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DIPTEROFAUNA WITH PARTICULAR CONSIDERATION OF PREDACIOUS *SYRPHIDAE* ON CULTIVATION FIELD ADJOINING AFFORESTATION

ALEKSANDRA GRABARKIEWICZ

INSTITUTE OF PLANT PROTECTION, DEPARTMENT OF ECOLOGY
AND AGRICULTURAL ENVIRONMENT PROTECTION,
MICZURINA 20, 60-318 POZNAŃ, POLAND
e-mail: a.grabarkiewicz@ior.poznan.pl

Abstract. Studies carried out for many years in the experimental field in Winna Góra refer to the biocenotic regulation of aphids in agricultural cultivations by aphidophagous *Diptera* of *Syrphidae*. Experiments were carried out in conditions of an agricultural lanscape differentiated by the presence of field afforestation.

Key words: field afforestation, agricultural landscape, *Diptera, Syrphidae,* aphidophagous larvae, pradator – to – victim proportion

I. INTRODUCTION

Field afforestations enrich the impoverished agricultural landscape and they create favourable life conditions for numerous invertebrate and vertebrate animals (Węgorek and Grabarkiewicz 1996).

In order to define the distribution of some taxonomic groups in the agricultural landscape, attempts were made to classify the environment according to the faunistic resources (Karg 1989). A typology of environments creating the agricultural landscape in the aspect of its density and biomass was carried out also the imagines of *Diptera* (Dąbrowska-Prot 1986) and for their larvae in the soil (Nabiałczyk-Karg 1980; Karg 1985; Peplińska 1982). Aphidophagous species of *Diptera* from the *Syrphidae* family, being important from plant protection point of view, have become objects of interest in Poland since the 1970-ies.

In 1986, in the Experimental Department of the IPP in Winna Góra, studies were undertaken on *Diptera* occuring on an cultivation field adjacent to field afforestation. The investigations carried out during six vegetation seasons, aimed to define the role of aphidophagous *Syrphidae (Diptera)* in the selected agrocenosis, in connection with the influence exerted on their presence by the afforestation.

II. MATERIAL AND METHODS

The studies were carried out on a 3,5 ha field in Winna Góra. This field adjoins along 120 m a field afforestation resembling a forest cluster 200 m wide and 350 m long (Fig.1). The most important species of trees and shrubs of this afforestation are shown in Table 1, and the plants grown in the years 1986-1991 are listed in Table 2.

