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***Coccinellidae* (Coleoptera) of the canopy layer in pine forests\***

**Abstract.** The study was carried out in the years 1986–1987 in Puszcza Białowieska, Puszcza Biała and Bory Tucholskie in moist pine forest stands representing three age classes: 15–20, 40–60 and 80–100 years old. 14 *Coccinellidae* species were registered, *Scymnus suturalis* Thbg. and *Myrrha octodecimguttata* (L.) being most abundant.

INTRODUCTION

Besides *Curculionidae*, *Coccinellidae* are the most abundant group of beetles in the canopy layer entomofauna of pine forests (HÖREGOTT 1960, WINIARSKA, CHOLEWICKA 1990). The most complete data on *Coccinellidae* inhabiting this habitat concern young pine stands, while much less is known about the *Coccinellidae* fauna of older stands, which is due to technical difficulties in sampling.

Studies of species richness and the quantitative structure of *Coccinellidae* communities in young stands have been carried out by BIELAWSKI (1961) and KLAUSNITZER (1965, 1967). In addition, BIELAWSKI's paper contains an in-depth analysis of seasonal qualitative and quantitative changes in communities inhabiting young stands. GUMOŚ and WIŚNIEWSKI (1960) provide a comparative analysis of species composition and numerical relations in *Coccinellidae* communities in young stands and pole wood (about 40-year-old trees). Information about *Coccinellidae* living in canopies of old pines can be found in HÖREGOTT (1960), KLAUSNITZER (1968) and CZECHOWSKA (1994). Moreover, certain observations about the occurrence of certain ladybird species in stands of pine are contained in papers by KOEHLER (1957, 1961).

\* The material was collected within the framework of the research problem CBPP 04.10.07.

The aim of this paper is to present the species composition, abundance and structure of *Coccinellidae* communities of tree canopies in moist pine stands of three age classes (young, medium age and mature stands) and to investigate changes occurring in these communities.

#### TIME AND AREA OF STUDY

The study was conducted in the years 1986–1987 in Puszcza Białowieska (Hajnówka forest inspectorate), Puszcza Biała (Ostrów Mazowiecka forest inspectorate) and Bory Tucholskie (Osie forest inspectorate).

Puszcza Białowieska is situated in the elevated area of Wysoczyzna Bielska, Puszcza Biała lies in the Mazovian Lowland and Bory Tucholskie is located in the area of Southern Pomeranian Lakeland.

In terms of phytosociology, moist pine forests belong to the *Dicrano-Pinion* association where the pine (*Pinus silvestris*) is the stand-forming species. The wide geographical distribution of these forests has resulted in their floristic diversity as seen in slightly differing species composition of the herb layer, undergrowth and tree additions. Basically, two varieties of this association type can be found in Poland: the suboceanic moist pine forest (*Leucobryo-Pinetum*) and the subcontinental moist pine forest (*Peucedano-Pinetum*). Regional varieties can also be seen within these two basic types (TRAMPLER et al. 1987, MATUSZKIEWICZ 1987). The following is a brief description of the moist pine forests studied. A more detailed description is provided in the introductory paper (MATUSZKIEWICZ et al. 1993).

**Puszcza Białowieska.** The subboreal variety of the subcontinental moist pine forest (*Peucedano-Pinetum*) with constant presence of spruce (*Picea excelsa*) in the undergrowth and the tree layer. Deciduous trees found there include: birch (*Betula verrucosa*) as well as oak (*Quercus robur*) and hornbeam (*Carpinus betulus*) occurring sporadically in the undergrowth.

**Puszcza Biała.** The sarmatian variety of the subcontinental moist pine forest (*Peucedano-Pinetum*) characterized by a considerable proportion of juniper (*Juniperus communis*) in the undergrowth. The birch, and sporadically spruce, were additional species in the tree layer.

**Bory Tucholskie.** A suboceanic moist pine forest (*Leucobryo-Pinetum*) composed almost entirely of homogeneous pine forest stands with only a slight proportion of birch.

In the coniferous complexes studied, sampling was done in stands of three age classes: young (15–20 years old), medium age (40–60 years old) and mature (80–100) stands.

#### MATERIAL AND METHODS

The insects were caught into yellow bowls (Moericke's traps) (MOERICKE 1950, BAŃKOWSKA, GARBARCZYK 1981) hung in canopies of pines. Three plots were selected in stands of each age group, and 5 traps were hung within each plot (1

trap per tree). The insects were collected once a fortnight from April to the end of October. The catches yielded a total of 3807 imagines of *Coccinellidae*, 1841 of which were caught in the young stands, 1241 in medium age stands and 1085 in mature stands.

