than were found in the study. Only Jack 2 estimator indicated a higher number of subfamilies: 4 to 5 for the orchard (C1) and the neighbouring road (C2) in comparison with those yielded by the study. The estimators provided similar numbers of Ichneumonidae subfamilies as for habitats of the orchard and the edges. ACE and Chao1 indicated the same number of subfamilies as was found in the orchard and shrubberies (B1-B2). For the other habitats (A1-A2 and C1-C2) all the estimators yielded very similar numbers of subfamilies; they indicated only 1 or 2 subfamilies more than the numbers actually found during research.

We analysed the number and abundance of Ichneumonidae subfamilies occurring in particular habitats, using hierarchical grouping with the cluster method (fig. 2). It was found that agricultural cultivations were inhabited by subfamilies which showed the least similarity in their quality and quantity structures to the subfamilies caught in the other habitats. The following subfamilies were found to be similar:

– the subfamilies found in the orchard (C1) and on the neighbouring road (C2),

– the subfamilies found in the orchard (A1) bordering on agricultural cultivations an shrubberies (B2) as well as in the orchard (B1) bordering on shrubberies.

The similarities between subfamilies inhabiting particular habitats were analysed with ANOVA test (tab. 3) and Tukey multiple comparison test method (tab. 4). Similar abundances were found between subfamilies of the orchards (B1, C1) with rich plant life on edges. The abundances of subfamilies in the other habitats differed. The largest differences were found between the subfamilies of agricultural cultivations (A2) and shrubberies (B2). The lowest abundance of subfamilies was found in the agricultural cultivations and the highest in the shrubberies.

Table 4. Similarities of habitats established with Tukey's multi tests on the basis of Ichneumonidae subfamilies abundances (A1 – Głuchowo, orchard; A2 – Głuchowo, field; B1 – Gorzyczki, orchard I; B2 – Gorzyczki, shrubberies; C1 – Gorzyczki, orchard II; C2 – Gorzyczki, road)

Groups	Habitat
a*	B2
b	C2
c	A1
d	B1, C1
e	A2

* Letters indicate groups which are statistically significantly different

The diversity of the number and abundance of subfamilies infesting particular habitats as well as the relation between subfamilies and their habitat were studied using a multi-dimensional statistical RDA analysis (fig. 3). It was confirmed that Campopleginae (S5), Cryptinae (S7), Orthocentrinae (S16) and Pimplinae (S20) are among the most numerous subfamilies of parasitoids in the studied habitats. It was found that the abundances of Cryptinae (S7) and Orthocentrinae (S16) subfamilies are similar in most studied habitats. A close relationship was found between the following subfamilies and particular habitats:

– Campopleginae (S5) in shrubberies (B2),

– Diplazontinae (S10) in orchards (B1, C1) with richly developed edge plants,

– Ichneumonidae (S11) in agricultural cultivations (A2) and on the road (C2),

– Pimplinae (S25) in the orchard and shrubberies (B1-B2) and in agricultural cultivations (A2).

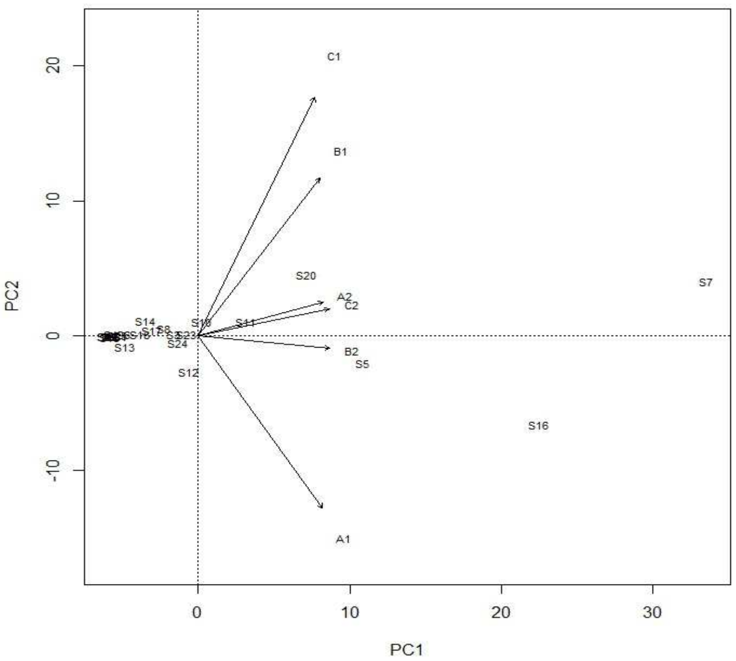

Fig. 3. Redundancy analysis (RDA) biplot showing distribution 25 subfamilies of Ichneumonidae (S1, S2, …S25) in relation to the habitats (A1 – Głuchowo, orchard; A2 – Głuchowo, field; B1 – Gorzyczki, orchard I; B2 – Gorzyczki, shrubberies; C1 – Gorzyczki, orchard II; C2 – Gorzyczki, road)

DISCUSSION

The study conducted in 2008–2010 in apple orchards with various kinds of plant life on their edges clearly proved that slightly more subfamilies and definitely higher abundances of Ichneumonidae were found in apple orchards neighbouring on shrubberies and a road lined with trees and shrubberies than in an orchard environment made up by an orchard and neighbouring agricultural cultivations. The results obtained thus confirmed a positive impact of wild plants in the vicinity of orchards on the increase of parasitoid abundance in orchard habitats. A previous study by Miliczky and Horton [2005] proved that diverse wild plant life around an orchard is a favourable habitat for advantageous entomofauna and positively influences its occurrence in agrocenoses. Also Debras et al. [2006] indicated a positive correlation between a varied plant life of hedges in the vicinity of pear orchards and the entomophages in those orchards. A similar conclusion was reached by Dib et al. [2012], who found a positive impact of flowering plant belts near apple orchards on the occurrence of parasitoids which control the abundance of diapausing *Cydia pomonella* larvae in orchards.

