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Diversification of *Syrphidae (Diptera)* fauna in the canopy of Polish pine forests in relation to forest stand age and forest health zones

[With 6 tables and 1 figure in the text]

Abstract. Hover-flies communities in pine-forest canopies show different stucture due to the age of the forest. In young stands species diversity is greatest, these forest are settled by forms from different ecosystems. Medium stage stands exhibit less species diversity due to elimination of forms strenge to the forest ecosystems. Mature stands have hover-flies communities composed of little number of species, but thes show greatest stability.

INTRODUCTION

Syrphidae are a group of dipterans that shows diverse habitat preferences as well as alimentary requirements of the larvae. Most *Syrphidae* species dwell in forest areas, but a number have an affinity for open areas such as arable lands, meadows or pastures.

As regards their diet, the larvae of *Syrphidae* fall into three basic categories: zoophages, phytophages and saprophages, while all adult forms are mellitophagous. Quite abundant in pine forests, the dipterans play a major role in matter circulation in forest ecosystems. Most saprophagous larvae, living in litter or decayed wood, contribute significantly to breaking up and processing plant debris, thus enriching the humus layer of forest soil. Phytophagous larvae contribute to the decomposing of ground cover herbaceous plants, while predatory larvae function as specialised predators. Some species attack maggots, but most feed only on aphids. Apart from the larvae of predatory lady-birds and lacewings, these larvae play an essential role in controlling aphids, particularly in pine cultures, where they occur abundantly in aphid colonies on young shoots. The mellitophagous imagines congregate in large numbers in canopies of pines, often on honey-dew, where they are eaten by a number of other predators such as wasps or spiders.

The fieldwork was conducted simultaneously in three regions of Poland: Puszcza Białowieska, Puszcza Biała and Bory Tucholskie. A geobotanical description of the forests is contained in a paper by MATUSZKIEWICZ (1993). The specimens were caught with Moericke's pitfall traps throughout the vegetational seasons from April to late autumn, in the years 1986-1987. The study areas were situated in stands belonging to various age classes: young pine stands (15–25 years old), medium age stands (40–60 years old) and mature stands (over 80 years old). Each age class was represented by three study areas so that the total number of study areas was 27. Five Moericke's traps were installed in each study area. Specimens were collected systematically every fortnight. The material collected consists of more than 4000 *Syrphidae* imagines and as such provides a reliable basis for an analysis of the structure of syrphid communities from the canopy layer in pine forests. The paper does not cover the whole of *Syrphidae* fauna occurring in pine forests (in the herb layer and the undergrowth). It is limited to the fauna of pine canopies since very little has been known about this group so far. This was due to technical difficulties in sampling at such a height. Only after the employment of Moericke's pitfall traps has systematical quantitative sampling of insects in tree crowns been made possible. This technique was first used in a comparative research over *Syrphidae* communities in Białołęka Dworska and natural forest habitats in the Mazovia Region (BAŃKOWSKA 1982a) and in urban parks in Warsaw (BAŃKOWSKA 1982b). Research of this kind over *Syrphidae* in pine forests has not been conducted so far either in Poland or abroad.

ANALYSIS OF THE MATERIAL

100 *Syrphidae* species were registered in the three coniferous forests studied (Tab. I), accounting for about 30% of Polish *Syrphidae* fauna. The number appears to be quite high if one takes into consideration the fact that most of the species of this family occur only in mountainous areas, xerothermic plots or meadows.

Tab. I. Abundance of pine canopy Syrphids

No	Species	Puszcza Białowieska					
		Young stands		III clas.		Mature st.	
		n	%	n	%	n	%
1	2	3	4	5	6	7	8
1	*Eristalis arbustorum* L.	0.0045	0.35			0.0048	1.00
2	*Eristalis tenax* L.	0.0451	3.54	0.0035	0.66	0.0167	3.50
3	*Eristalis rupium* FABR.			0.0012	0.22	0.0012	0.25
4	*Eristalis nemorum* L.	0.0023	0.18			0.0012	0.25
5	*Eristalis horticola* DEG.	0.0023	0.18			0.0012	0.25

Puszcza Białowieska is the forest area most abundant in syrphids with 91 species recorded in pine canopies. Nearly twice less species were found in Bory Tucholskie and Puszcza Biała – 46 and 47 species respectively. Similarly, average abundance of *Syrphidae* in Puszcza Białowieska doubles the values obtained for the other two forest areas (Tab. IV).

