Türk. entomol. derg., 2015, 39 (4): 333-343 ISSN 1010-6960
DOI: http://dx.doi.org/10.16970/ted.92495

Orijinal araştırma (Original article)

The impact of the vegetation of apple orchard edges on quantity and quality structure of predatory hoverflies (Diptera: Syrphidae) communities

Elma bahçesi sınır vejetasyonlarının avcı çiçek sineği (Diptera: Syrphidae) komünitelerinin nicel ve nitel yapılarına etkisi

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Summary

The research on the impact of apple orchard edges vegetation on quantity and quality structure of predatory Syrphidae was carried out between 2008 and 2010 in the vicinity of Czempiń in the western part of Wielkopolska, Poland. Quality and quantity analyses of Syrphidae communities in the apple orchards and on their edges were conducted; the edges included fields, shrubberies and a road lined with trees and bushes. The total of 35 Syrphidae species were found, which constituted 8.8% of the national fauna of this family. In the orchards 24 species and on the edges 32 species were caught. The total number of specimens of the family was 5080, out of which 2338 were caught in the orchards and 2742 on the edges.. Apple orchards with developed edge vegetation yielded higher abundances of Syrphidae than the orchard bordering on the fields. All the orchards and their edges were dominated by two species, namely *Episyrphus balteatus* (De Geer, 1776) and *Eupeodes corollae* (Fabricius, 1794). It was found that the majority of Syrphidae flies communities inhabiting the orchards and their edges showed a high similarity in their quality and quality-quantity structures. The research showed that the occurrence of well-developed vegetation with diversified species on apple orchard edges positively influences the species richness and abundance of predatory Syrphidae occurring in the orchard habitat.

Keywords: Cluster method, diversity functions, hoverflies, plants of orchard edge, Poland, Syrphidae

Özet

Bu çalışma elma bahçesi sınır vejetasyonlarının bahçe içerisindeki avcı Syrphidae'lerin nicel ve nitel yapısı üzerindeki etkilerinin belirlenmesi için 2008 ve 2010 yılları arasında Wielkopolska (Polonya)'nın batı kısmında bulunan Czempin bölgesinde yürütülmüştür. Çalışmada elma bahçelerindeki ve bahçe sınır vejetasyonlarındaki Syrphidae komünitelerinin nicel ve nitel analizleri yapılmış olup sınır vejetasyonlarına bahçe kenarında bulunan çalılıklar, ağaçlar ve yol alanları dahil edilmiştir. Çalışma sonucunda toplamda ülke syrphid faunasının %8.8'ni oluşturan 35 Syrphidae türü saptanmıştır. Bahçe içerisinde 24, bahçe sınırlarında 32 syrphid türü belirlenmiştir. Çalışmada toplamda yakalanan birey sayısı 5080 olup bu bireylerden 2338 adeti bahçe içerisinden 2742 adeti bahçe kenarlarından yakalanmıştır. Çalışma sonucunda bahçe sınırlarının vejetasyon bakımından zengin olduğu bahçelerde tür zenginliğinin bahçe sınırlarının düzenlendiği ve vejetasyon bakımından zengin olmayan bahçelere oranla daha zengin olduğu belirlenmiştir. Vejetasyon bakımından daha zengin elma bahçeleri, bahçe kenarında bitkinin olmadığı elma bahçelerine nazaran daha baskın Syrphidae faunasına sahip bulunmuştur. Hem elma bahçeleri hem de bahçe sınır vejetasyonlarında en çok *Episyrphus balteatus* (De Geer, 1776) ve *Eupeodes corollae* (Fabricius, 1794) türlerine rastlanılmıştır. Bahçe içerisinde ve bahçe sınırlarında tespit edilen syrphid komünitelerinin nicel ve nitel bakımdan birbirlerine çok benzediği tespit edilmiştir. Çalışma sonucunda bahçe sınırlarının zenginleştirildiği elma bahçelerinde Syrphidae faunasının zenginleştirilmemiş elma bahçelerine nazaran daha zengin olduğu tespit edilmiştir.