The following numbers of specimens were caught in each of the forest areas: Puszcza Białowieska – 1072, Bory Tucholskie – 1032 and Puszcza Biała – 1023.

The abundance of *Coccinellidae* in pine canopies was determined on the basis of the number of individuals caught into one bowl during a 24-hours' period.

The degree of faunistical similarity of *Coccinellidae* communities was calculated according to SÖRENSEN'S formula (1948), while Morisita's formula modified by HORN (1966) was used for calculating the degree of similarity of dominance structures.

The taxa were determined according to BIELAWSKI'S key (1959) using nomenclature modifications by KLAUSNITZER and KLAUSNITZER (1979).

#### RESULTS

The total material collected contained 14 species of ladybirds. All the species were observed in Puszcza Białowieska, while the sampling in Puszcza Biała yielded 11 species, compared to 10 registered in Bory Tucholskie (Table I).

Table I. Abundance (n) and proportion (%) of particular species of *Coccinellidae* in canopies of moist pine forests (general data for the forest complexes studied; + - n < 0.001)

No	Species	Forest complex		Puszcza Białowieska		Puszcza Biała		Bory Tucholskie	
		n	%	n	%	n	%		
1	<i>Scymnus haemorrhoidalis</i> HERBST	0.001	0.9	+	+	-	-	-	-
2	<i>Scymnus suturalis</i> THUNB.	0.069	60.5	0.042	57.5	0.031	52.5		
3	<i>Scymnus nigrinus</i> KUGEL.	+	+	+	+	-	-	-	-
4	<i>Exochomus quadripustulatus</i> (L.)	0.001	0.9	0.001	1.4	0.003	5.1		
5	<i>Aphidecta oblitterata</i> (L.)	0.001	0.9	+	+	-	-	-	-
6	<i>Adalia conglomerata</i> (L.)	+	+	-	-	-	-	-	-
7	<i>Adalia decempunctata</i> (L.)	+	+	-	-	+	+		
8	<i>Coccinella septempunctata</i> (L.)	0.005	4.4	0.002	2.7	0.004	6.8		
9	<i>Harmonia quadripunctata</i> (PONT.)	0.005	4.4	0.005	6.8	0.003	5.1		
10	<i>Myrrha octodecimpunctata</i> (L.)	0.025	21.8	0.017	23.3	0.010	16.9		
11	<i>Calvia decempunctata</i> (L.)	+	+	-	-	+	+		
12	<i>Calvia quatuordecimpunctata</i> (L.)	0.002	1.8	0.002	2.7	0.003	5.1		
13	<i>Mysia oblongoguttata</i> (L.)	0.002	1.8	0.002	2.7	+	+		
14	<i>Anatis ocellata</i> (L.)	0.003	2.6	0.002	2.7	0.005	8.5		
Total		0.114		0.073		0.059			
Number of species		14		11		10			

Table II. Abundance (n) and proportion (%) of particular species of *Coccinellidae*

No	Species	Forest complex; age stands	Puszcza Białowiecka						Puszcza		
			Young		Medium age		Mature		Young		Medium
			n	%	n	%	n	%	n	%	n
1	<i>Scymnus haemorrhoidalis</i>		+	+	0.002	2.2	0.001	1.6	+	+	+
2	<i>Scymnus suturalis</i>		0.133	71.3	0.049	53.2	0.024	38.1	0.020	50.0	0.074
3	<i>Scymnus nigrinus</i>		+	+	-	-	-	-	+	+	-
4	<i>Exochomus quadripustulatus</i>		0.004	2.2	+	+	-	-	0.001	2.5	0.001
5	<i>Aphidecta obliterated</i>		0.002	1.1	0.001	1.1	0.001	1.6	-	-	-
6	<i>Adalia conglomerata</i>		-	-	+	+	+	+	-	-	-
7	<i>Adalia decempunctata</i>		+	+	-	-	+	+	-	-	-
8	<i>Coccinella septempunctata</i>		0.010	5.4	0.002	2.2	0.002	3.2	0.005	12.5	-
9	<i>Harmonia quadripunctata</i>		0.005	2.7	0.004	4.3	0.006	9.5	0.005	12.5	0.004
10	<i>Myrrha octodecimpunctata</i>		0.024	12.9	0.028	30.4	0.023	36.5	0.003	7.5	0.030
11	<i>Calvia decemguttata</i>		-	-	+	+	-	-	-	-	-
12	<i>Calvia quatuordecimpunctata</i>		0.004	2.2	0.001	1.1	+	+	0.003	7.5	0.001
13	<i>Mysia oblongoguttata</i>		0.002	1.1	0.003	3.3	0.001	1.6	0.003	7.5	0.002
14	<i>Anatis ocellata</i>		0.002	1.1	0.002	2.2	0.005	7.9	+	+	0.003
Total			0.186		0.092		0.063		0.040		0.115
Number of species			12		12		11		10		