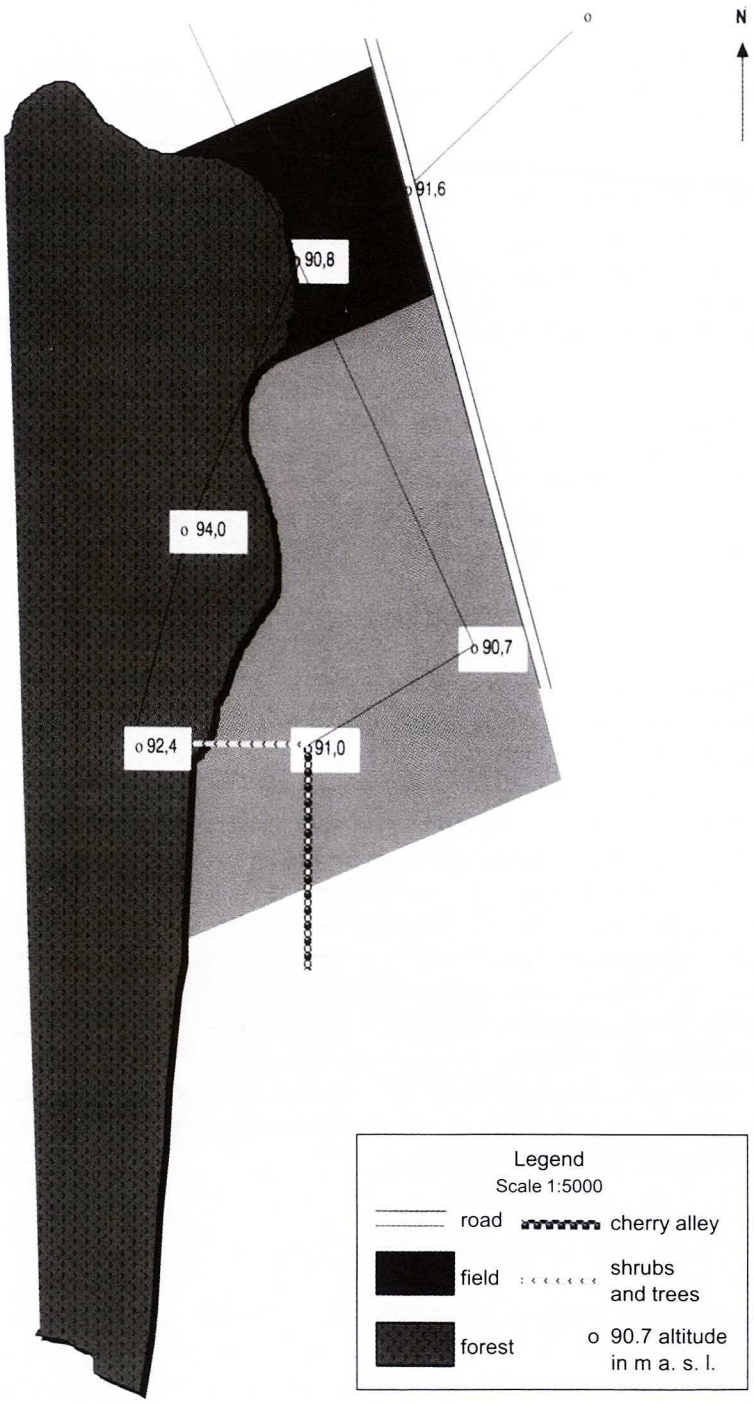

Fig. 1. Site plan of the experimental area in Winna Góra

Table 1

Species of trees and shrubs of the field afforestation in Winna Góra

No.	Trees	%	Shrubs	%
1.	Common maple (*Acer plantanoides* L.)	22	Bird-cherry (*Padus vulgaris* Borkh.)	16
2.	False acacia (*Robinia pseudoacacia* L.)	17	Elder (*Sambucus nigra* L.)	14
3.	Common pine (*Pinus silvestris* L.)	5	European spindle tree (*Evonymus europaea* L.)	6
4.	Spruce (*Picea excelsa* Link.)	4	Barberry shrub (*Berberis vulgaris* L.)	5
5.	Common birch (*Betula verrucosa* Ehrh.)	4	Guelder rose (*Viburnum opulus* L.)	4
6.	European ash (*Fraxinus excelsior* L.)	3		

The climate of Winna Góra is characterized by comparatively mild winters and not abundant rainfalls. The mean annual day temperatures (during the last 10 years) ranged between 7.7°C and 10.6°C, and the sum of rainfalls was between 388 mm and 484 mm.

The experimental field was divided into 1-meter wide belts lying parallelly to the afforestation in distances being the multiplicity of the average altitude of the field equalling 15 m and marked by the symbol h. The wall of the forest was marked with symbol 0 h. The experimental variants were grown in the following distances from the forest: 1 h = 15 m, 2 h = 30 m, 4 h = 60 m, 8 h = 120 m, 16 h = 240 m, 20 h = 300 m (Fig. 2).

In spring and in autumn 1987, litter with a 10 cm deep humus layer was sampled from eight 25 × 25 cm sampling surfaces in two replications (16 samples) localities were chosen on the so called forest wall (0 h), and 2 m deep into the afforestation parallelly to the forest wall line (every 60 m). The zooedaphon was checked under a binocular and the *Diptera* families were identified. Among 1,712 *Diptera,* there were 1,088 wintering *Syrphidae.*

Table 2

Plants grown in the experimental field

Year	Plant	Cultivar	Sowing date	Harvest date
1986	Maize	KBDC	Apr. 29	end of Aug.
1987	Spring barley (mix)	Aramit, Gryt, Tryumph	Apr. 17	Aug. 22
1988	Winter rape	POH 285	Aug. 28 1987	July 13
1989	Winter wheat	Begra	after Sept. 15 1988	Aug. 10
1990	Field pea with pea – sown in main crop	Fidello	Apr. 15	June 5 – 20
	Horse bean with maize, sunflower and pea – sown in secondary crop	Nadwiślański	June 22	end of Aug.
1991	Winter wheat	Lanca	Oct. 4 1990	Aug. 7