Anahtar sözcükler: Kümeleme metodu, çeşitlilik faktörleri, çiçek sinekleri, bahçe sınırı bitkileri, Polonya, Syrphidae

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Alınış (Received): 14.04.2015 Kabul ediliş (Accepted): 27.10.2015 Çevrimiçi Yayın Tarihi (Published Online): 02.12.2015

Introduction

The preservation of the existing uncultivated refuge habitats in agrocenoses, as well as enriching them with various advantageous elements, such as: shrubbery belts, road edges, tree groups of fragments of forest communities increases the diversity of their entomofauna, including predatory Syrphidae species. It was proved by numerous studies (Wnuk, 1972; Branquart & Hemptinne, 2000; Colley & Luna, 2000; Solomon et al., 2000; Carreck & Williams, 2002; Bostanian et al., 2004; Ambrosino et al., 2006; Rossi et al., 2006; Haenke et al., 2009). Refuge habitats stabilise the processes related to the functioning of ecosystems, and properly enriched habitats bordering directly on cultivated fields also shape the living conditions of beneficiary entomofauna of the Syrphidae family (MacLeod, 1999; Sutherland et al., 2001; Trzciński & Piekarska-Boniecka, 2009).

The larvae of Syrphidae reduce the population of aphids (Hemiptera, Aphidoidea), economically important pests in orchards. Adult Syrphidae play a significant role in biocenoses, as they pollinate plants. Therefore, flourishing vegetation may be a attractant factor for this insects to orchard.

The aim of the study was to define the impact of the vegetation of apple orchard edges in the form of fields, shrubberies and the road grown with trees and bushes on quality and quantity structure of the communities of predatory Syrphidae which occur in the orchard habitat.

Material and Methods

The study was conducted between 2008 and 2010 in three orchards located in the vicinity of Czempiń in Wielkopolska (Greater Poland). One orchard was located in Głuchowo and two orchards were in Gorzyczki. The orchard in Głuchowo was 15 km away from the orchards in Gorzyczki I, while the orchards in Gorzyczki I were 1 km away from each other, Gorzyczki II (Figure 1).

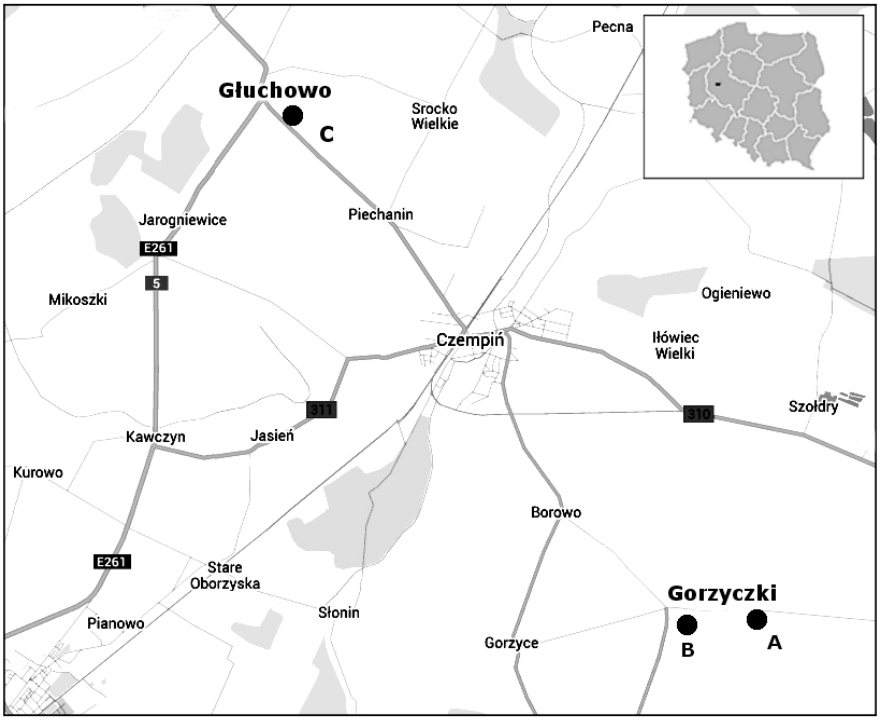

Figure 1. The location of apple orchards in the vicinity of Czempiń (Poland): A – the orchard in Głuchowo, B – orchard in Gorzyczki I, C – orchard in Gorzyczki II.