These differences are probably due to multiple factors, one of which is the fact that Puszcza Białowieska is situated in the region least polluted with industrial dust, especially sulphur compounds. The study sites were located outside the nature reserve area, but its immediate vicinity and the existence of diversified habitats have undoubtedly affected faunal richness of the coniferous forest habitats studied, all the more so that *Syrphidae* can fly very well and cover a distance of ten or so kilometres without difficulty. Silvicultural practices, particularly the number of completed felling cycles, are yet another factor that should be mentioned. Both in Bory Tucholskie and central Poland one-crop silviculture was introduced much earlier than in the east, under Russian partition, which can also be an explanation for the reduction of species richness in the former forest areas.

The distribution of species richness and abundance also vary in relation to the age of the stand (Tab. IV). The greatest numbers of *Syrphidae* species were registered in young stands, while in older stands the number decreases substantially. Similarly, in all the three forest areas, the abundance of syrphids per sample was the greatest in samples taken in young stands. This results from both different microclimatic conditions in the three age classes (humidity, insolation) and stabilisation processes occurring in the course of forest growth and aging. An interesting fact is the presence of numerous open area species in the young stands. In the older stands such species occur only sporadically or do not occur at all.

An analysis of ecological flexibility of the *Syrphidae* species inhabiting pine canopies in stands belonging to different forest health zones has shown that the smallest percentage of eurytopic species (14%) was obtained for the coniferous

communities in the three age classes

Bory Tucholskie						Puszcza Biala					
Young stands		III clas.		Mature st.		Young stands		III clas.		Mature st.	
n	%	n	%	n	%	n	%	n	%	n	%
9	10	11	12	13	14	15	16	17	18	19	20
0.0010	0.20	0.0010	0.28			0.0011	0.18				
0.0010	0.20					0.0307	4.96			0.0011	0.61
						0.0011	0.18				
0.0030	0.59			0.0010	0.32	0.0022	0.35				
0.0010	0.20	0.0010	0.28					0.0011	0.75		

1	2	3	4	5	6	7	8
6	*Eristalis intricarius* L.						
7	*Eristalinus sepulchralis* L.	0.2052	16.11	0.0280	5.31	0.0012	0.25
8	*Myathropa florea* L.	0.0023	0.18	0.0012	0.22		
9	*Helophilus pendulus* L.	0.1725	13.54	0.0793	15.04	0.0191	4.00
10	*Helophilus hybridus* Loew	0.0023	0.18				
11	*Helophilus parallelus* Harr.	0.0068	0.53	0.0012	0.22		
12	*Helophilus affinis* Whalb.			0.0012	0.22		
13	*Helophilus.lineatus*, Fabr.	0.1139	8.94	0.0105	1.99	0.0024	0.50
14	*Parhelophilus versicolor* Fabr.	0.0056	0.44	0.0012	0.22	0.0012	0.25
15	*Helophilus lunulatus* Meig.	0.0079	0.62				
16	*Parhelophilus frutetorum* Fabr.			0.0012	0.22		
17	*Lathyrophtalmus aeneus* Scop.	0.0045	0.35	0.0012	0.22	0.0024	0.50
18	*Eumerus strigatus* Fall.					0.0024	0.50
19	*Temnostoma bombylans* Fabr.	0.0011	0.09				
20	*Temnostoma vespiforme* L.	0.0056	0.44				
21	*Temnostoma apiforme* Fabr.	0.0023	0.18				
22	*Xylota segnis* L.	0.0135	1.06				
23	*Xylota tarda* Meig.	0.0011	0.09				
24	*Chalcosyrphus piger* Fabr.	0.0124	0.97				
25	*Xylota femorata* L.	0.0023	0.18				
26	*Xylota sylvarum* L.	0.0068	0.53			0.0012	0.25
27	*Xylota abiens* Meig.	0.0068	0.53	0.0012	0.22		
28	*Xylota florum* Fabr.	0.0180	1.42	0.0047	0.88	0.0012	0.25
29	*Chalcosyrphus nemorum* Fabr.	0.0124	0.97	0.0023	0.44	0.0048	1.00
30	*Xylota ignava* Panz.	0.0011	0.09				
31	*Syritta pipiens* L.	0.0011	0.09			0.0012	0.25
32	*Lejota ruficornis* Zett.			0.0012	0.22		
33	*Triglyphus primus* Loew			0.0012	0.22		
34	*Pipizella varipes* Meig.	0.0023	0.18				
35	*Neocnemodon fulvimanus* Zett.			0.0070	1.33	0.0036	0.75
36	*Neocnemodon vitripennis* Meig.	0.0011	0.09				
37	*Pipiza quadrimaculata* Panz.			0.0058	1.11		
38	*Cheilosia pagana* Meig.			0.0012	0.22		
39	*Cheilosia ruralis* Meig.	0.0034	0.27	0.0012	0.22		
40	*Cheilosia vernalis* Fall.	0.0034	0.27	0.0023	0.44		