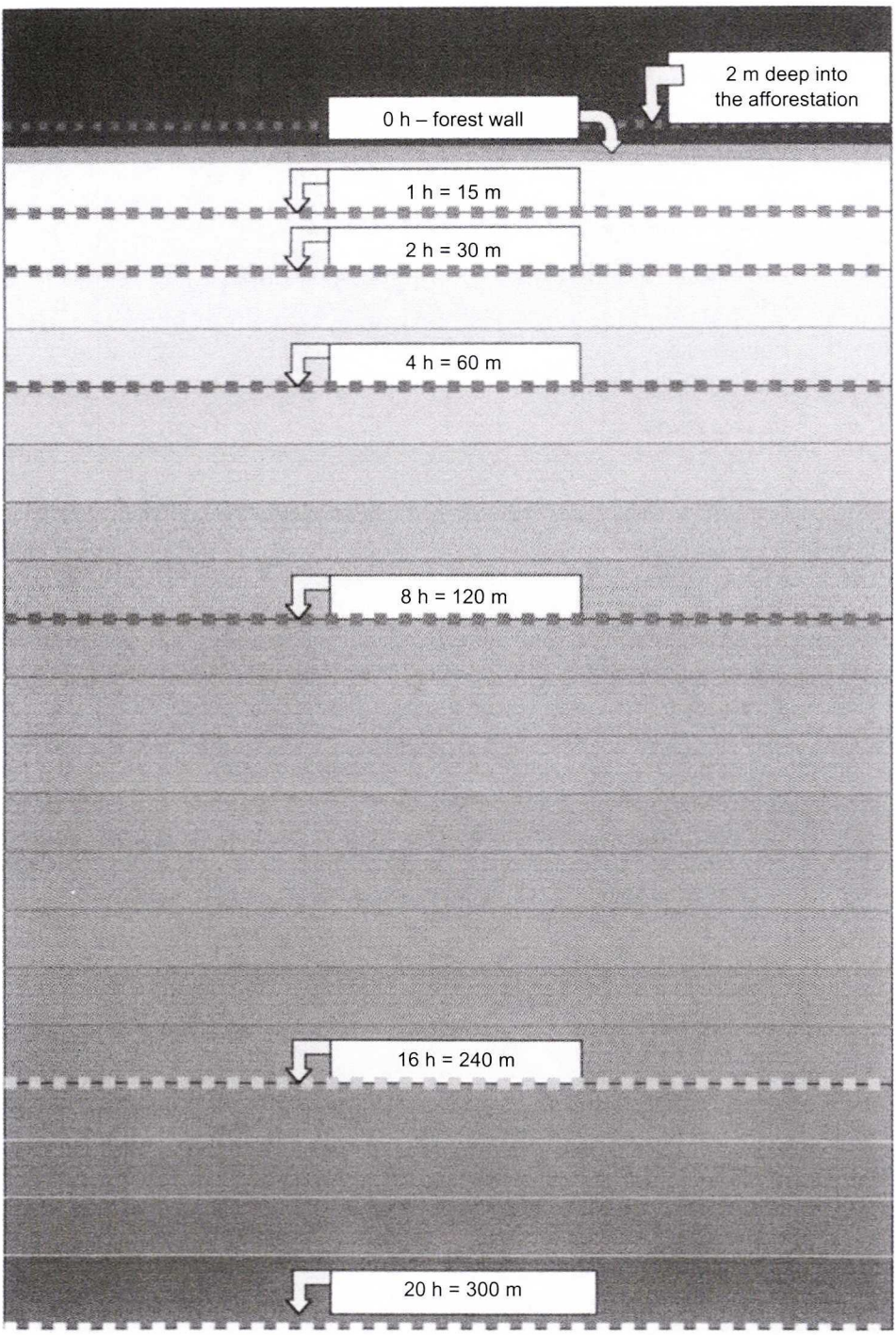

Fig. 2. Scheme of the experimental field

In the field, the entomofauna was caught with a regular entomological net. One sample included 100 ladlings with the net (4 × 25 ladlings). The net samples were taken in the years 1986-1991 in the vegetation periods on each experimental belt (0 h, 1 h, 2 h, 4 h, 8 h, 16 h, 20 h) in 7-10 day intervals, before noon. The *Diptera* collected by the neting method were selected from the total mass of the caught insects, they were kept dry, and then they were identified. The total number of caught *Diptera* was 5,689 individuals including 3,995 *Syrphidae*. The percentage of each taxon was determined in reference to the total collected material. The Peus' scale was used to determine the domination of taxons (Kowalczyk 1972). For the identification of the collected entomofauna, the keys of the following authors were applied: Plavilshtshikov (1972), Bańkowska (1963), Trojan (1957), Sack (1932) and Lindner (1930). The nomenclature of *Diptera* was accepted after Razowski (1991). In order to compare the number of *Syrphidae*, in the three years of studies (1987-1989), in different distance from the forest, an analysis of variance was carried out and the Tukey's multiple test was used at $\alpha = 0.05$. The Shannon-Weaver coefficient of species diversity /H'/ and the Berger-Parker domination index /D/ of the observed *Syrphidae* species were determined for all distances from the afforestation.

Observations of aphidophagous *Syrphidae* larvae were carried out in the vegetation seasons 1987-1991. On each experimental belt, from 1 h to 20 h, ten plants were randomly chosen and aphids and *Syrphidae* larvae were counted on them. Three observation terms (in every decade) were determined for each cultivation in the period of the greatest endargenment by aphids. The presented numbers of aphids and *Syrphidae* larvae were calculated per one plant.

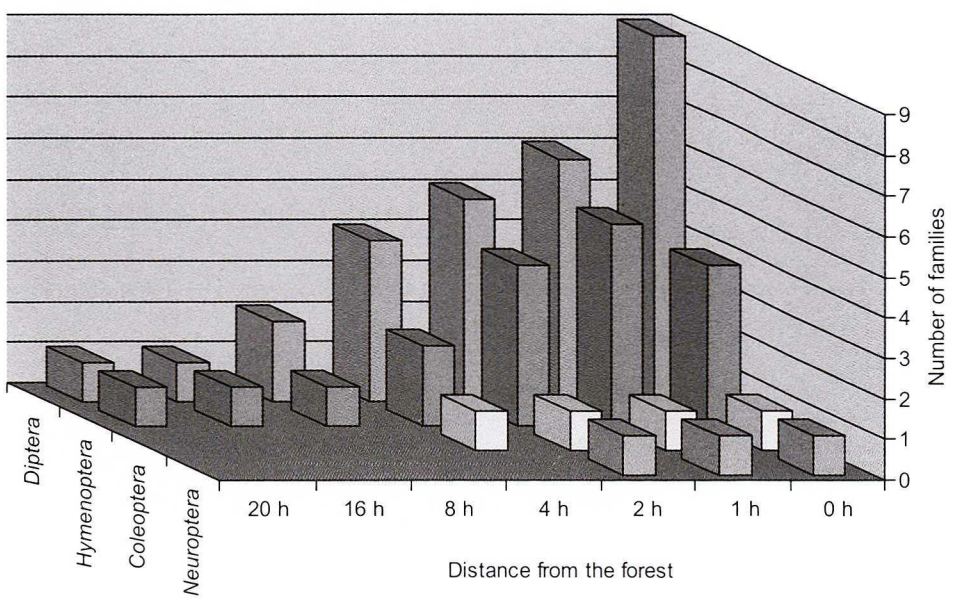

Fig. 3. Influence of forest on entomofauna

In the examination of the aphidophagous *Syrphidae* larvae, the analysis of variance for a three – factor experiment was applied with the use of Tukey's multiple test at $\alpha = 0.05$. Three observation terms, six distances from the forest (1 h, 2 h, 4 h, 8 h, 16 h and 20 h), and six cultivated plants: spring barley, winter rape, winter wheat, pea with field pea, horse bean and again winter wheat were take into consideration. The ratio of predacious *Syrphidae* larvae to aphids was analysed.

III. RESULTS

1. Zooedaphon

The zooedaphon was most numerously represented by *Diptera* and 7 families of them were identified: *Syrphidae, Fungivoridae, Asilidae, Empididae, Therevidae, Tipulidae, Bibionidae* (Tab. 3).

