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THE OCCURRENCE FREQUENCY OF Syrphidae (Diptera) SPECIES IN APPLE ORCHARDS AND ON THEIR EDGES

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Abstract. The study was aimed at determining the attractiveness of neighbouring habitats for Syrphidae (Diptera). The frequency of Syrphidae occurrence in apple orchards and on their edges was studied in 2008–2010. A quality analysis of Syrphidae communities in apple orchards and surrounding habitats was performed. The studied orchards bordered on cultivated fields, shrubberies and a road overgrown with trees and bushes. In total 55 Syrphidae species were reported, which made up 13.9% of this family fauna in Poland, with 38 species recorded in the orchards and 49 species in their vicinity. Both in the orchards and in their edges the dominant were zoophagous species. The analysis of occurrence frequencies for the Syrphidae in orchards and their vicinity established that they were similar and at the same time higher than for all the other habitats except the orchard and the agricultural land bordering on it. All the habitats were dominated by two zoophages, namely *Episyrphus balteatus* (De Geer) and *Eupeodes corollae* (F.). The study proved that the plants of orchard edges constitutes a more attractive habitat for Syrphidae species than the orchard itself. The orchard edge habitats with abundant blooming greenery are the elements which attract Syrphidae more strongly than agricultural cultivations and which may determine the migration of those useful species onto orchards.

Key words: hoverflies, flies, fruit crops, Chao coefficient, cluster analysis, dendrogram

INTRODUCTION

Predatory Syrphidae play an important role among numerous entomophagous species that control phytophages abundance. They reduce the population of aphids (Hemiptera, Aphidoidea), economically important pests which year by year infest orchards in great numbers. The effectiveness of those entomophages as aphid control species is widely known [Wnuk and Medvey 1986, Chambers and Adams 1986, Tenhumberg and Poehling 1991, 1995, MacLeod 1999, Wyss et al. 1999, Wnuk 2000, Solomon et al.

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2000, Miňarro and Dapena 2001, Ambrosino et al. 2006]. It is the larvae that are zoophages, while imagines belong to melitophages, feeding on pollen and nectar as well as plant juices and honeydew. Adult Syrphidae play an important role in biocenoses, as they pollinate plants. Orchards might be made more attractive for them thanks to the plants in their immediate vicinity. The attractiveness of blooming plants to Syrphidae imagines has been highlighted in many papers [e.g. Solomon et al. 1999, Branquart and Hemptinne 2000, Colley and Luna 2000, Carreck and Williams 2002, Bostanian et al. 2004, Ambrosino et al. 2006, Rossi et al. 2006, Kelm et al. 2007, 2009, Haenke et al. 2009].

The aim of the study was to analyse the frequency of Syrphidae occurrence in apple orchards and in their vicinity, which included agricultural land, shrubberies and a road with trees and bushes.

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, Gorzyczki I (UTM, XT27; 52.10106°N, 16.81199°E) 20 ha in area (B1 = Gorzyczki I-orchard), 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 I-shrubberies), namely thicket phytocenoses of *Euonymo-Prunetum spinosae* and *Querco-Ulmetum* forest, herbaceous communities and ruderal plant communities. Tree communities were formed mainly by: European elm (*Ulmus laevis* Pall.), sessile oak (*Quercus robur* L.), ash tree (*Fraxinus excelsior* L.), maple (*Acer platanoides* L.), boxelder maple (*Acer negundo* L.) and single apple trees (*Malus domestica* Borkh.) with hybrid black poplar (*Populus* × *canadensis* Moench). Herbaceous plants were dominated by stinging nettle (*Urtica dioica* L.) and Canada thistle (*Cirsium arvense* (L.) Scop.). In the patches of ruderal shrubberies the following were recorded: elder (*Sambucus nigra* L.), common hawthorn (*Crataegus monogyna* Jacq.), matrimony vine (*Lycium barbarum* L.), dog rose (*Rosa canina* L.) and hazel (*Corylus avellana* L.).