9	10	11	12	13	14	15	16	17	18	19	20
		0.0010	0.28	0.0010	0.32						
						0.0011	0.18				
0.1742	34.19	0.1621	45.87	0.0665	20.89	0.1840	29.73	0.0120	8.27	0.0263	14.63
				0.0010	0.32						
0.0020	0.40					0.0022	0.35			0.0011	0.61
						0.0022	0.35				
						0.0044	0.71			0.0011	0.61
0.0010	0.20	0.0010	0.28	0.0010	0.32	0.0011	0.18				
				0.0010	0.32	0.0033	0.53				
0.0020	0.40										
0.0010	0.20	0.0010	0.28			0.0011	0.18				
				0.0010	0.32	0.0022	0.35				
						0.0033	0.53				
						0.0110	1.77	0.0033	2.26	0.0022	1.22
0.0020	0.40					0.0011	0.18				
0.0010	0.20					0.0044	0.71	0.0022	1.50	0.0022	1.22
				0.0010	0.32	0.0022	0.35	0.0011	0.75		
0.0020	0.40					0.0011	0.18			0.0011	0.61

1	2	3	4	5	6	7	8
41	*Cheilosia chloris* MEIG.			0.0012	0.22		
42	*Cheilosia albitarsis* MEIG.						
43	*Cheilosia scanica* RHINGD.						
44	*Orthoneura nobilis* FALL.			0.0012	0.22		
45	*Orthoneura geniculata* MEIG.	0.0135	1.06	0.0070	1.33	0.0072	1.50
46	*Orthoneura intermedia* LUNDB.					0.0012	0.25
47	*Orthoneura frontalis* LOEW	0.0023	0.18				
48	*Orthoneura plumbago* LOEW						
49	*Chrysogaster viduata* L.	0.0654	5.13	0.0023	0.44	0.0048	1.00
50	*Paragus tibialis* FALL.						
51	*Didea intermedia* LOEW	0.0023	0.18	0.0163	3.10	0.0131	2.75
52	*Didea fasciata* MACQ.	0.0011	0.09	0.0012	0.22	0.0012	0.25
53	*Didea alneti* FALL.			0.0012	0.22	0.0012	0.25
54	*Scaeva pyrastri* L.	0.0011	0.09	0.0012	0.22	0.0060	1.25
55	*Scaeva selenitica* MEIG.	0.0090	0.71	0.0012	0.22	0.0024	0.50
56	*Dasysyrphus albostriatus* FALL.			0.0012	0.22		
57	*Dasysyrphus venustus* MEIG.	0.0271	2.12	0.0513	9.73	0.0429	9.00
58	*Syrphus torvus* O.-S.	0.0101	0.80	0.0105	1.99	0.0095	2.00
59	*Episyrphus balteatus* DEG.	0.2424	19.03	0.1690	32.08	0.2324	48.75
60	*Metasyrphus corollae* FABR.	0.1094	8.58	0.0548	10.40	0.0572	12.00
61	*Syrphus vitripennis* MEIG.	0.0011	0.09	0.0023	0.44	0.0012	0.25
62	*Syrphus ribesii* L.	0.0011	0.09	0.0082	1.55	0.0024	0.50
63	*Parasyrphus lineolus* ZETT.	0.0011	0.09				
64	*Meligramma cincta* FALL.			0.0012	0.22		
65	*Meliscaeva cinctella* ZETT.	0.0056	0.44	0.0047	0.88		
66	*Metasyrphus latifasciatus* MACQ.			0.0012	0.22		
67	*Meligramma guttata* FALL.					0.0012	0.25
68	*Melangyna compositarum* VERR.				0.00		
69	*Parasyrphus punctulatus* VERR.				0.00		
70	*Dasysyrphus tricinctus* FALL.			0.0012	0.22		
71	*Epistrophe eligans* HARR.					0.0012	0.25
72	*Melanostoma mellinum* L.	0.0192	1.50	0.0012	0.22	0.0083	1.75
73	*Melanostoma scalare* FABR.	0.0068	0.53	0.0012	0.22	0.0012	0.25
74	*Sphaerophoria scripta* L.	0.0124	0.97	0.0105	1.99	0.0048	1.00
75	*Sphaerophoria menthastri* L.	0.0135	1.06				