Table 3

***Diptera* families occurring in the edaphon of field afforestation (1987)**

Peus' scale	Dominants > 5.0%		Subdominants 2.1 – 5.0%		Accessory < 2.1%	
	No	%	No	%	No	%
Spring (March, April)						
0 h	*Syrphidae* 432	90%	*Fungivoridae* 16	3.3%	–	
	Empididae 32	6.7%	–		–	
2 m deep into the afforestation	*Fungivoridae* 288	90%	*Therevidae* 16	5%	–	
	–		*Tipulidae* 16	5%	–	
Autumn (September, October)						
0 h	*Syrphidae* 656	85.4%	–		*Empididae* 16	2,0%
	Asilidae 96	12.6%	–		–	
2 m deep into the afforestation	*Asilidae* 96	66.7%	–		–	
	Fungivoridae 32	22.2%	–		–	
	Bibionidae 16	11.1%	–		–	

No. – Number of individuals /m²

In the group of dominants, in spring and in autumn, *Syrphidae* participated in 85.4 – 90%. The afforestation close to the crop represents an ideal place for the abiding and wintering for both the imagines, larvae and pupae of other soil *Diptera* as well, because the forest vegetal cover and the undergrowth are favourable for the rich and moist litter. In the zooedaphon, the following predacious *Diptera* were distinguished: *Asilidae, Empididae* and *Therevidae*.

2. Flying insects

In 1986, in experimental field, a general assessment of the qualitative and quantitative relations of the flying entomofauna was carried out. In the analysis of the caught insects, four orders were taken into consideration: *Diptera, Hymenoptera, Coleoptera* and *Neuroptera. Diptera* were the dominating ones (Fig. 3). The greatest number of families (from the total number of 15) from four orders of insects reaching 94% was identified on the forest wall (0 h) and in the belts 1 h (15 m) through 4 h (60 m).

3. *Diptera*

In the years 1987-1989, among nine identified *Diptera* families, *Syrphidae* family was the most numerously represented one (Tab. 4).

Table 4

Number and percent participation of *Diptera* families identified in the years 1987-1989

Family	Number of individuals			Total number	Percentage (%)
	years				
	1987	1988	1989		
Syrphidae	304	2003	688	2995	64.1
Muscidae	195	397	212	804	17.2
Conopidae	134	216	31	381	8.1
Tachinidae	53	172	23	248	5.3
Empididae	36	88	4	128	2.7
Therevidae	22	62	0	84	1.8
Tabanidae	–	–	21	21	0.4
Asilidae	–	–	10	10	0.2
Dolichopodidae	–	–	9	9	0.2
Total	744	2938	998	4680	100.0

Totally, 4,680 *Diptera* were collected including 2,995 *Syrphidae,* i. e. 64.1%. Insects from the remaining families participated in a much lesser degree – from 17.2% *(Muscidae)* to 0.2% *(Dolichopodidae).* On barley, 304 *Syrphidae* was caught, on rape, there were 2,003 individuals, and on wheat, 688 were found. Winter rape, due to its abundant and early blooming with yellow flowers, lured more *Syrphidae* which in their adult form feed on nectar and pollen.

Table 5

Number and percent participation of *Diptera* families occurring in the particular experimental belts in the years 1987, 1988 and 1989

Families		Experimental variants																				
		0 h			1 h			2 h			4 h			8 h			16 h			20 h		
		'87	'88	'89	'87	'88	'89	'87	'88	'89	'87	'88	'89	'87	'88	'89	'87	'88	'89	'87	'88	'89
Syrphidae	number	–	–	–	204	1332	464	63	401	135	12	87	30	23	171	55	–	–	–	2	12	4
	%	–	–	–	27.4	45.3	46.5	8.5	13.7	13.6	1.6	3.0	3.0	3.1	5.8	5.5	–	–	–	0.3	0.4	0.4
Muscidae	number	–	–	–	–	–	–	–	–	–	74	151	81	49	99	53	72	147	78	–	–	
	%	–	–	–	–	–	–	–	–	–	9.9	5.1	8.1	6.6	3.4	5.3	9.7	5.0	7.8	–	–	–
Conopidae	number	–	–	–	107	166	30	–	–	–	–	–	–	–	–	–	27	50	1	–	–	–
	%	–	–	–	14.4	5.7	3.0	–	–	–	–	–	–	–	–	–	3.6	1.7	0.1	–	–	–
Tachinidae	number	43	139	19	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10	33	4
	%	5.8	4.7	1.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.3	1.1	0.4
Empididae	number	29	68	2	–	–	–	7	20	2	–	–	–	–	–	–	–	–	–	–	–	–
	%	3.9	2.3	0.2	–	–	–	0.9	0.7	0.2	–	–	–	–	–	–	–	–	–	–	–	–
Therevidae	number	–	–	–	–	–	–	22	62	–	–	–	–	–	–	–	–	–	–	–	–	–
	%	–	–	–	–	–	–	3.0	2.1	–	–	–	–	–	–	–	–	–	–	–	–	–
Tabanidae	number	–	–	21	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	%	–	–	2.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Asilidae	number	–	–	–	–	–	–	–	–	10	–	–	–	–	–	–	–	–	–	–	–	–
	%	–	–	–	–	–	–	–	–	1.0	–	–	–	–	–	–	–	–	–	–	–	–
Dolichopodidae	number	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9	–	–	–	–	–	–
	%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.9	–	–	–	–	–	–

Note: in the years { 1987 – 100% = 744 pcs; 1988 – 100% = 2,938 pcs; 1989 – 100% = 998 pcs }

The statistical analysis with the application of Tukey's test indicated that the number of *Syrphidae* in the three years of observation (1987, 1988, 1989) on the investigated distances from the forest (Tab. 5) was significantly (at $\alpha = 0.05$) differenciated. The *Syrphidae* occurred the most frequently in the distance of 15 m (1 h) from the afforestation. A significantly lower number of adult insects was found in the distance of 30 m from the forest (2 h). On the belts: 0 h, 4 h and 8 h, the number of insects was lower than on the 2 h belt. In the distance of 240 m (16 h), no individuals *Syrphidae* were found, and in the belt of 20 h (300 m away from the forest), the least significant number of individuals was present in comparison with the number of *Syrphidae* on all distances.