The study sites included:

A) 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.

B) Apple orchard, Gorzyczki I (UTM, XT27; 52.10106 °N, 16.81199 °E) 20 ha in area (B1 = Gorzyczki I orchard), where the 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.).

C) Apple orchard in 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 snoberry (*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 were 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 integrated fruit production policy was implemented in orchards. Apple protection program was also practised in the same terms against the diseases and pests in all the 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.

Method of study

The study used a common method of trapping Syrphidae imagines the yellow Moericke traps (Moericke, 1953). The trap was composed of 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 apart 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. The collected materials were stored in 75% ethyl alcohol and they were deposited in the Department of Entomology and Environmental Protection, the University of Life Sciences in Poznan.

Imagines of Syrphidae were determined based on the keys by van Veen (van Veen, 2004) and Speight and Sarthou (Speight & Sarthou, 2010).

Statistical analysis

The species richness data was pooled for each habitat and compared among study sites with dominance diversity curves. The similarity among the apple orchards and surrounding habitats was estimated with the abundance-based estimator for Jaccard and Sorensen classic index (Chao et al., 2005). An indvidual-based curve was calculated with 95 percent confidence intervals curve using Mao-Tau function (Colwell et al., 2004). In addition, expected species accumulation curves per individual were used to compare the taxonomical diversity in the samples of different sizes. The similarity was studied with cluster analysis, and the results were presented as a dendrogram. The abundance of predatory species found on each bait type and site were examined by applying principal components analysis. Statistical calculations were performed with Estimates (Colwell, 2011) and R software, version 3.2.1 (R Core Team, 2015).

Results

The total numbers of 3644 samples were caught between 2008 and 2010 in the orchard habitats near Czempiń, out of which 1818 samples were from the orchards and 1826 were from their edges. Overall 35 Syrphidae predatory species were reported, which constitutes 8.8% of the national fauna of this family (Soszyński, 2007) (Table 1). In the orchards 24 species occurred, while on the orchard edges 32 specimens were reported. The total number of the caught Syrphidae was 5080, with 2338 specimens from the orchards and slightly more, i.e. 2742, specimens from the edges.

In orchard habitats where orchards bordered on well-developed edge vegetation, i.e. shrubberies (B2) and a road lined with trees and bushes (C2), predatory Syrphidae species were found in higher abundances (Table 1).

In apple orchards, regardless of the abundance of the vegetation they bordered on, similar numbers of Syrphidae species were caught. In orchards with abundant vegetation (B1, C1) higher Syrphidae abundances were found than in the orchard (A1) which bordered on agricultural cultivations.

In all the orchards and their edges 8 (22.8%) common species were found, namely: *Episyrphus balteatus* (De Geer, 1776), *Eupeodes corollae* (Fabricius, 1794), *Melanostoma mellinum* (Linnaeus, 1758), *Scaeva pyrastri* (Linnaeus, 1758), *Sphaerophoria scripta* (Linnaeus, 1758), *Syrphus ribesii* (Linnaeus, 1758), *S. torvus* Osten-Sacken, 1875 and *S. vitripennis* Meigen, 1822. There were 2 species exclusive for the orchards (5.7%): *Sphaerophoria rueppellii* (Wiedemann, 1830) and *Triglyphus primus* Loew, 1840. In edge habitats 10 (28.6%) the following exclusive species were found: *Dasysyrphus tricinctus* (Fallen, 1817), *Epistrophe nitidicollis* (Meigen, 1822), *Melangyna lasiophthalma* (Zetterstedr, 1843), *M. quadrimaculata* Verrall, 1873, *M. umbellatarum* (Fabricius, 1794), *Parasyrphus punctulatus* (Verrall, 1873), *Pipizella viduata* (Linnaeus, 1758), *Platycheirus fulviventris* (Macquart, 1829), *Xanthogramma pedissequum* (Harris, 1776) and *X. stackelbergi* Violovitsh, 1975.