9	10	11	12	13	14	15	16	17	18	19	20
				0.0010	0.32						
								0.0022	1.50		
										0.0022	1.22
						0.0011	0.18				
0.0010	0.20										
						0.0033	0.53	0.0011	0.75		
								0.0011	0.75		
0.0111	2.17	0.0181	5.13	0.0302	9.49	0.0022	0.35	0.0033	2.26	0.0110	6.10
		0.0010	0.28	0.0010	0.32	0.0011	0.18	0.0011	0.75		
0.0010	0.20	0.0010	0.28			0.0110	1.77			0.0011	0.61
						0.0011	0.18				
0.1047	20.55	0.0775	21.94	0.1249	39.24	0.1051	16.99	0.0887	60.90	0.0602	33.54
0.0101	1.98	0.0060	1.71	0.0070	2.22	0.0110	1.77			0.0033	1.83
0.0937	18.38	0.0564	15.95	0.0604	18.99	0.1106	17.88	0.0088	6.02	0.0438	24.39
0.0111	2.17	0.0050	1.42	0.0030	0.95	0.0361	5.84			0.0066	3.66
0.0050	0.99	0.0010	0.28	0.0030	0.95	0.0033	0.53	0.0011	0.75	0.0033	1.83
0.0030	0.59	0.0050	1.42	0.0040	1.27	0.0099	1.59	0.0033	2.26	0.0022	1.22
				0.0010	0.32						
				0.0010	0.32	0.0011	0.18			0.0011	0.61
0.0010	0.20							0.0011	0.75		
0.0010	0.20										
				0.0010	0.32						
0.0121	2.37					0.0011	0.18	0.0022	1.50	0.0011	0.61
		0.0010	0.28								
0.0060	1.19	0.0010	0.28	0.0010	0.32						
0.0010	0.20	0.0010	0.28			0.0055	0.88	0.0055	3.76		
0.0161	3.16	0.0050	1.42	0.0030	0.95	0.0186	3.01	0.0011	0.75	0.0022	1.22
0.0232	4.55	0.0020	0.57	0.0010	0.32	0.0329	5.31	0.0022	1.50	0.0044	2.44

1	2	3	4	5	6	7	8
76	*Sphaerophoria philanthus* Meig.	0.0011	0.09				
77	*Xanthogramma citrofasciatum* Deg.	0.0011	0.09				
78	*Platycheirus albimanus* Fabr.	0.0011	0.09				
79	*Platycheirus peltatus* Meig.	0.0011	0.09				
80	*Platycheirus clypeatus* Meig.	0.0034	0.27	0.0012	0.22		
81	*Xanthandrus comtus* Harr.	0.0011	0.09			0.0012	0.25
82	*Melangyna quadrimaculata* Verr.			0.0012	0.22		
83	*Baccha elongata* Fabr.			0.0012	0.22		
84	*Baccha obscuripennis* Meig.					0.0012	0.25
85	*Neoascia dispar* Meig.					0.0012	0.25
86	*Neoascia aenea* Meig	0.0147	1.15	0.0023	0.44	0.0012	0.25
87	*Neoascia floralis* Meig.					0.0012	0.25
88	*Neoascia geniculata* Meig.			0.0070	1.33		
89	*Sphegina verecunda* Coll.						
90	*Chrysotoxum vernale* Loew	0.0023	0.18				
91	*Chrysotoxum festivum* L.	0.0011	0.09				
92	*Chrysotoxum elegans* Loew	0.0011	0.09	0.0012	0.22		
93	*Chrysotoxum arcuatum* L.						
94	*Chrysotoxum octomaculatum* Curt.			0.0012	0.22		
95	*Brachyopa panzeri* Goffe	0.0214	1.68				
96	*Brachyopa scutellaris* Rob.-Desv.					0.0024	0.50
97	*Microdon devius* L.	0.0011	0.09			0.0012	0.25
98	*Blera fallax* L.	0.0011	0.09				
99	*Sericomyia lappona* L.	0.0034	0.27	0.0023	0.44	0.0012	0.25
100	*Sericomyia silentis* Harr.	0.0045	0.35	0.0012	0.22	0.0012	0.25
Total		1.2740	100.00	0.5268	100.00	0.4768	100.00

forests of Puszcza Białowieska, while in the other two regions such species constituted more than 25% of a community (Tab. III). The proportion of polytopic species is similar in the three areas, while oligotopic species are the most frequent in Puszcza Białowieska, a little less frequent in Bory Tucholskie and the least frequent in Puszcza Biała – 27.7%. Stenotopic species were not identified. Such structural organization reflects the degree of biocenosis transformation in the three regions studied and proves the unique properties of Puszcza Białowieska.