Table 6

***Diptera* families separated from the faunistic material collected in the years 1987-1989 and grouped according to Peus' scale**

Peus' scale / Experimental variant	Dominants (D) > 5.0%	Subdominants (S) 2.1-5.0%	Accesory (A) <2.1%
0 h	–	*Tachinidae* 4.3%	*Tabanidae* 0.4%
	–	*Empididae* 2.1%	
1 h	*Syrphidae* 42.7%	–	*Empididae* 0.6%
	Conopidae 6.5%	–	
2 h	*Syrphidae* 12.8%	–	*Therevidae* 1.8%
			Asilidae 0.2%
4 h	*Muscidae* 6.5%	*Syrphidae* 2.8%	–
8 h	*Syrphidae* 5.3%	*Muscidae* 4.3%	*Dolichopodidae* 0.2%
16 h	*Muscidae* 6.4%	–	*Conopidae* 1.7%
20 h	–	–	*Tachinidae* 1.0%
	–	–	*Syrphidae* 0.4%

Table 6 shows, according to Peus' scale, a comparison of *Diptera* collected from the successive belts of the experimental field. In the group of dominants, the *Syrphidae* reached the highest dominance level in the 1 h belt (42.7%). The *Syrphidae* occurred as subdominants in belt 4 h (2,8%), and in belt 20 h, they were found as accesory species (0,4%).

4. *Syrphidae*

In the years 1989-1991, subject of detailed analysis was the influence of afforestation on the occurrence of the particular species of *Syrphidae*. In each one of the years, eight species of *Syrphidae* were caught.

The number and percentage of *Syrphidae* in the investigated years are shown in Table 7. Four species occurred as the most frequent ones: *Episyrphus balteatus* (Deg.) /641/, *Syrphus ribesii* (L.) /358/, *Metasyrphus corollae* (Fabr.) /319/ and *Syrphus vitripennis* (Meig.) /188/. Less numerous were: *Scaeva selenitica* (Meig.) /75/ and *Neocnemodon vitripennis* (Meig.) /58/. The least numerous were the species: *Heringia heringii* (Zett.) /33/ and *Platycheirus scutatus* (Meig.) /16/.

Table 7

Number and percent participation of *Syrphidae* species caught in the experimental fields in the years 1989-1991

Species	Number and percentage of individuals			Total number	Percentage
	years				
	1989	1990	1991		
Episyrphus balteatus (Deg.)	289 (42.0)	220 (36.6)	132 (33.1)	641	38.0
Syrphus ribesii (L.)	131 (19.0)	138 (23.0)	89 (22.3)	358	21.2
Metasyrphus corollae (Fabr.)	117 (17.0)	118 (19.6)	84 (21.0)	319	18.9
Syrphus vitripennis (Meig.)	69 (10.1)	68 (11.3)	51 (12.8)	188	11.2
Scaeva selenitica (Meig.)	34 (4.9)	23 (3.8)	18 (4.5)	75	4.4
Neocnemodon vitripennis (Meig.)	27 (3.9)	17 (2.9)	14 (3.5)	58	3.4
Heringia heringii (Zett.)	14 (2.0)	11 (1.8)	8 (2.0)	33	2.0
Platycheirus scutatus (Meig.)	7 (1.1)	6 (1.0)	3 (0.8)	16	0.9
Total	688 (100.0)	601 (100.0)	399 (100.0)	1,688	100.0

In each belt (0 h, 1 h, 2 h, 4 h, 8 h, 16 h and 20 h) – (Tab. 8) – the occurrence of three different species was found. The values of S – W coefficient (H') and the value of the domination index (D) were found for each belt. The maximal value of the H'^{max} coefficient for seven compared belts was H' = 1,585. When we compare the H' and D values, we can see that at the distances of 0 h and 1 h, the S-W coefficient is low and the dominance index is high indicating a high differentiation in the number of the identified species and a dominational species structure. On the forest wall (0 h), there dominated *Syrphus ribesii* (L.), and in the belt 15 m away from the forest (1 h), *Episyrphus balteatus* (Deg.) was the dominant.

On the successive belts 2 h, 4 h and 8 h, the number of the species was increasingly more equalized. On belt 8 h the H' value was approximately equal to H' max. On the further distances, 16 h and 20 h, the occuring species were not numerous.

Table 9 compares, according to Peus' scale, the species collected from the experimental field in the particular belts. In the group of dominants on belts 0 h – 2 h, there occurred the following species: *Episyrphus balteatus* (Deg.) (29,4 %), *Syrphus ribesii* (L.) (17,3%), *Metasyrphus corollae* (Fabr.) (14,5%) and, on belt 16 h, *Syrphus vitripennis* (Meig.) (11,1%) was found. The above mentioned species, except for the latter one, occurred also as subdominants and accessory species on the remaining distances from the forest.

5. Dependence between the predator and the victim

During the successive vegetation seasons, aphidophagous *Syrphidae* larvae were observed from the aspect of predator / victim relation (Tab. 10).

Table 8

Number and percent participation of species from *Syrphidae* family caught in the experimental belts in the years 1989, 1990 and 1991