In all the apple orchards and on their edges (A1 – C2) one eudominant was found - this was *Episyrphus balteatus* with the share of 48.8 - 82.6%. Another abundant species was *Eupeodes corollae*, which was eudominant and dominant with 8.1 - 31.2% share in the orchard habitats (A1 - C2). In the apple orchard (A1) and the neighbouring fields (A2) one dominant was found: *Sphaerophoria scripta,* with shares 5.1% and 7.6%. Also in the shrubberies (B2) a dominant was caught: *Syrphus vitripennis* with 5.3% share. Other Syrphidae species were less abundant in particular habitats and they included mainly subrecedents and recedents (Table 1 and Figure 2).

Having analysed the number of species and abundances of Syrphidae in particular orchards and on their edges based on Mao-Tau function the most Syrphidae species and the highest abundances were found in the shrubberies (B2). The poorest species composition of those entomophages and the lowest abundance were found in the fields (A2) (Figure 3).

Table 1. The list of species and abundances of predatory Syrphidae caught in the orchard habitat near Czempiń in 2008 - 2010 (N – abundance, D - dominance index)

	Species	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	*Baccha elongata* (Fabricius 1775)							3	0.2%	1	0.2%		
S2	*Dasysyrphus tricinctus* (Fallen, 1817)											1	0.1%
S3	*Epistrophe eligans* (Harris, 1780)							2	0.2%	1	0.2%	1	0.1%
S4	*Epistrophe nitidicollis* (Meigen, 1822)							1	0.1%				
S5	*Episyrphus balteatus* (De Geer, 1776)	384	64.9%	258	48.8%	720	64.1%	991	76.1%	501	80.5%	752	82.6%
S6	*Eupeodes corollae* (Fabricius, 1794)	100	16.9%	165	31.2%	205	18.2%	161	12.4%	70	11.3%	74	8.1%
S7	*Eupeodes latifasciatus* (Macquart, 1829)	1	0.2%										
S8	*Eupeodes luniger* (Meigen, 1822)					6	0.5%	9	0.7%	4	0.6%	1	0.1%
S9	*Melangyna lasiophthalma* (Zetterstedt, 1843)							1	0.1%				
S10	*Melangyna quadrimaculata* Verrall, 1873			1	0.2%			2	0.2%				
S11	*Melangyna umbellatarum* (Fabricius, 1794)											1	0.1%
S12	*Melanostoma mellinum* (Linnaeus, 1758)	23	3.9%	13	2.5%	37	3.3%	11	0.8%	4	0.6%	10	1.1%
S13	*Melanostoma scalane* (Fabricius, 1794)					11	1.0%	1	0.1%	2	0.3%	4	0.4%
S14	*Meligramma cincta* (Fallen, 1817)							1	0.1%		0.0%		
S15	*Meliscaeva auricollis* (Meigen, 1822)			1	0.2%					1	0.2%		
S16	*Parasyrphus punctulatus* (Verrall, 1873)							1	0.1%				
S17	*Pipizella viduata* (Linnaeus, 1758)							1	0.1%				
S18	*Platycheirus albimanus* (Fabricius, 1781)	1	0.2%			1	0.1%					1	0.1%
S19	*Platycheirus clypeatus* (Meigen, 1822)			3	0.6%	1	0.1%	1	0.1%	1	0.2%		

Table 1 (continued)