3. Apple orchard, Gorzyczki II (UTM, XT27; 52.10208°N, 16.81451°E) 10 ha in area (C1 = Gorzyczki II-orchard). The studies were conducted on 2-hectar plots with 20-year-old Golden Delicious apple trees. The orchard borders on a road

(C2 = Gorzyczki II-road) overgrown with plants typical of *Rhamno-Prunetea* class. The road was lined with walnut (*Juglans regia* L.), maples: boxelder (*Acer negundo* L.), common (*A. platanoides* L.), sycamore (*A. pseudoplatanus* L.) and sessile oak (*Quercus robur* L.), with some dog rose shrubs (*Rosa canina* L.), hawthorn (*Crataegus* × *media* Bechst.), hazel (*Corylus avellana* L.) and snowberry (*Symphoricarpos albus* Duhamel). Herbaceous plants were dominated by grass, stinging nettle (*Urtica dioica* L.), wormwood (*Artemisia absinthium* L.), yarrow (*Achillea millefolium* L.) and cleavers (*Galium aparine* L.).

In all 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. Apple protection program was implemented in the same terms and against the same diseases and pests in all orchards. In each of the orchards were performed 5–8 procedures against diseases and 6–8 procedures against pests in the different years of study.

Study methods. The study used a commonly used method of trapping Syrphidae imagines the yellow traps Moerickego [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.
Imagines Syrphidae were determined based on the keys of van Veen [2004] and Speight and Sarthou [2010].

Statistical analysis. Species frequency in the habitats was analysed with Chao coefficient. It is known that the index is based on a probabilistic approach to species abundance data and take account of "common species" [Chao et al. 2005]. In addition, the similarity was studied using cluster analysis and using principal components analysis. All statistical analysis were performed in R, version 2.10.0 [R Development Core Team 2009].

RESULTS

The total of 3,644 samples was caught in 2008–2010 in the orchard habitats near Czempiń, out of which 1,818 samples came from the orchards and 1,826 from their edges. Overall 55 Syrphidae species were reported, which constitutes 13.9% of the national fauna of this family [Soszyński 2007] (tab. 1). In the orchards 38 species occurred, and on their edges 49 species.

Both in the orchards and on the edges 32 species were found (58.2%), while in all the study sites 13 (23.6%) common species were found. Only 6 (10.1%) species were caught exclusively in the orchards, while 17 (30.9%) species were gathered on the edges.

Table 1. The occurrence frequency (F), abundance (N) and dominance index (D in %) of Syrphidae species in apple orchards and on their edges

No	Species	Trophism	Environment																	
			Głuchowo						Gorzyczki I						Gorzyczki II					
			Orchard (A1)			Field (A2)			Orchard (B1)			Shrubberies (B2)			Orchard (C1)			Road (C2)		
			F	N	D	F	N	D	F	N	D	F	N	D	F	N	D	F	N	D
1.	*Baccha elongata* (Fabricius, 1775)	z*										2	3	0.2	1	1	0.1			
2.	*Brachypalpus valgus* (Panzer, 1798)	s							3	15	1.2	2	12	0.9				2	4	0.4
3.	*Cheilosia albipila* Meigen, 1838	f																1	1	0.1
4.	*Cheilosia grossa* (Fallen, 1817)	f										1	1	0.1						
5.	*Cheilosia vernalis* (Fallen, 1817)	f							1	1	0.1									
6.	*Dasysyrphus tricinctus* (Fallen, 1817)	z																1	1	0.1
7.	*Epistrophe eligans* (Harris, 1780)	z										1	2	0.1	1	1	0.1	1	1	0.1
8.	*Epistrophe nitidicollis* (Meigen, 1822)	z										1	1	0.1						
9.	*Episyrphus balteatus* (De Geer, 1776)	z	22	384	61.0	11	258	47.4	32	720	55.8	26	991	71.8	28	501	74.8	23	752	79.3
10.	*Eristalinus aeneus* (Scopoli, 1763)	s										1	1	0.1						
11.	*Eristalinus sepulchralis* (Linnaeus, 1758)	s							1	1	0.1									
12.	*Eristalis arbustorum* (Linnaeus, 1758)	s	3	5	0.8	1	1	0.2	19	40	3.1	7	11	0.8	6	9	1.3	3	3	0.3
13.	*Eristalis intricaria* (Linnaeus, 1758)	s							1	1	0.1									
14.	*Eristalis pertinax* (Scopoli, 1763)	s							1	1	0.1	2	3	0.2						
15.	*Eristalis similis* (Fallén, 1817)	s							2	2	0.2	1	1	0.1						
16.	*Eristalis tenax* (Linnaeus, 1758)	s	9	12	1.9	4	5	0.9	10	22	1.7	8	13	0.9	6	9	1.3	7	11	1.2
17.	*Eumerus sogdianus* (Stackelberg, 1952)	f																1	1	0.1
18.	*Eumerus strigatus* (Fallen, 1817)	f	2	5	0.8	2	3	0.6	3	17	1.3	1	1	0.1	2	4	0.6	2	2	0.2
19.	*Eupeodes corollae* (Fabricius, 1794)	z	14	100	15.9	13	165	30.3	22	205	15.9	14	161	11.7	13	70	10.4	14	74	7.8
20.	*Eupeodes latifasciatus* (Macquart, 1829)	z	1	1	0.2															
21.	*Eupeodes luniger* (Meigen, 1822)	z							5	6	0.5	7	9	0.7	3	4	0.6	1	1	0.1
22.	*Helophilus hybridus* (Loew, 1846)	s							1	1	0.1	2	2	0.1	1	1	0.1			
23.	*Helophilus pendulus* (Linnaeus, 1758)	s	1	1	0.2				2	2	0.2	4	4	0.3	3	4	0.6	1	1	0.1
24.	*Helophilus trivittatus* (Fabricius, 1805)	s	3	6	1.0	2	3	0.6	8	11	0.9	3	3	0.2	3	3	0.4	1	1	0.1
25.	*Melangyna lasiophthalma* (Zetterstedt, 1843)	z										1	1	0.1						
26.	*Melangyna quadrimaculata* (Verrall, 1873)	z				1	1	0.2				2	2	0.1						