Species		Experimental variants																				
		0 h			1 h			2 h			4 h			8 h			16 h			20 h		
		'87	'88	'89	'87	'88	'89	'87	'88	'89	'87	'88	'89	'87	'88	'89	'87	'88	'89	'87	'88	'89
Episyrphus balteatus (Deg.)	number	16	14	9	215	173	108	11	8	4	45	24	10	–	–	–	–	–	–	2	1	1
	%	2.4	2.3	2.3	31.2	28.7	27.1	1.6	1.3	1.1	6.5	4.0	2.6	–	–	–	–	–	–	0.3	0.2	0.2
Syrphus ribesii (L.)	number	107	112	73	–	–	–	–	–	–	–	–	–	7	10	6	9	9	6	8	7	4
	%	15.6	18.6	18.3	–	–	–	–	–	–	–	–	–	1.0	1.7	1.4	1.3	1.5	1.4	1.1	1.2	1.1
Metasyrphus corollae (Fabr.)	number	–	–	–	21	24	15	92	90	63	–	–	–	4	4	6	–	–	–	–	–	–
	%	–	–	–	3.1	4.0	3.8	13.3	15.0	15.6	–	–	–	0.6	0.7	1.6	–	–	–	–	–	–
Syrphus vitripennis (Meig.)	number	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	69	68	51	–	–	–
	%	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10.1	11.3	12.8	–	–	–
Scaeva selenitica (Meig.)	number	8	4	4	–	–	–	17	12	8	3	2	2	–	–	–	1	1	2	5	4	2
	%	1.2	0.7	1.0	–	–	–	2.5	2.0	2.1	0.4	0.3	0.5	–	–	–	0.1	0.2	0.4	0.8	0.7	0.5
Neocnemodon vitripennis (Meig.)	number	–	–	–	–	–	–	–	–	–	27	17	14	–	–	–	–	–	–	–	–	–
	%	–	–	–	–	–	–	–	–	–	3.9	2.8	3.5	–	–	–	–	–	–	–	–	–
Heringia heringii (Zett.)	number	–	–	–	14	11	8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	%	–	–	–	2.0	1.8	2.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Platycheirus scutatus (Meig.)	number	–	–	–	–	–	–	–	–	–	–	–	–	7	6	3	–	–	–	–	–	–
	%	–	–	–	–	–	–	–	–	–	–	–	–	1.0	1.0	0.7	–	–	–	–	–	–
S – W coefficient (H')	S – W	0.769			0.777			0.904			1.216			1.552			0.633			1.359		
Domination index	D (%)	84.1			81.2			80.3			54.9			43.4			87.0			55.9		
		0 h			1 h			2 h			4 h			8 h			16 h			20 h		

Note: in the years 1989 – 100% = 688 pcs; in the years 1990 – 100% = 601 pcs; in the years 1991 – 100% = 399 pcs

Table 9

***Syrphidae* species collected on the belts of the experimental field in the years 1989-1991 and grouped according to Peus' scale**

Distance	Dominants > 5.0%	Subdominants 2.1-5.0%	Accessory < 2.1%
0 h	*Syrphus ribesii* (L.) 17.3%	*Episyrphus balteatus* (Deg.) 2.3%	*Scaeva selenitica* (Meig.) 0.9%
1 h	*Episyrphus balteatus* (Deg.) 29.4%	*Metasyrphus corollae* (Fabr.) 3.6%	*Heringia heringii* (Zett.) 2.0%
2 h	*Metasyrphus corollae* (Fabr.) 14.5%	*Scaeva selenitica* (Meig.) 2.3%	*Episyrphus balteatus* (Deg.) 1.4%
4 h	–	*Neocnemodon vitripennis* (Meig.) 3.4% *Episyrphus balteatus* (Deg.) 4.7%	*Scaeva selenitica* (Meig.) 0.4%
8 h	–	–	*Platycheirus scutatus* (Meig.) 0.9% *Syrphus ribesii* (L.) 1.4% *Metasyrphus corollae* (Fabr.) 0.8%
16 h	*Syrphus vitripennis* (Meig.) 11.1%	–	*Scaeva selenitica* (Meig.) 0.2% *Syrphus ribesii* (L.) 1.4%
20 h	–	–	*Episyrphus balteatus* (Deg.) 0.2% *Syrphus ribesii* (L.) 1.1% *Scaeva selenitica* (Meig.) 0.7%
Total	72.3%	16.3%	11.4%

It was found that in the majority of cultivations the number of aphids (and *Syrphidae* larvae as well) decreased with the increase of the distance from the afforestation. Thus, the mutual proportions of these groups were similar within the whole field.

The statistical analysis of the relation: predator / victim indicated, however, that the proportion of the predacious *Syrphidae* larvae to the aphids differed significantly between the particular observation terms and between the cultivated plants. Usually, the proportion was the highest in the third term (it was significantly higher than in the first term), and a tendency of increase was visible (Tab. 11).

Most frequently, there occurred the following predator / victim proportion values (calculated per one individual predator): on spring barley 1 : 8; on winter wheat 1 : 17; on pea with field pea 1 : 15; on horse bean 1 : 11 and on winter wheat cultivated again 1 : 9.

Table 10

Proportion of *Syrphidae* larvae to aphids on the cultivations adjoining the afforestation

Cultivation and observation term	Distance from the afforestation (h)						
	1 h	2 h	4 h	8 h	16 h	20 h	Average
			Spring barley (1987)				
I	3:48	5:52	3:25	1:16	1:10	–	2.6:30.2
II	3:40	5:44	3:24	1:11	1:9	2:6	2.5:22.3
III	1:6	1:5	1:4	1:8	2:9	2:9	1.3:6.8
Observations were carried out in the phases of earing and blooming of barley in the period: 1.07 – 31.07							
			Winter rape (1988)				
I	3:58	4:101	2:48	2:32	2:28	1:20	2.3:47.8
II	3:107	4:138	2:62	2:51	1:40	1:16	2.2:69
III	4:82	5:92	3:52	2:43	1:31	1:12	2.7:52
Observations were carried out in the phase of loose flower buds to the formation of silique in the period: 1.06 – 30.06							
			Winter wheat (1989)				
I	4:82	3:51	2:33	2:31	4:54	2:40	2.8:48.5
II	4:78	3:50	2:34	2:28	4:51	2:38	2.8:46.5
III	3:51	2:31	1:25	1:18	1:31	1:26	1.5:30.3
Observations were carried out before and after wheat earing in the period: 10.06 – 10.07							
			Pea with field pea (1990)				
I	2:31	3:35	2:42	1:19	1:17	1:15	1.7:26.5
II	3:51	3:56	4:63	4:71	2:45	2:30	3:52.7
III	3:42	3:31	2:28	1:14	1:10	1:8	1.8:22.2
Observations were carried out before blooming. in the blooming period until the beginning of pods formation, from the moment of the first aphid colonies appearance. in the period: 1.05 – 30.05							
			Horse bean (1990)				
I	2:28	2:26	2:25	2:18	2:21	1:12	1.8:21.7
II	3:60	4:63	2:48	2:28	2:21	2:18	2.5:39.7
III	2:49	2:34	2:31	1:19	1:11	–	1.6:28.8
Observations were carried out from the beginning of bud formation to the formation of pods. in the period: 11.07 – 11.08							
			Winter wheat (1991)				
I	3:28	3:31	2:21	1:9	1:8	–	2:19.4
II	3:29	2:31	1:19	1:8	–	1:9	1.6:19.2
III	3:42	3:22	1:15	1:10	1:9	1:9	1.7:17.8
Observations were carried out in the phases of wheat earing and blooming. in the period: 20.06 – 20.07							