The following species were common to the forest complexes studied: *Scymnus suturalis*, *Exochomus quadripustulatus*, *Coccinella septempunctata*, *Harmonia quadripunctata*, *Myrrha octodecimpunctata*, *Calvia quatuordecimpunctata*, *Mysia oblongoguttata* and *Anatis ocellata*. The above species were most constant and most abundant among the ladybirds occurring in pine canopies.

The results also generally reveal a high degree of structural similarity of *Coccinellidae* communities in the three forest complexes, but certain differences can also be seen.

The following is a description of *Coccinellidae* communities in the moist pine forest stands studied.

#### Young stands

A total of 12 *Coccinellidae* species were registered in this group (Table II), the figures ranging from 8 to 12 species in a stand. The similarity of these faunas ranged between 80% and 91% (Table III).

in canopies of moist pine forests (data for the particular age stands studied; + - n < 0.001)

Biała			Bory Tucholskie						Mean					
age	Mature		Young		Medium age		Mature		Young		Medium age		Mature	
%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
+	+	+	-	-	-	-	-	-	+	+	0.001	1.2	+	+
64.3	0.031	49.2	0.020	40.0	0.018	39.1	0.055	64.7	0.058	62.3	0.047	55.2	0.037	52.9
-	-	-	-	-	-	-	-	-	+	+	-	-	-	-
0.9	0.002	3.2	0.004	8.0	0.001	2.2	0.005	5.9	0.003	3.2	0.001	1.2	0.002	2.9
-	+	+	-	-	-	-	-	-	0.001	1.1	+	+	+	+
-	-	-	-	-	-	-	-	-	-	-	+	+	+	+
-	-	-	-	-	+	+	+	+	+	+	+	+	+	+
-	+	+	0.009	18.0	0.002	4.3	0.002	2.4	0.008	8.6	0.001	1.2	0.002	2.9
3.5	0.005	7.9	0.002	4.0	0.003	6.5	0.004	4.7	0.004	4.3	0.004	4.7	0.005	7.1
26.1	0.018	28.6	0.002	4.0	0.015	32.6	0.012	14.1	0.010	10.8	0.024	28.2	0.018	25.7
-	-	-	-	-	-	-	+	+	-	-	+	+	+	+
0.9	0.002	3.2	0.006	12.0	0.003	6.5	0.001	1.2	0.004	4.3	0.002	2.4	0.001	1.4
1.7	0.002	3.2	+	+	+	+	0.001	1.2	0.002	2.2	0.002	2.4	0.001	1.4
2.6	0.003	4.7	0.007	14.0	0.004	8.7	0.005	5.9	0.003	3.2	0.003	3.5	0.004	5.7
	0.063		0.050		0.046		0.085		0.093		0.085		0.070	
8	10		8		9		10		12		13		13	

The mean value of the *Coccinellidae* abundance index in young stands equalled 0.093, the figures for a particular stand ranging from 0.040 to 0.186 (Table II). The following species had the greatest shares in the material from young stands: *Scymnus suturalis* (62.3%), *Myrrha octodecimguttata* (10.8%) and *Coccinella septempunctata* (8.6%).

The young stand *Coccinellidae* communities in the areas studied were characterized by high similarity of their quantitative structures. A common feature was the predominance of *S. suturalis* over the other species. Certain differences could be seen in the subdominant group. In Puszcza Białowieska these positions were occupied by *Myrrha octodecimguttata* and *Coccinella septempunctata*; in Puszcza Biała - by *Coccinella septempunctata* and *Harmonia quadripunctata*, and in Bory Tucholskie - by *Coccinella septempunctata*, *Anatis ocellata* and *Calvia quatuordecimpunctata*. The similarity of the community structure expressed by means of Morisita's index oscillated between 0.80-0.91 (Table III).