Research helped to establish that the numbers of subfamilies found in orchard habitats were very similar to those provided with estimators ACE, Chao1 and Jack1. These estimators can be thus fully used to determine the diversity of Ichneumonidae subfamilies in agrocenoses.

The research showed that on orchard edges which were made up of shrubberies and a road lined with trees and shrubberies the abundances of Ichneumonidae subfamilies were definitely higher than in the neighbouring orchards. Previous Piekarska-Boniecka and Suder-Byttner [2002] and Piekarska-Boniecka et al. [2013] studies also proved a higher abundance of entomophages in shrubberies than in the neighbouring apple orchard. As it shows, wild plants attract parasitoids to these habitats. Blooming plants provide food for entomophages imagines through their pollen, honeydew and nectar [Carreck and Williams 2002]. Dąbrowski et al. [2008] and Olszak et al. [2009] presented a list of plant species attractive for beneficial entomofauna. These included the bushes: *Crataegus monogyma*, *Sambucus nigra*, *Viburnum opulus*, *Caragana arborescens*, *Prunus* sp., *Evonymus europea* and trees: *Alnus* spp., *Carpinus betulus*, *Ulmus* spp., *Acer* spp., *Fraxinus excelsior*, *Malus* and *Prunus.* According to Olszak et al. [2009] the bushes of *Crataegus* sp., *Sambucus nigra* and *Viburnum* sp. were inhabited by most entomophages. Also *Crataegus monogyma, Sambucus nigra, Acer negundo, A. plantanoides, A. pseudoplatanus* and *Fraxinus excelsior* grew in most shrubberies and on the road, so these species can be deemed particularly important source of food for parasitoids. On the other hand Idris and Grafius [1997] indicated that Brassicaceae and Apiaceae are among the plants very frequently visited by entomophages.

Research established that in all the habitats of the orchard environment 4 dominant subfamilies included: Campopleginae, Cryptinae, Orthocentrinae and Pimplinae. A high abundance of Pimplinae in the orchard habitat was found in previous study by Piekarska-Boniecka and Suder-Byttner [2002]. Species of the Campopleginae subfamily belong first of all to parasitoids of the larvae of Lepidoptera, Coleoptera and Symphyta. Cryptinae parasitise the larvae and pupae of Lepidoptera, Coleoptera, Diptera, Hymenoptera and Arachnida eggs. Orthocentrinae are parasitoids of Diptera fungi-feeding larvae (Mycetophilidae), or less frequently saprophagous Diptera (Sciaridae). The representatives of Pimplinae are usually parasites of larvae and pupae of Lepidoptera, Coleoptera, Diptera and Hymenoptera as well as eggs and adults of Arachnida [Yu et al. 2012]. Trophic relations of parasitoid families which are numerous in apple orchards and on their edges prove their significant role in regulation of phytophagous species feeding in apple orchards.

The research suggest that neighbouring environments in the form of orchards and their edges are a compact and open space of constant interaction between plants and the parasitoids which inhabit them. A similar conclusion was drawn by Piekarska-Boniecka et al. [2013, 2015], who established that parasitoids and predatory Syrphidae migrate between neighbouring environments. The plants there may constitute a dispersion route for entomophages into neighbouring habitats.

According to Karg and Bałazy [2009] fragments of refuge habitats preserved in agrocenoses reduced the threat posed by pests in agricultural cultivations. Olszak [2010] claimed that an increase in the diversity and abundance of parasitoids can be stimulated by a suitable design of agrocenoses, their edges or adjacent habitats. However, this does not mean enhancing agrocenoses with plant communities, but also a proper selection of plant species [Olszak et al. 2009]. This is why one of rational actions in integrated fruit production is to design agrocenoses in such a way as to ensure the existence of the largest number of entomophages possible. A species diversity of plants in a habitat is one of significant factors affecting the stability of inhabiting species, as the species diversity of beneficial fauna increases with the increase of plant species number.

CONCLUSION

The orchard environment made up of an apple orchard and edge plants with varied species create better conditions for parasitoids of the Ichneumonidae family than the orchards and bordering agricultural cultivations. Orchard edges made up e.g. by *Crataegus monogyma*, *Sambucus nigra*, *Acer negundo*, *A. plantanoides*, *A. pseudoplatanus* and *Fraxinus excelsior* are attractive habitats for these entomophages and draw them to the orchard. The diversity of apple orchard edges plants more positively influences the abundance than the number of Ichneumonidae subfamilies in the orchard. These entomophages can control the number of pests infesting the orchard.

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