I, II, III – observation terms in the successive decades

Table 11

Predator to victim proportion (*Syrphidae* larvae/aphids) on different cultivations (mean values for the whole field. calculated per one *Syrphidae* larva)

Cultivations (year)	Observation term				
	I	II	III	average	most frequently
Spring barley (1987)	1:12	1:8.9	1:5.2	1:8.7	1:8
Winter rape (1988)	1:20	1:31	1:19.9	1:23.6	1:20
Winter wheat (1989)	1:17.1	1:16.4	1:21	1:18.2	1:17
Pea with field pea (1990)	1:16.1	1:17.7	1:12	1:15.3	1:15
Horse bean (1990)	1:11.9	1:15.7	1:17.8	1:15.1	1:11
Winter wheat (1991)	1:9.6	1:12.5	1:10.7	1:10.9	1:9

I, II, III – observation terms in the successive decades
Observation terms are specified in table 10.

A significantly higher proportion of larvae to aphids was found on spring barley, a slightly lower one was identified on winter wheat (in 1991). The remaining proportions were similar, but on winter wheat (in 1991), the proportion was significantly higher than on rape. An analysis of the cultivated plants, for each term separately, indicated that in the first term, there were no differences between the cultivated plants regarding the predacious larvae / aphids proportion. In the second and in the third term, this proportion on barley was significantly higher than on the four remaining cultivations.

IV. DISCUSSION AND CONCLUSIONS

The vegetation of field afforestation, also the herbaceous and wildly growing one, lures useful insects by secreting easily available nectar. Elder, guelder rose, European spindle tree and bird – cherry cause that predacious *Syrphidae* feeding on their nectar live longer, more actively and they lay more eggs (Humprey and Hawes 1999). Thereby, their role in the limiting of aphid populations increasses. Many authors, such as Ryszkowski and Karg (1991), Karg (1994) and Salveter (1998), believe that such elements as afforestations, shrubs, meadows and balks have a significant influence on the formation of faunistic agroecosystems providing a favourable refuge for wintering and development.

In the *Diptera* edaphon collected on the experimental area, *Syrphidae* belonged to the dominants. They could be seen in each forest soil sample, since for the majority of soil animals, afforestations offer better air and water conditions. Particularly, in the phenophases of spring and autumn (in the period of insect migration from and to the wintering grounds), numerous entomophagous organisms are effective bioregulators of predator populations. Their number is limited by food resources in the habitat (Górny 1975; Hammad 1961; Krause 1997). These authors state that *Diptera* larvae represent typical soil forms belonging to the most important ones from the biological point of view.

In the zone of the wide ecotone, including the area of cultivation field lying within the distance up to 60 m from the afforestation, an increased density of predacious insects was found

(Bowie and Gurr 1999). In the identified families of *Diptera* order, many of them participate in the pollination. *Syrphidae, Conopidae* play an important role as pollinators, while the role of *Tabanidae, Empididae, Dolichopodidae* and *Muscidae* is smaller in that respect. Karg and Kundzewicz (1992) stressed the role of plants in the existence process of animals, which by their life style and their physiological properties and structure adapt themselves to the feeding on definite plant groups. The pollen containing protein is necessary for adult *Syrphidae* since they feed on pollen and nectar for the production of eggs. Niemczyk (1975) ascribes to honey – yielding plants a high luring function for predacious and parasitizing insects.

In my own studies, subject of observations were all developmental stages of eight *Syrphidae* species occurring throughout the whole vegetation period of cultivated plants. These species are found in different environments: on crops, in afforestations, parks and gardens. Frequently, the species dominating in field cultivations may play a greater role in orchards and vice versa. The species composition of *Syrphidae* on different cultivated plants, on fruit trees and shrubs and on ornamental shrubs, were investigated by: Kowalska (1985), Wiech (1991), Wiąckowska and Wąckowski (1968), Malinowska (1973), Ziarkiewicz and Kozłowska (1973), Jasiołek et al. (1974), Bańkowska and Mikołajczyk (1976), Kozłowska (1978). The problem of the species composition of *Syrphidae* on similar plants as in our country was dealt with by the following authors: in Germany by Schneider (1969) and Sol (1966), Prescher and Buchs (1988); in Czechoslovakia by Bondarenko and Asiakin (1973) and in Romania by Malshi and Mustea (1997).

The species of *Syrphidae* caught in Winna Góra inhabit convergent ecological niches which overlap each other. According to Morris (1998), this convergence of ecological niches causes the interspecific competition of animals with common life needs and this brings in effect some regulation. Such regulation determined the characteristic structure of *Syrphidae* on the discussed experimental area. The afforestation introduced as a composition element of the environment decresses the biocenotically undesirable effect of monoculture and exerts a constructive effect on the organization of a relatively balanced biocenosis.