	Species	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
S20	*Platycheirus fulviventris* (Macquart, 1829)			1	0.2%								
S21	*Platycheirus peltatus* (Meigen, 1822)									1	0.2%	1	0.1%
S22	*Platycheirus scutatus* (Meigen, 1822)	1	0.2%			3	0.3%	1	0.1%	1	0.2%		
S23	*Scaeva pyrastri* (Linnaeus, 1758)	11	1.9%	20	3.8%	18	1.6%	5	0.4%	7	1.1%	5	0.5%
S24	*Scaeva selenitica* (Meigen, 1822)	1	0.2%	1	0.2%			1	0.1%	1	0.2%	2	0.2%
S25	*Sphaerophoria rueppellii* (Wiedemann, 1830)	1	0.2%										
S26	*Sphaerophoria scripta* (Linnaeus, 1758)	30	5.1%	40	7.6%	41	3.6%	20	1.5%	12	1.9%	14	1.5%
S27	*Sphaerophoria taeniata* (Meigen, 1822)	2	0.3%	2	0.4%	2	0.2%					2	0.2%
S28	*Syrphus ribesii* (Linnaeus, 1758)	10	1.7%	5	0.9%	9	0.8%	14	1.1%	1	0.2%	6	0.7%
S29	*Syrphus torvus* Osten-Sacken, 1875	2	0.3%	9	1.7%	8	0.7%	6	0.5%	1	0.2%	6	0.7%
S30	*Syrphus vitripennis* Meigen, 1822	21	3.5%	10	1.9%	50	4.4%	69	5.3%	12	1.9%	22	2.4%
S31	*Triglyphus primus* Loew, 1840					1	0.1%						0.0%
S32	*Volucella pellucens* (Linnaeus, 1758)									1	0.2%	1	0.1%
S33	*Xanthandrus comtus* (Harris, 1780)	4	0.7%			11	1.0%					4	0.4%
S34	*Xanthogramma pedissequum* (Harris, 1776)											1	0.1%
S35	*Xanthogramma stackelbergi* Violovitsh, 1975							1	0.1%			1	0.1%
	Total number of specimens	592	100%	529	100%	1124	100%	1303	100%	622	100%	910	100%
		1,121				2,427				1,532			
	Total number of species	15		14		16		22		18		21	
		19				26				25			