27. *Melangyna umbellatarum* (Fabricius, 1794)	z																1	1	0.1
28. *Melanostoma mellinum* (Linnaeus, 1758)	z	7	23	3.7	6	13	2.4	14	37	2.9	4	11	0.8	3	4	0.6	9	10	1.1
29. *Melanostoma scalane* (Fabricius, 1794)	z							3	11	0.9	1	1	0.1	1	2	0.3	2	4	0.4
30. *Meligramma cincta* (Fallen, 1817)	z										1	1	0.1						
31. *Meliscaeva auricollis* (Meigen, 1822)	z				1	1	0.2							1	1	0.1			
32. *Myathropa florea* (Linnaeus, 1758)	s				1	1	0.2												
33. *Parasyrphus punctulatus* (Verrall, 1873)	z										1	1	0.1						
34. *Pipizella viduata* (Linnaeus, 1758)	z										1	1	0.1						
35. *Platycheirus albimanus* (Fabricius, 1781)	z	1	1	0.2				1	1	0.1							1	1	0.1
36. *Platycheirus clypeatus* (Meigen, 1822)	z				2	3	0.6	1	1	0.1	1	1	0.1	1	1	0.1			
37. *Platycheirus fulviventris* (Macquart, 1829)	z				1	1	0.2												
38. *Platycheirus peltatus* (Meigen, 1822)	z													1	1	0.1	1	1	0.1
39. *Platycheirus scutatus* (Meigen, 1822)	z	1	1	0.2				3	3	0.2	1	1	0.1	1	1	0.1			
40. *Pocota personata* (Harris, 1780)	s																1	1	0.1
41. *Scaeva pyrastri* (Linnaeus, 1758)	z	5	11	1.7	7	20	3.7	7	18	1.4	3	5	0.4	5	7	1.0	3	5	0.5
42. *Scaeva selenitica* (Meigen, 1822)	z	1	1	0.2	1	1	0.2				1	1	0.1	1	1	0.1	2	2	0.2
43. *Sphaerophoria rueppellii* (Wiedemann, 1830)	z	1	1	0.2															
44. *Sphaerophoria scripta* (Linnaeus, 1758)	z	9	30	4.8	9	40	7.4	10	41	3.2	10	20	1.4	6	12	1.8	6	14	1.5
45. *Sphaerophoria taeniata* (Meigen, 1822)	z	1	2	0.3	1	2	0.4	1	2	0.2							1	2	0.2
46. *Syritta pipiens* (Linnaeus, 1758)	s	7	9	1.4	2	2	0.4	14	47	3.6	8	11	0.8	10	14	2.1	8	10	1.1
47. *Syrphus ribesii* (Linnaeus, 1758)	z	6	10	1.6	3	5	0.9	5	9	0.7	10	14	1.0	1	1	0.1	3	6	0.6
48. *Syrphus torvus* (Osten-Sacken, 1875)	z	2	2	0.3	3	9	1.7	3	8	0.6	4	6	0.4	1	1	0.1	5	6	0.6
49. *Syrphus vitripennis* (Meigen, 1822)	z	10	21	3.3	6	10	1.8	11	50	3.9	18	69	5.0	7	12	1.8	8	22	2.3
50. *Triglyphus primus* (Loew, 1840)	z							1	1	0.1									
51. *Volucella pellucens* (Linnaeus, 1758)	z													1	1	0.1	1	1	0.1
52. *Xanthandrus comtus* (Harris, 1780)	z	3	4	0.6				7	11	0.9							2	4	0.4
53. *Xanthogramma pedissequum* (Harris, 1776)	z																1	1	0.1
54. *Xanthogramma stackelbergi* Violovitsh, 1975	z										1	1	0.1				1	1	0.1
55. *Xylota segnis* (Linnaeus, 1758)	s							4	5	0.4	4	14	1.0	4	4	0.6	3	3	0.3
Total			630	100		544	100		1290	100		1380	100		670	100		948	100