9	10	11	12	13	14	15	16	17	18	19	20
0.0020	0.40										
		0.0010	0.28					0.0022	1.50		
										0.0022	1.22
0.0010	0.20			0.0010	0.32						
								0.0011	0.75		
0.0010	0.20										
						0.0022	0.35				
0.0020	0.40										
						0.0011	0.18				
0.0010	0.20										
						0.0011	0.18				
0.0101	1.98	0.0040	1.14	0.0010	0.32						
0.5096	100.00	0.3535	100.00	0.3182	100.00	0.6188	100.00	0.1457	100.00	0.1796	100.00

Similar conclusions have been obtained from an analysis of ecological activity of the various *Syrphidae* species. In Puszcza Białowieska the share of expansive species (most of which are eurytopic and often hemisysantrophic) is the lowest (16.5%), while in the other regions it exceeds 25%. On the other hand, the share of recessive (endangered) species is the highest in Puszcza Białowieska (39.5%), whereas in Puszcza Biała and Bory Tucholskie it never exceeds 28.4%.

Table II. Proportions of trophic groups in Syrphids communities inhabiting pine canopies in three regions of Poland. N - number of species

Trophic type	Puszcza Białowieska		Bory Tucholskie		Puszcza Biała	
	N	%	N	%	N	%
Zoophagous	41	45.0	24	52.4	24	51.0
Fitophagous	5	5.5	4	8.6	6	12.8
Xylophagous	12	13.2	4	8.6	3	6.4
Saprophagous	33	36.3	14	30.4	14	29.8
Total	91	100	46	100	47	100

Table III. Proportions of ecological elements in pine canopy Syrphids communities in three regions of Poland

Ecological elements	Puszcza Białowieska		Bory Tucholskie		Puszcza Biała	
	N	%	N	%	N	%
Ecological amplitude, Eurytopic	13	14.3	12	26.0	12	25.5
Polytopic	38	41.7	17	37.0	22	46.8
Oligotopic	40	44.0	17	37.0	13	27.7
Activity, Expansive	15	16.5	12	26.0	13	27.6
Stable	40	44.0	21	45.6	22	46.8
Recessive	36	39.5	13	28.4	12	25.6

Table IV. Mean abundance of pine canopy Syrphids in pine forests of three regions of Poland and in different age classes of the forest stand, N - the number of species. n - number of individuals per sample

Plot	Young stands		Medium age stands		Mature stands		Total	
	N	n	N	n	N	n	N	n
Puszcza Białowieska	64	1.274	53	0.527	44	0.477	91	0.759
Bory Tucholskie	34	0.509	22	0.353	25	0.318	46	0.394
Puszcza Biała	39	0.619	21	0146	21	0.179	47	0.315
Total	79	0.800	62	0.342	59	0.325	100	0.489

As has been mentioned in the Introduction, all imagines of the family *Syrphidae* are mellitophagous and feed on pollen and nectar and frequently on honey-dew: hence their presence in the tree canopy layer, including pines. Abundant in this layer are species whose larvae are saprophages and complete their entire development cycle in litter, decaying wood, animal waste or water habitat. However, the greatest share among pine canopy *Syrphidae* communities is that of predatory species (Tab. II), whose larvae feed mostly on aphids. These species not only find aphid food for their predatory larvae on shoots of pine, but they can also feed there as imagines on enormous quantities of honey-dew produced by aphids in tree crowns.

The lowest shares in pine forest syrphid communities were registered for those *Syrphidae* species whose larvae are phytophagous and mine leaves and stems of herbaceous plants in the forest floor. A comparative analysis of pine canopy *Syrphidae* communities from the three forest areas studied has revealed great similarities in the proportions of trophic groups. One should, however, pay attention to an increased share of saprophagous species, especially xylophages, in Puszcza Białowieska in comparison to the other areas.