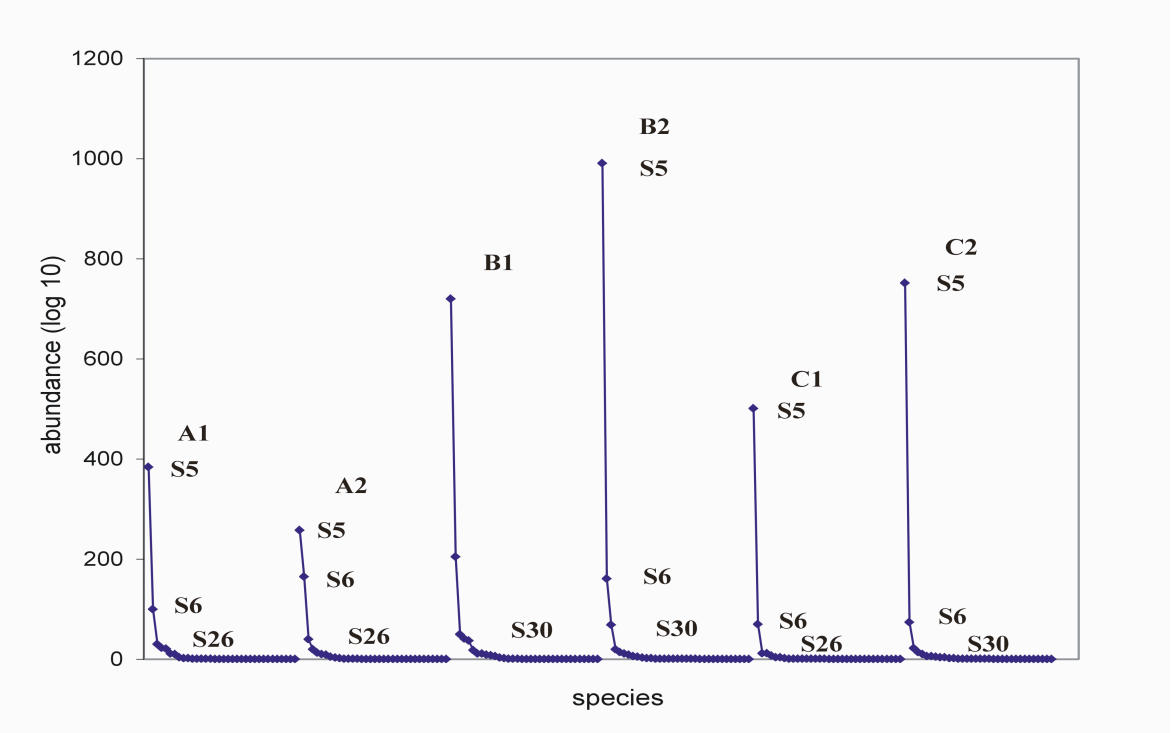

Figure 2. Dominance diversity curves based on the number of individuals (log 10 abundance) per species in each habitat. A1 = Głuchowo orchard, A2 = Głuchowo field, B1 = Gorzyczki I orchard, B2 = Gorzyczki I shrubberies, C1 = Gorzyczki II orchard, C2 = Gorzyczki II road, S5 = *Episyrphus balteatus*, S6 = *Eupeodes corollae*, S26 = *Sphaerophoria scripta*, S30 = *Syrphus vitripennis*. High quality figures are available online.

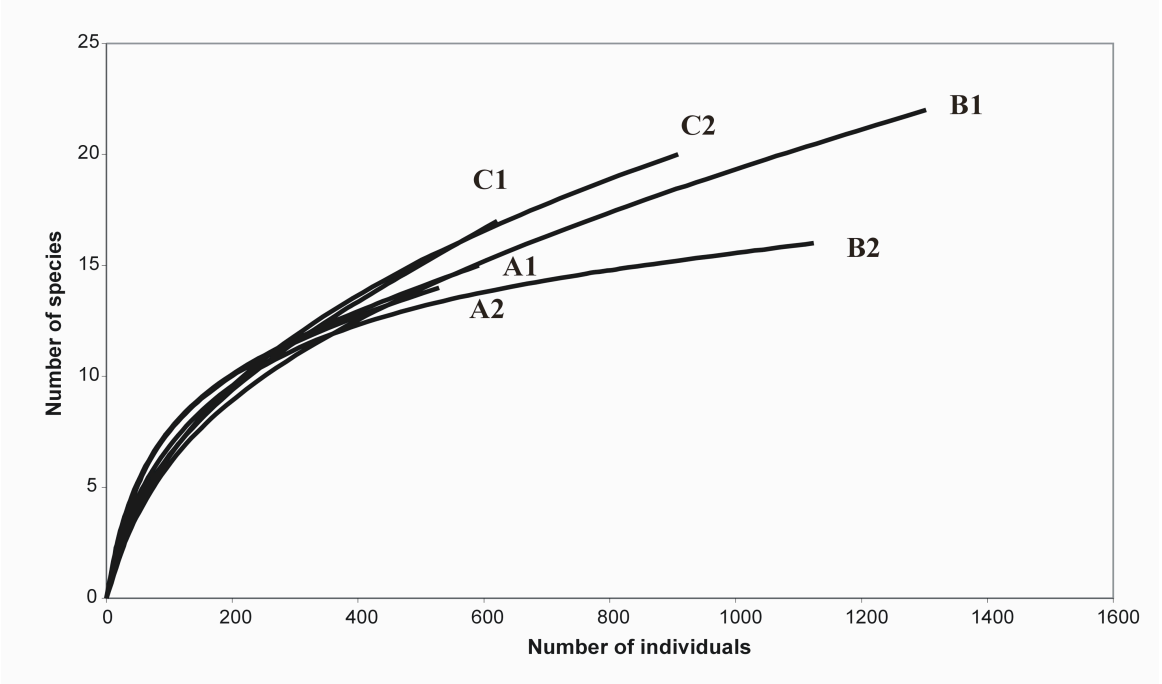

Figure 3. Expected species accumulation curves based on Mao-Tau function for all habitats. A1 = Głuchowo orchard, A2 = Głuchowo field, B1 = Gorzyczki I orchard, B2 = Gorzyczki I shrubberies, C1 = Gorzyczki II orchard, C2 = Gorzyczki II road. High quality figures are available online.

The communities of predatory Syrphidae caught in the apple orchards and on their edges were compared in quantity terms with Jaccard and Sorensen indices (Table 2). The communities of particular habitats were found to be mostly similar in over half of their species composition, except the communities caught in orchard in Gorzyczki II (C1) and shrubberies (B2). Those communities reached Jaccard index below 0.5.