* f – phytophage, s – saprophage, z – zoophage

Predatory species were dominant both in the orchards and on the edges (tab. 1). They belonged to the genera: Baccha, Dasysyrphus, Epistrophe, Episyrphus, Eupeodes, Melangyna, Melanostoma, Meligramma, Parasyrphus, Pipizella, Platycheirus, Scaeva, Sphaerophoria, Syrphus, Triglyphus, Volucella, Xanthandrus and Xanthogramma. The number of species caught in the orchards was 24 (63.2%) and on the edges – 32 (65.3%). Another numerously represented trophic group were saprophages, which included water saprophages and saproxylobionts as well as species developing in rotten wood. They belonged to the following genera: Brachypalpus, Eristalinus, Eristalis, Helophilus, Myathropa, Pocota, Syritta and Xylota. The orchard catch yielded 12 saprophagous species (31.5%) and their edges 13 such species (26.5%). The other trophic groups were represented by single species. The phytophagous species caught, i.e. 5, belonged to Cheilosia and Eumerus genera, with 2 of them found in the orchards (5.3%), and 4 on the edges (8.2%).

The occurrence frequency of the Syrphidae of particular habitats in study years (Figure 1) was found to be similar in most habitats, i.e. the orchards in Głuchowo (A1) and Gorzyczki II (C1), the shrubberies in Gorzyczki I (B2) and on the road overgrown with trees and shrubberies in Gorzyczki II (C2). It was, however, higher than the frequency calculated for the orchard in Głuchowo (A1) and its neighbouring field (A2). The highest frequency of species occurrence was reported from the orchard bordering on the shrubberies in Gorzyczki I (B1) in 2009, while the lowest one in the agricultural cultivation in Głuchowo (A2) in 2010.

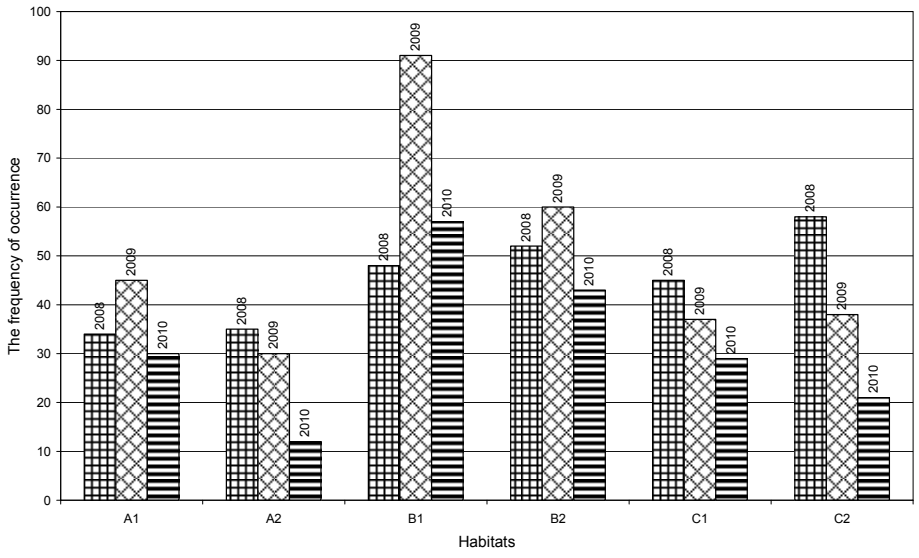

Fig. 1. The occurrence frequency of Syrphidae species in particular habitats in 2008–2010 (A1 = Głuchowo-orchard, A2 = Głuchowo-field, B1 = Gorzyczki I-orchard, B2 = Gorzyczki I-shrubberies, C1 = Gorzyczki I-orchard, C2 = Gorzyczki II-road)