Table III. Qualitative similarity (Sørensen index) and similarity of dominance structure (Morisita index) of the communities of *Coccinellidae* in the moist pine forests studied

	Young stands			Medium age stands			Mature stands			Morisita index
	Puszcza Białowieska	Puszcza Biała	Bory Tucholskie	Puszcza Białowieska	Puszcza Biała	Bory Tucholskie	Puszcza Białowieska	Puszcza Biała	Bory Tucholskie	
Puszcza Białowieska	-	0.91	0.80	-	0.98	0.95	-	0.96	0.83	
Puszcza Biała	91	-	0.90	80	-	0.90	86	-	0.94	
Bory Tucholskie	80	89	-	76	82	-	76	80	-	
Sørensen index (%)										

In comparison to older stands, young stand *Coccinellidae* communities were characterized by a greater proportion of *Coccinella septempunctata*, *Calvia quatuordecimpunctata* and *Exochomus quadripustulatus* (Table II).

#### Medium age stands

The catches in these pine stands produced 13 *Coccinellidae* species in total (Table II). The figures for particular stands fell between 8 and 12 species with faunistical similarity varying between 76–82% (Table III).

The mean value of the *Coccinellidae* abundance index in pines of this age class was 0.085, while indices for particular areas fluctuated from 0.046 to 0.115 (Table II). The most abundant species in the total material obtained from stands in this age class were *Scymnus suturalis* (55.2%) and *Myrrha octodecimguttata* (28.2%). Their shares in the quantitative structures of particular communities fluctuated quite widely. However, *S. suturalis* always remained the dominant species. Of the other species, *Harmonia quadripunctata* and *Anatis ocellata* had slightly higher shares. Dominance structure similarity of *Coccinellidae* communities ranged from 0.90 to 0.98 in a stand.

Compared to young stand communities, *Coccinellidae* communities in medium age stands were characterized above all else by higher abundance of *Myrrha octodecimguttata* (2.4 times on average). A substantial increase in the abundance of this species was noted in Bory Tucholskie and Puszcza Biała (Table II). On the other hand, a considerable fall in abundance could be seen in the case of *Scymnus suturalis*, *Coccinella septempunctata* and a slighter one, in *Exochomus quadripustulatus* and *Calvia quatuordecimpunctata*. The mean value

of the abundance index of *Coccinellidae* communities in this age class of forest stand was lower by approximately 9% than in young stands.

#### Mature stands

Similarly to medium age stands, 13 *Coccinellidae* species were registered in mature stands. The figures for individual stands varied from 10 to 11 and the faunistical similarity index ranged from 76–86% (Tabs II, III).

Mean abundance of *Coccinellidae* in pine canopies was 0.070 (0.063 to 0.085 in a stand).

*Scymnus suturalis* (52.9%) and *Myrrha octodecimguttata* (25.7%) were the most abundant species, just as in medium age stands. Other species with relatively high abundance included *Harmonia quadripunctata* and *Anatis ocellata* (Table II).

The structural similarity of *Coccinellidae* communities in mature stands oscillated between 0.83 to 0.96.

Mean abundance of *Coccinellidae* in mature stands was lower by about 18% than in medium age stands, which was chiefly due to decreased abundance of *Scymnus suturalis* and *Myrrha octodecimguttata* (Table II). In comparison to young stands, mean abundance of ladybirds in canopies of old pines was lower by nearly 25%.

#### SUMMARY

In the study, 14 *Coccinellidae* species were recorded in pine canopies, 11 of which were found in stands of all the three age classes. *Scymnus nigrinus* was only noted in young stands while *Adalia conglomerata* and *Calvia decemguttata* were only recorded from older stands.

The mean abundance of *Coccinellidae* communities was the highest in young stands (0.93), while the lowest values were obtained in mature stands (0.70). A marked decrease in ladybird abundance associated with the growing age of the stand was only recorded in Puszcza Białowieska in both seasons. Since the abundance of ladybirds was the highest in this region, the results influenced the mean values. In Bory Tucholskie, also in both seasons, ladybirds were most numerous in mature stands, while in Puszcza Biała the greatest abundance was measured in medium age stands.