Table 2. Compositional Jaccard and Sorensen classic index matrix for all the habitats: A1 = Głuchowo orchard, A2 = Głuchowo field, B1 = Gorzyczki I orchard, B2 = Gorzyczki I shrubberies, C1 = Gorzyczki II orchard, C2 = Gorzyczki II road

Jaccard Classic / Sorensen Classic	A1	A2	B1	B2	C1	C2
A1		0.520	0.542	0.500	0.444	0.500
A2	0.684		0.750	0.700	0.609	0.609
B1	0.703	0.857		0.650	0.636	0.636
B2	0.667	0.824	0.788		0.458	0.591
C1	0.615	0.757	0.788	0.629		0.583
C2	0.667	0.757	0.788	0.743	0.737	

The last task was to determine an estimated number of species in a particular habitat, specify 95% confidence interval and determine the standard deviation on the basis of species accumulation curve. Mao-Tau function was used to achieve this. It is known to show the average number of individuals per number of samples and is used in plotting a species accumulation curve. A detailed interpretation of Mao-Tau function was presented in Mao et al. (2005). An analysis showed that for the orchard habitats bordering on abundant edge vegetation (B1, C1) on the edges themselves (B2, C2) the mean number of Syrphidae caught in one sample was the highest. On the other hand, in the orchard bordering on fields (A1) one sample yielded the lowest number of these aphytophages (Table 3).

Table 3. Mao-Tau function for orchard and shrubberies communities (A1 = Głuchowo orchard, A2 = Głuchowo field, B1 = Gorzyczki I orchard, B2 = Gorzyczki I shrubberies, C1 = Gorzyczki II orchard, C2 = Gorzyczki II road)

Habitats	Mao -Tau	95% CI Lower Bound	95% CI Upper Bound	Standard Deviation
A1	17.5	12.56	22.44	2.52
A2	23.4	18.08	28.72	2.71
B1	27.35	21.83	32.87	2.81
B2	30.33	24.66	36.01	2.9
C1	32.83	26.93	38.73	3.01
C2	35	28.79	41.21	3.17

Syrphidae communities inhabiting apple orchards and their edges were compared in quantity and quality terms using order grouping with the cluster method (Figure 4). The caught Syrphidae were proved to create 2 groups of communities similar in quantity and quality structures. The following communities were similar: the communities of the apple orchard in Głuchowo (A1) and apple orchard in Gorzyczkach II (C1) as well as the community caught in the field (A2); the community of apple orchard in Gorzyczki I (B1) and that of the road lined with trees and shrubberies (C2).

Figure 4. Cluster analysis of habitats with group single 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). High quality figures are available online.

The Syrphidae community found in shrubberies (B2) definitely differed from other communities in its quality and quantity structure.

The analysis of the similarities in quantity and quality structures of Syrphidae communities found in particular habitats was completed with comparing their structures with principal components analysis method (Figure 5). The method allows to analyze the abundances of particular species. The results corroborated the similarity of the same communities as determined with the cluster method and a separate character of the community occurring in the shrubberies (B2). They also confirmed that the species *Episyrphus balteatus* (S5) and *Eupeodes corollae* (S6) were very abundant in comparison with others and at the same time they differed in abundance between each other.