The proportions of phagous groups are also similar in *Syrphidae* communities inhabiting stands belonging to different age classes. The only considerable difference is a double rise of the phytophages' share in mature stands. It is probably due to insolation of the forest floor in mature stands that promotes the development of herbage thus supporting the dipterans that mine it. On the other hand, the share of saprophagous species, especially xylophages, is lower in mature stands. The high proportion of xylophages in young stands is probably connected with the practice of leaving old trees' rootstocks after clear-cutting and planting the area with a new forest. The rootstocks decay over a long period of time fertilizing the ground.

An analysis of the structure of dominance in the *Syrphidae* communities studied has revealed the occurrence of three co-dominant species. Two of them: *Episyrphus balteatus* and *Dasysyrphus venustus* are predators, while the third one – *Helophilus pendulus* – is a saprophage (Tab. V). All the three species are quite closely associated with forest habitats, *D. venustus* being a species typical of coniferous forest associations (BAŃKOWSKA 1980). This species belongs to the group of predators that produce one generation of offspring a year, while *E. balteatus* may have a couple within the season depending on climatic conditions and food availability. The abundance of *E. balteatus* remains at approximately the same level throughout the season, though it may rise in the second half of summer, while *D. venustus* is abundant only in spring until the end of June. The larvae of *Helophilus pendulus* develop in wet, often swampy, habitats and the imagines forage in tree crowns. One should also pay attention to the small proportion of the hemisynanthropic *Eristalis tenax* in the forests studied. Two more saprophagous species are also quite abundant in Puszcza Białowieska. They develop in water basins or in turfy soil and thus are not directly connected with the pine forest habitat. They probably fly there from adjacent wet grounds.

Table V. The structure of dominance of pine canopy Syrphids communities in three forest health zones (in per cent)

Species	Puszcza Białowieska	Bory Tucholskie	Puszcza Biała
Episyrphus balteatus	33.2	17.7	16.0
Dasysyrphus venustus	6.9	27.2	37.1
Metasyrphus corollae	10.3	0.2	3.1
Helophilus pendulus	10.8	33.6	17.5
Helophilus lineatus	3.8		
Eristalis tenax	2.6	0.1	1.8
Eristalinus sepulchralis	7.2		

Table VI presents the structure of dominance in the pine canopy syrphid communities from stands situated in the three age classes. The proportions of two co-dominant predatory species *E. balteatus* and *D. venustus* rise clearly as the stand grows older and reach the highest values in mature stands. On the other hand, the share of the saprophagous *H. pendulus* is twice as low in mature stands as in young pine forest. The proportions of the other subdominant species in medium age and mature forests are also lower. As occasional species and forms that are not permanently associated with coniferous forest habitat are eliminated from the *Syrphidae* community, its structure becomes stabilized.

Table VI. The structure of dominance of pine canopy Syrphids communities in three classes of forest stand age (in per cent)

Species	Young stands	Medium age stands	Mature stands
Episyrpus balteatus	18.4	18.0	30.7
Dasysyrphus venustus	13.2	30.8	27.7
Metasyrphus corollae	5.5	3.9	5.5
Helophilus pendulus	25.8	23.0	13.1
Helophilus lineatus	2.9	0.6	0.1
Eristalis tenax	3.0	0.2	1.3
Eristalinus sepulchralis	5.3	1.7	0.1

This stabilisation process can be pursued very closely if one analyses the structure of dominance in a community of predatory aphidophages (Fig. 1). In young stands there is quite a high proportion of open area species of the genus *Sphaerophoria* which are alien to woodland habitats. Dominance relations between forest species such as *E. balteatus*, *D. venustus* and *H. corollae* are not stable yet. As early as in medium age stands the structure becomes normalised:

the first dominant species is *E. balteatus* and *D. venustus* and *M. corollae* are rated second and third. The fourth place is occupied by *Didea intermedia*, a species characteristic of coniferous forest habitats which is rather invisible in young stands.