The species most abundant in young stands include *Scymnus suturalis*, *Coccinella septempunctata* and *Calvia quatuordecimpunctata*. *Myrrha octodecimguttata* was the only species that was more abundant in medium age and mature stands than in young ones. Similar abundance index values in the three age classes were obtained for *Exochomus quadripustulatus*, *Harmonia quadripunctata*, *Mysia oblongoguttata* and *Anatis ocellata*.

9 of the 14 species found in canopies of pine develop on coniferous trees. Among them, *Scymnus suturalis*, *S. nigrinus*, *Exochomus quadripustulatus*, *Harmonia quadripunctata* and *Myrrha octodecimguttata* are characteristic

elements of pine forest entomofauna. The other 4 species, namely *Aphidecta obliterata*, *Adalia conglomerata*, *Mysia oblongoguttata* and *Anatis ocellata* occur also on spruce, larch and fir (BIELAWSKI 1971, 1978, STEBNICKA 1972).

Ladybirds associated with deciduous stands were represented in the forests studied only by single specimens of *Adalia decempunctata* and *Calvia decempunctata*.

On the other hand, eurytopic species – *Coccinella septempunctata* and *Calvia quatuordecimpunctata* – were relatively abundant, especially in young stands. *Scymnus haemorrhoidalis*, which occurs in various habitats but is never numerous, was collected on pines in all age classes in Puszcza Biała and Puszcza Białowieska.

Apart from the generally high similarity in species composition and structure, *Coccinellidae* communities in individual forest complexes possess certain specific features resulting from local factors.

In the moist pine forests studied, Puszcza Białowieska had the greatest species richness and abundance of *Coccinellidae* in pine canopies. *Scymnus suturalis* and *Myrrha octodecimpunctata* were more abundant there than in the other two areas. The relative abundance of *Aphidecta obliterata* in this area should probably be attributed to the high proportion of spruce in the pine forest and adjacent habitats. Bory Tucholskie had relatively high proportions of *Exochomus quadripustulatus* and *Anatis ocellata*, while in Puszcza Biała *Harmonia quadripunctata* was quite abundant.

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## STRESZCZENIE

[Tytuł: Biedronkowate (*Coccinellidae*, *Coleoptera*) warstwy koron borów sosnowych]

Badania przeprowadzono na terenie Puszczy Białowieskiej, Puszczy Białej i Borów Tucholskich w drzewostanach sosnowych różnych klas wiekowych – młodnikach (15–20-letnich), drzewostanach III klasy wieku (40–60-letnich) i starodrzewach (80–100-letnich) – rosnących w siedlisku boru świeżego.

W materiale liczącym 3807 osobników stwierdzono obecność 14 gatunków *Coccinellidae*. W poszczególnych kompleksach borów świeżych występowało od 10 do 14 gatunków biedronek (Tab. I). Skład gatunkowy zgrupowań *Coccinellidae* w drzewostanach sosnowych poszczególnych klas wiekowych różnił się w bardzo niewielkim stopniu. W młodnikach stwierdzono łącznie 12, a w drzewostanach III klasy wieku i starodrzewach po 13 gatunków biedronek, w tym 11 gatunków było wspólnych dla zgrupowań z drzewostanów wszystkich badanych klas wiekowych.

Średni wskaźnik liczebności biedronkowatych wynosił: w młodnikach – 0.093, drzewostanach III klasy wieku – 0.085, starodrzewach – 0.070. Mimo pewnych różnic ilościowych, struktura zgrupowań *Coccinellidae* była wszędzie bardzo podobna. Dominantem był zawsze *Scymnus suturalis*, pozycję subdominanta zajmował w starszych drzewostanach *Myrrha octodecimguttata*,

natomiast w młodnikach jako subdominanty występowały także *Coccinella septempunctata*, *Harmonia quadripunctata*, *Anatis ocellata* oraz *Exochomus quadripustulatus*.

Badane bory sosnowe zasiedlone były głównie przez biedronki odbywające rozwój na drzewach iglastych. Spośród nich do form stenotopowych, charakterystycznych dla drzewostanów sosnowych, należą *Scymnus suturalis*, *S. nigrinus*, *Harmonia quadripunctata* i *Myrrha octodecimguttata*. Udział ilościowy tego elementu był wyższy w drzewostanach starszych, natomiast zgrupowania *Coccinellidae* w młodnikach odznaczały się znacznie większym udziałem gatunków eurytopowych, takich jak *Coccinella septempunctata* i *Calvia quatuordecimpunctata*.

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