In terms of frequency there were 7 dominant species (fig. 2), out of which 5 were zoophagous and 2 was saprophagous. 2 zoophagous dominated in all the habitats, and those were *Episyrphus balteatus* (De Geer) and *Eupeodes corollae* (F.). Another dominant was the zoophagous *Syrphus vitripennis* Meigen, which occurred in the orchard in Głuchowo (A1) and shrubberies in Gorzyczki I (B2). The other dominants included the species found in only one habitat, namely the zoophagous *Spaerophoria scripta* (L.) caught in the field in Głuchowo (A2) and the zoophagous *Melanostoma mellinum* (L.) reported from the road in Gorzyczki II (C2) as well as the saprophagous *Eristalis arbustorum* (L.) reported from the orchard in Gorzyczki I (B1) and saprophagous *Syritta pipiens* (L.) found in the orchard in Gorzyczki II (C1).

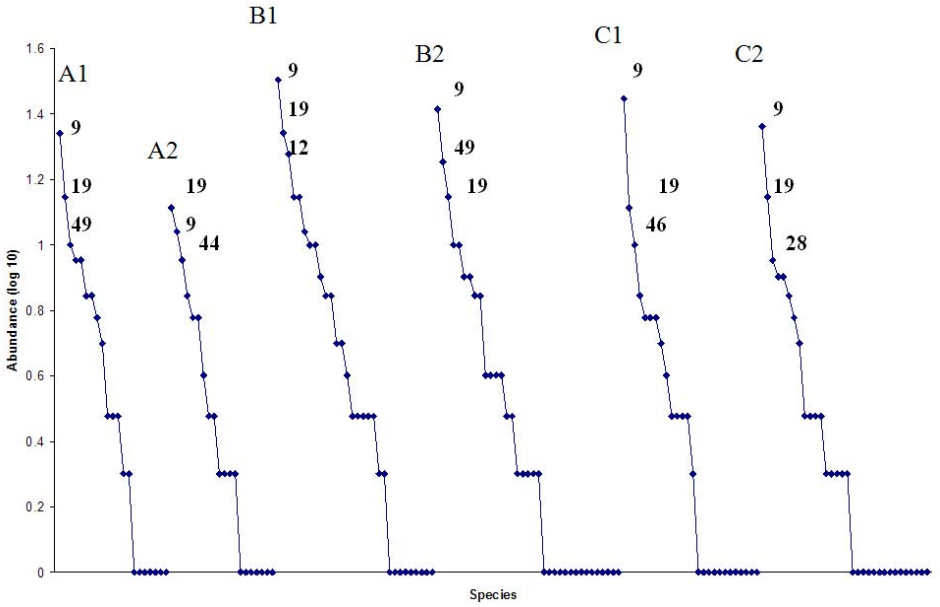

Fig. 2. Dominance diversity curves based on the number of species (log 10 abundance) per species in each habitat (A1 = Głuchowo-orchard, A2 = Głuchowo-field, B1 = Gorzyczki I-orchard, B2 = Gorzyczki I-shrubberies, C1 = Gorzyczki II-orchard, C2 = Gorzyczki II-road). The order of species importance: 9 – *Episyrphus balteatus*, 12 – *Eristalis arbustorum*, 19 – *Eupeodes corollae*, 28 – *Melanostoma mellinum,* 44 – *Sphaerophoria scripta*, 46 – *Syritta pipiens*, 49 – *Syrphus vitripennis*

An abundance analysis of Syrphidae species of dominant occurrence frequency showed that the species which dominated in all the habitats also showed the highest abundances in those habitats (tab 1).