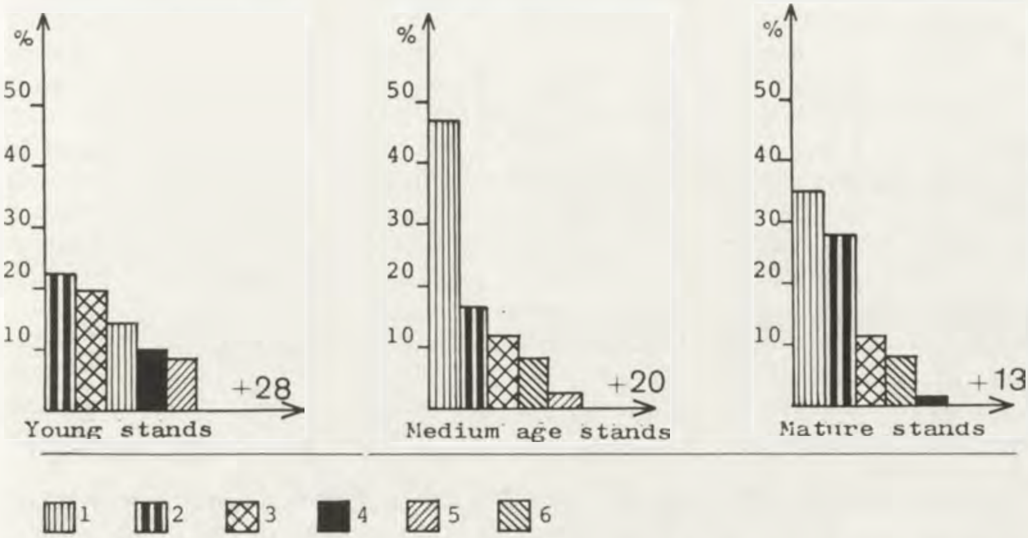

Fig. 1. The structure of dominance in aphidophagous *Syrphidae* communities in three classes of forest stand age: 1 – *Dasysyrphus venustus*, 2 – *Episyrphus balteatus*, 3 – *Metasyrphus corollae*, 4 – *Sphaerophoria menthastri*, 5 – *S. scripta*, 6 – *Didea intermedia*.

In the mature stand, dominance relations within the aphidophagous community do not differ from the structure observed in medium age stands, with a considerable rise in the share of the other species characteristic of coniferous forests – *D. venustus*. Such a structure of dominance provides a basis for the hypothesis that the stabilisation process in syrphid communities begins in medium age stands, and in mature stands the structure undergoes only further stabilisation.

THE DISCUSSION OF RESULTS

The *Syrphidae* fauna of pine canopies is relatively rich both in terms of the number of species registered and abundance of the communities. Similar data have been obtained by comparing communities of *Syrphidae* in various forest associations, including the coniferous forests of Puszcza Kampinoska (BAŃKOWSKA 1982a).

Of the three forest areas under study, the *Syrphidae* fauna of Puszcza Białowieska appears to be visibly distinct from the other two both in terms of abundance and species richness (Tab. IV). Puszcza Białowieska is located in the zone of the lowest exposure to industrial emissions so that the stands are hardly transformed and highly resistant. Ample environmental resources allow high numbers of saprophagous larvae to develop in soil and litter. The imagines then penetrate upwards to the crown layer in search of food on the honey-dew. The richness of the syrphid fauna results also from the presence of diverse forest habitats as linden-oak-hornbeam forests, carrs and mixed coniferous forests in Puszcza Białowieska. *Syrphidae* caught in the crowns have a high flying capacity so that they are able to cover long distances while foraging. It is not surprising then that a characteristic of the syrphid fauna occurring in the forest stands studied in Puszcza Białowieska is a large number of species rare or absent from other forest areas. These species are evidently recessive and cannot adapt to rapid changes in their natural environment. On the other hand, unlike Puszcza Biała and Bory Tucholskie, Puszcza Białowieska syrphid communities have a small percentage of expansive eurytopic species that have been able to adapt themselves to man-induced changes so well that their abundance has risen considerably (hemisynanthropic species).

The following three species closely associated with forest habitats are dominant in *Syrphidae* communities inhabiting coniferous forests: the aphidophagous *E. balteatus* and *D. venustus*, and the saprophagous *H. pensulus*. *E. balteatus* and *H. pendulus* are dominant in fresh and wet forest habitats as well (Bańkowska 1980).

As the forest stand grows older. the structures of animal communities living there change. The changes concern species composition and abundance. This process is also observed in *Syrphidae* communities of coniferous forests, and, as has been shown in our study, it takes a similar course in each of the three forest areas studied.

The communities of *Syrphidae* in young stands are characterized by a high number of species and high abundance. There is a high proportion of species alien to forest habitats and characteristic of meadows and swampy areas (Tab. IV, VI). As the stands grow, the average abundance of a syrphid community decreases and the number of species is considerably reduced. Species alien to coniferous forest habitats are eliminated, while species associated with these habitats increase their proportions. In young stands, the structure of *Syrphidae* communities is not stable, it reaches certain stabilization and equilibrium only in medium age stands (Fig. 1).