The investigators of the *Syrphidae* association on different plants (Dusek and Laska 1967; Hart and Bale 1997) believe that economically important are mainly the following species: *Episyrphus balteatus* (Deg.), *Syrphus ribesii* (L.), *Syrphus vitripennis* (Meig.) *and Platycheirus scutatus* (Meig.).

Among the *Syrphidae* species collected in Winna Góra, there dominated *Episyrphus balteatus* (Deg.). This predator occurring in an active state throughout the whole period of aphids appearance has a great potential of limiting their number. Already in 1979, Wnuk defined *Episyrphus balteatus* (Deg.) species as the most spread one all over Poland. It is found on many cultivated and wildly growing plants. The larvae of *Episyrphus balteatus* (Deg.) exterminate aphids at a predator/victim proportion ranging between 1 : 15 and 1 : 200. The best effects were obtained with a proportion 1 : 15 to 1 : 50, and in case of 1 : 100 rate, the result was good but the time of the liquidation of an aphid colony was longer. In the first days of the predacious larvae development, the food requirement is not high, therefore, a smaller proportion of the predacious larvae in relation to the aphids is more favourable (Wnuk 1979).

The observed effectivity of the aphidophagous predacity of *Syrphidae* larvae permits to believe that they belong to highly specialized predators and they play an impor-

tant role in the dynamics of aphid populations. The definition of the effectivity of the biocenotic regulation process in the trophic chain: aphids-aphidophagous *Syrphidae* was the research objective of Wnuk and Sławiński (1972). The importance of the particular *Syrphidae* species occuring in the colonies of different aphid species is variable in the particular years and in definite habitats. My own studies have confirmed that there are great difficulties in the assessment of the biocenotic role of the preadators, particularly as their nutritional spectrum extends, and because of the variability in their number of generations.

The zone in the vicinity of the afforestation showed a higher density of *Syrphidae* larvae and an increased density of *Aphididae*. Karg and Szeflińska (1996) believe that the structure of agricultural landscape, and paricularly the refuge elements included in it, such as afforestations, shrubs, meadows and balks, essentially influence the formation of fauna agroecosystems. The mentioned authors conclude that the effectivity of the biocenotic regulation processes in the trophic chain: aphids – *Syrphidae*, was significantly higher in the ecotonic zone in the cultivation than in the open field.

The afforestation together with the adjacent cultivation field in Winna Góra permit to preserve the biological balance in this part of the agricultural landscape. Freier and Triltsch (1997) state that each field afforestation creates in the agricultural landscape some conditions for the filling of the reserve ecological niches contributing to the development of additional interactions in the world of living organisms.

On the basis of the presented studies, the following conclusions can be drawn:

1. Observations of the edaphon from the afforestation area indicate a high participation of *Syrphidae* (88%) among the wintering *Diptera*
2. Among the flying fauna, being the most numerous one of *Diptera* order, the occurrence of nine families was found: *Syrphidae, Muscidae, Conopidae, Tachinidae, Tabanidae, Empididae, Therevidae, Asilidae* and *Dolichopodidae* with a distinct supremacy of *Syrphidae* (64%)
3. In the *Syrphidae* family, there occurred eight aphidophagous species: *Episyrphus balteatus* (Deg.), *Syrphus ribesii* (L.), *Metasyrphus corollae* (Fabr.), *Syrphus vitripennis* (Meig.), *Scaeva selenitica* (Meig.), *Neocnemodon vitripennis* (Meig.), *Heringia heringii* (Zett.) and *Platycheirus scutatus* (Meig.)
4. *Episyrphus balteatus* (Deg.) was the most frequent and the most numerous among the identified species. *Syrphus ribesii* (L.) was also frequently caught but in a smaller number.
5. On the area of the field, at the distance up to 120 m (0 h – 8 h), a more numerous dipterofauna with *Syrphidae* among it was observed
6. The observation of predacious *Syrphidae* larvae on barley, rape, wheat, pea with field pea and horse bean, showed that they were feeding on the following aphids: cereal aphid (*Sitobion avenae* F.), cabbage aphid (*Brevicoryne brassicae* L.), bird – cherry and cereal aphid (*Rhopalosiphum padi* L.), pea aphid (*Acyrthosiphon pisum* Harris) and European spindle tree and red beet aphid (*Aphis fabae* Scop.)
7. The number of aphids and predacious *Syrphidae* larvae usually decreases with the increasing distance from the afforestation, and the average predator/victim proportion of 1 : 15 testifies a significant efficiency of the regulation processes

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Aleksandra Grabarkiewicz

DIPTEROFAUNA ZE SZCZEGÓLNYM UWZGLĘDNIENIEM DRAPIEŻNYCH *SYRPHIDAE* NA POLU UPRAWNYM PRZYLEGŁYM DO ZADRZEWIENIA

STRESZCZENIE

W latach 1986-1991 przeprowadzono badania w RZD IOR w Winnej Górze dotyczące występowania dipterofauny, a szczególnie *Syrphidae,* na polu uprawnym przyległym do pasa leśnego.

Wśród dipterofauny lotnej wystąpiło 9 rodzin, z przewagą *Syrphidae.* W rodzinie bzygowatych (*Syrphidae*) oznaczono osiem afidofagicznych gatunków.

W największej liczebności odławiano *Episyrphus balteatus* (Deg.), a *Syrphus ribesii* (L.) równie często lecz mniej licznie. Liczniejsze występowanie *Syrphidae* obserwowano na pasach od 0 h do 8 h, czyli do 120 m od ściany lasu.

Liczebność mszyc i drapieżnych larw *Syrphidae* na uprawach spadała w miarę oddalania od zadrzewienia, przy czym średni stosunek drapieżcy do ofiary 1 : 15 świadczy o wydolności procesów regulacyjnych.