The analysis of similarities in occurrence frequency for Syrphidae species in particular habitats based on Chao coefficient values, with cluster analysis and the results pre-

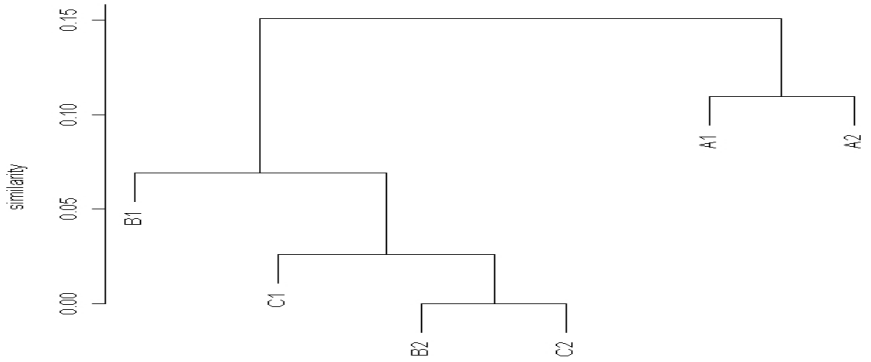

Fig. 3. Cluster analysis of habitats with Chao similarity coefficient and group average linking as the clustering method (A1 = Głuchowo-orchard, A2 = Głuchowo-field, B1 = Gorzyczki I-orchard, B2 = Gorzyczki I-shrubberies, C1 = Gorzyczki II-orchard, C2 = Gorzyczki II-road)

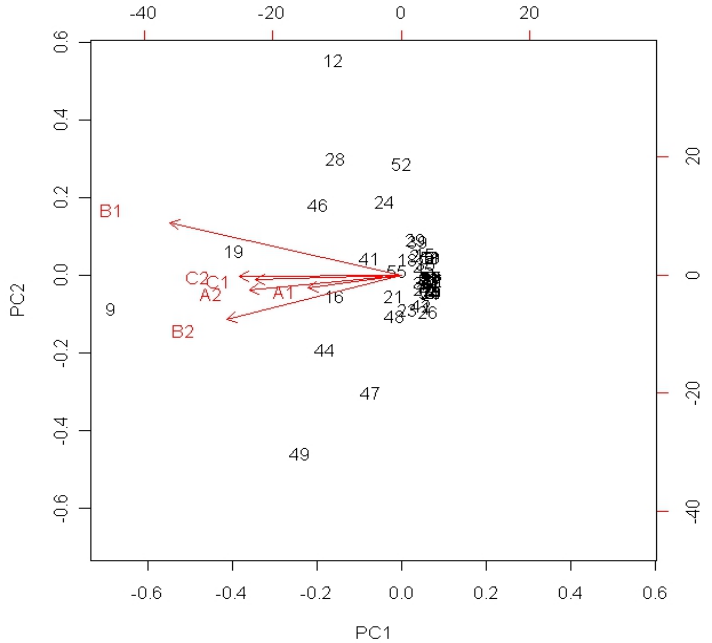

Fig. 4. Plot of principal components analysis of habitats (A1 = Głuchowo-orchard, A2 = Głuchowo-field, B1 = Gorzyczki I-orchard, B2 = Gorzyczki I-shrubberies, C1 = Gorzyczki II-orchard, C2 = Gorzyczki II-road ; number denote number of species as in Table 1)

sented as a dendrogram (fig. 3) and principal component analysis with the results are shown in Figure 4 helped to establish the following facts:

– the habitats of orchard (A1) and cultivated field on its edge (A2) were similar to each other and at the same time differed from other habitats;

– the habitats of shrubberies (B2) and the road (C2) were similar to each other and at the same time differed from the orchards;

– the habitats of orchard (B1 and C1) bordering on the shrubberies and the road were similar to each other.

DISCUSSION

The studies of the occurrence frequency of Syrphidae species in apple tree orchards and on their edges conducted in 2008–2010 clearly proved that the orchard edge habitats, when analysed as a whole, were characterized by a higher species diversity than the orchards themselves. Thus the study results indicate that the plants of orchard edges plays an important role in biocenosis as a habitat for aphid entomophages, which can migrate onto the orchards. This correlation was previously corroborated in the studies by Wyss [1995, 1999], who states that more predatory Syrphidae occurred on apple trees bordering on blooming plants than on apple trees without such habitats in their vicinity.