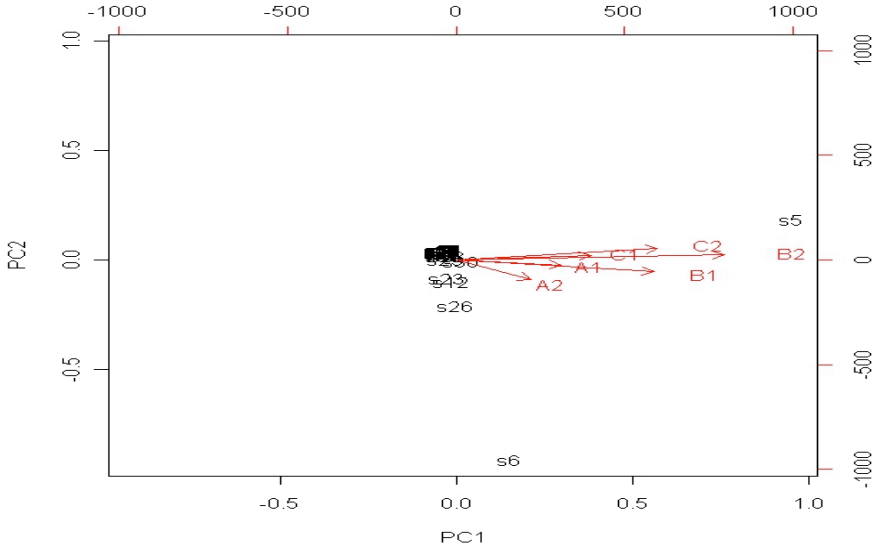

Figure 5. Plot of principal components analysis of habitats and species (A1 = Głuchowo orchard, A2 = Głuchowo field, B1 = Gorzyczki I orchard, B2 = Gorzyczki I shrubberies, C1 = Gorzyczki II orchard, C2 = Gorzyczki II road; the numbers denote the number of species as in Table 1). High quality figures are available online.

Discussion

The research conducted between the years 2008 and 2010 in orchard habitats near Czempiń clearly proved that in the apple orchards and on their edges which were made up of abundant in species and well-developed vegetation in the form of shrubberies and the road lined with trees and bushes, a high diversity of predatory Syrphidae species was found as well as their higher abundance than in orchard habitats composed of the orchards and neighbouring fields. The results confirmed a positive influence of wild vegetation in the vicinity of orchards onto their species richness and the increase of the abundance of predatory Syrphidae, as the research of aphytophages including Syrphidae, conducted by Wyss (1995) and Rossi et al. (2006) in apple orchards of Switzerland and Italy, proved such a relationship. Also earlier research by Trzciński & Piekarska-Boniecka (2009) concerning the occurrence of *Episyrphus balteatus* in apple orchards in the vicinity of Poznań indicated a positive impact of shrubberies near the orchard on the abundance of the species.

The results also showed that abundant vegetation of orchard edges constituted a more attractive habitat for predatory Syrphidae than the apple orchard biocenosis. This could have been caused by the influence of blooming flowers attracting the imagines of Syrphidae. Branquat & Hemptinne (2000), Ambrosino et al. (2006) and Kelm et al. (2009) indicated that it was the plant species of Apiaceae, Asteraceae, Lamiaceae, Ranunculaceae and Rosaceae which effectively attracted Syrphidae.

The research showed a definite dominance of *Episyrphus balteatus* and *Eupeodes corollae* (F.) in all the apple orchards and on their edges, thus it corroborated a high abundance of these species in the orchard habitat, as they had been previously indicated as dominant in this habitat by Wnuk (1972), Solomon et al. (2000), Miňarro & Dapena (2001), Rossi et al. (2006) and Trzciński & Piekarska-Boniecka (2009). The dominance of these species in all the orchards and on their edges indicates their migration between neighbouring biocenoses, which results in the controlling of the abundance of orchard-infesting aphids. *E. balteatus* is considered a very effective predator of *Aphis pomi* Deg., *Dysaphis devecta* (Walker) and *D. plantaginea* (Pass) and other species of aphids infesting fruit trees and bushes (Wnuk, 1972, 1977, 1979; Wyss, 1999; Wyss et al., 1999; Trandafirescus et al., 2004; Miňarro & Dapena, 2001). The migration of Syrphidae species between the orchard and edge vegetation is also supported by the fact that those communities in their majority showed a high similarity in species composition.

The research helped to establish that only the Syrphidae community inhabiting shrubberies definitely differed in its quality and quantity structure from those inhabiting the remaining habitats. The most Syrphidae species were caught there and the highest abundances were reported.

To sum up, the occurrence of well-developed and diversified vegetation of apple orchard edges positively influences the species richness and abundance of predatory Syrphidae occurring in orchards. Thus it helps to a natural control of the aphids infesting those orchards. Rich vegetation of orchard edges is a vital element of ecological structure, which should be used in designing orchards.

Acknowledgments

The authors thank the Editor-in-Chief and the anonymous referees for their invaluable comments and suggestions which helped improve this manuscript.

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