It seems that dipterans of the family *Syrphidae* are a good indicator species and can well be used to register changes taking place in forest habitats.

REFERENCES

Bańkowska R. 1980. Fly communities of the family *Syrphidae* in natural and antropogenic habitats of Poland. Memorabilia Zool., Warszawa **33**: 3–93.

Bańkowska R. 1982a. Bzygowate *(Syrphidae, Diptera)*. In: Zoocenologiczne podstawy kształtowania środowiska przyrodniczego osiedla mieszkaniowego Białołęka Dworska w Warszawie. Fragm. faun., Warszawa, **26**: 407–420.

Bańkowska R. 1982b. Hover flies (*Diptera, Syrphidae)* of Warsaw and Mazovia. Memorabilia Zool., Warszawa, **35**: 57–78.

MATUSZKIEWICZ J.M., DEGÓRSKI M., KOZŁOWSKA A. 1993. Description of the plant association structure and soils of pine forest stands situated in five regions of Poland. Fragm. faun., Warszawa, **36**: 13–36.

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STRESZCZENIE

[Tytuł: Zróżnicowanie fauny *Syrphidae (Diptera)* w borach świeżych w zależności od wieku drzewostanu i jego zdrowotności]

Opracowanie dotyczy zgrupowań *Syrphidae* zasiedlających korony sosen w trzech regionach Polski o zróżnicowanej zdrowotności drzewostanu i w trzech różnych klasach wieku (Bory Tucholskie, Puszcza Biała i Puszcza Białowieska).

Z trzech badanych kompleksów leśnych fauna *Syrphidae* Puszczy Białowieskiej wyraźnie odbiega od dwu pozostałych, zarówno pod względem liczebności jak i bogactwa gatunkowego (Tab. IV). Tak dużą różnorodność gatunkową badanej grupy muchówek można tłumaczyć usytuowaniem puszczy Białowieskiej w strefie najmniejszego zagrożenia emisjami przemysłowymi oraz stosunkowo małym odkształceniem drzewostanów i ich wysoką odpornością. Zasobność środowiska umożliwia w glebie i ściółce rozwój dużej ilości larw saprofagicznych *Syrphidae*, które w formie imago migrują w korony sosen szukając pożywienia na spadzi. Na duże bogactwo fauny borowej badanych muchówek ma bezpośredni wpływ także bliskość bardzo zróżnicowanych i bogatych zbiorowisk leśnych samej puszczy (grądy, łęgi i bory mieszane).

Fauna *Syrphidae* Puszczy Białowieskiej charakteryzuje się nie tylko prawie dwukrotnie wyższą liczbą złowionych gatunków, ale na uwagę zasługuje występowanie tam wielu gatunków rzadko spotykanych, lub już nieobecnych na pozostałych terenach leśnych. Są to gatunki wyraźnie ustępujące (recesywne), które nie są w stanie przystosować się do szybko następujących przemian w środowisku przyrodniczym. Należą do nich głównie muchówki saprofagiczne z rodzajów *Helophilus* Meig., *Sericomyia* Meig. czy *Xylota* Meig. Jednocześnie daje się zaobserwować mały udział gatunków ekspansywnych, hemisynantropijnych (Tab. III).

Wraz z procesem starzenia się drzewostanu zmienia się struktura zgrupowań zwierzęcych, zamieszkujących te lasy, ich skład gatunkowy i liczebność. Zjawisko to zachodzi również w zgrupowaniach *Syrphidae* borów świeżych i jak wykazały nasze badania, przebiega ono w sposób bardzo zbliżony we wszystkich trzech badanych obszarach leśnych.

Zgrupowania badanych muchówek w młodnikach charakteryzuje duża liczba gatunków i wysoka liczebność (Tab.IV). Występuje spory procent gatunków obcych dla borów świeżych, a typowych dla środowisk łąkowych i terenów

bagiennych (przedstawiciele podrodziny *Eristalinae*). Wraz ze wzrostem drzewostanu zmniejsza się średnia liczebność zgrupowania *Syrphidae* i wyraźnie obniża się liczba gatunków (Tab. VI). Zostają wyeliminowane gatunki obce dla zbiorowisk borowych, a zwiększają swój udział gatunki z nimi związane. Struktura zgrupowań *Syrphidae* w młodnikach jest jeszcze nie uporządkowana i dopiero w III klasie wieku drzewostanu ulega pewnej stabilizacji i równowadze (Rys. 1).

Niniejsze opracowanie zostało wykonane w ramach programu badawczego CPBP 04.10.07.

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