The orchards and their edges were mainly inhabited by zoophagous species. The studies confirmed that those are the habitats for predatory Syrphidae, which can control the abundance of aphids in orchards. The effectiveness of *Episyrphus balteatus* (De Geer) in controlling the abundance of *Aphis pomi* Deg. and other aphids infesting fruit trees and bushes was presented by Wnuk [1972, 1977]. Trandafirescu et al. [2004] claim that the abundance of *Dysaphis devecta* (Walker) and *D. plantaginea* (Pass) was effectively controlled by Syrphidae, including *E. balteatus*. Miňarro and Dapena [2001] indicate that *E. balteatus* was one of the most effective predators of *D. plantaginea* in apple tree orchards in Spain.

The studies confirmed the dominance of *Episyrphus balteatus* (De Geer), *Eupeodes corollae* (F.) and *Syrphus vitripennis* Meigen in orchard habitat, as they had been previously described as dominant ones in that kind of habitat by Wnuk [1972], Solomon et al. [2000], Miňarro and Dapena [2001] and Rossi et al. [2006]. Also in Wielkopolska apple orchards *E. balteatus* has been listed among dominant ones for a number of years [Trzciński et al. 2006, 2009, 2011].

The study indicated a higher attractiveness of shrubberies and the road with trees and bushes for Syrphidae than cultivated fields. Thus the attractiveness of blooming flowers for Syrphidae imagines was confirmed, as had been indicated in earlier studies. Branquaet and Hemptinne [2000] also highlight that Syrphidae are attracted by the blooming plants of the families: Apiaceae, Asteraceae, Ranunculaceae and Rosaceae. Ambrosino et al. [2006)] indicate phacelia (*Phacelia tanacetifolia* Benth. as the plant that most effectively attracts Syrphidae. Kelm et al. [2009] suggest introducing herbaceous plants of *Lamiaceae* family in horticultural cultivations, as they attract predatory Syrphidae.

The studies helped to establish that most studied habitats had similar frequencies of Syrphidae occurrence, except for the orchard and a field on its edge. However, they also indicated that the orchard edge in the form of shrubberies and the road formed one group of similar habitats in terms of occurrence frequency and the bordering orchards formed another group of similar habitats.

CONCLUSIONS

1. Orchard edges in the form of abundant and blooming greenery are a more attractive habitat for Syrphidae than apple orchards.

2. Orchard edges with abundant greenery are biocenosis elements which attract Syrphidae more to apple orchards than field cultivations.

3. Orchard edges with abundant greenery determine the Syrphidae moving into orchards, thus increasing the chances of controlling aphid abundance there.

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CZĘSTOTLIWOŚĆ WYSTĘPOWANIA GATUNKÓW Syrphidae (Diptera) W SADACH JABŁONIOWYCH I NA ICH OBRZEŻACH

Streszczenie. Podjęte badania dotyczyły określenia atrakcyjności sąsiadujących ze sobą środowisk występowania w nich Syrhidae (Diptera). Badania nad częstotliwością występowania Syrphidae (Diptera) w sadach jabłoniowych i na ich obrzeżach prowadzono w latach 2008–2010. Dokonano analizy jakościowej Syrphidae występujących w sadach jabłoniowych i w środowiskach sąsiadujących z sadami. Obrzeżami sadów były uprawy rolnicze, zakrzewienia i droga porośnięta drzewami i krzewami. Stwierdzono łącznie 55 gatunków Syrphidae, które stanowiły 13,9% fauny krajowej tej rodziny. W sadach wystąpiło 38 gatunków, a na obrzeżach 49 gatunków. Zarówno w sadach, jak i na obrzeżach dominowały gatunki zoofagiczne. Przeanalizowano częstotliwość występowania gatunków Syrphidae w sadach i na ich obrzeżach i stwierdzono, że była ona podobna i równocześnie większa we wszystkich środowiskach z wyjątkiem sadu i graniczącego z nim pola uprawnego. We wszystkich środowiskach dominowały dwa zoofagi – *Episyrphus balteatus* (De Geer) i *Eupeodes corollae* (F.). Badania wykazały, że roślinność obrzeży sadu jest atrakcyjniejszym środowiskiem występowania gatunków Syrphidae niż sad. Środowiska obrzeży sadu z bujną i kwitnącą roślinnością są elementami biocenoz zwabiającymi intensywniej Syrphidae niż uprawy polowe i mogą one decydować o przemieszczaniu się tych pożytecznych gatunków w uprawy sadownicze.

Słowa kluczowe: bzygowate, muchówki, uprawy sadownicze, współczynnik Chao, analiza skupień, dendrogram

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