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Katarzyna CHOLEWICKA-WIŚNIEWSKA

Communities of weevils (*Coleoptera, Curculionidae*) in Polish pine forests of different age

[With 7 tables and 3 figures in the text]

Abstract. Stability changes in communities of weevils of the families *Attelabidae*, *Rhinomaceridae*, *Apionidae* and *Curculionidae*, related to forest stand age, have been investigated in stands of different age situated in pine forests (*Peucedano-Pinetum* and *Leucobryo-Pinetum*) of Puszcza Białowieska, Puszcza Biała and Bory Tucholskie.

INTRODUCTION

Weevil communities of Polish pine forests have not been extensively studied so far. This is probably due to the fact that communities of these beetles exhibit much greater species diversity in open areas. There are, nevertheless, a number of papers which discuss various forest habitats, particularly linden-oak-hornbeam forest. Other papers concentrate just on pine forest habitats (CMOLUCH 1961, CMOLUCH, ŁĘTOWSKI 1987, PETRYSZAK 1982, STACHOWIAK 1991). Another group consists of publications that explore weevil fauna inhabiting selected plant species characteristic of the pine forest (CMOLUCH, KOWALIK 1963, STACHOWIAK 1984). Up to now, no attempts have been made to analyse the process of weevil succession, which occurs in pine forests as the stands grow older. The following study tries to carry this task out.

The aim of this paper was to investigate changes in the structure of weevil communities that take place in the succession process in pine forests. This objective has been achieved by analysing species composition, dominance structure and by revealing changes in the dominant species' abundance.

AREA OF STUDY

The research was conducted in stands of different age situated within three pine forest areas in Poland: Puszcza Białowieska, Puszcza Biała and Bory

Tucholskie. The specimens were collected in young stands (9-27 years old), middle age stands (50–70 years old) and mature stands (85–150 years old). 9 study sites were selected in each area (3 sites in each age group), so the material was collected from a total of 27 sites.

A geobotanical descriptions of the stands has been provided by a team of phytosociologists (MATUSZKIEWICZ et al. 1993).

MATERIAL AND METHODS

The material analysed comprises the *Curculionidae* family sensu lato. The following families were represented in the material: *Attelabidae, Rhinomaceridae, Apionidae* and *Curculionidae*.

The catches were conducted throughout the vegetational season from April to October in the years 1986 and 1987 and yielded over 5000 specimens of imagines of weevils. The specimens were caught in Moericke's pitfall traps. 5 traps (yellow bowls) were hung high in pine canopies at each site. The bowls were emptied every fortnight.

The abundance of each species was expressed by means of a relative abundance index (nm), equivalent to the number of weevils caught into 10 MOERICKE's traps in 10 days.

In order to determine species richness of weevil communities in stands of different age, Shannon and Weaver's index of species diversity ($\bar{H}$) was used (ODUM 1977). A similarity coefficient (TROJAN 1975), or Jaccard's and Serensen's formula (J_o), was used to estimate the degree of similarity of the species composition of weevil communities in each forest area. Morisita's formula (1959), modified by Horn (1966), was used to evaluate similarity of dominance structures (*S*) of weevil communities inhabiting two areas under comparison (CHOLEWICKA-WIŚNIEWSKA 1993).

SPECIES COMPOSITION, ABUNDANCE AND DOMINANCE STRUCTURE

The weevil communities in stands of different age were only analysed in the canopy layer. A total of 66 species were identified (Tab. I).

The highest abundance index of weevil communities was obtained for middle age stands, exceeding 2.5 times the index obtained for young stands (Tab. II).

Brachonyx pineti was the dominant species in young stands. Its abundance is more than twice as high as that of *Rhinomacer attelaboides*, a species also abundant in forest stands of this age class. Other species relatively abundant in young stands include: *Strophosoma capitatum* and *Magdalis phlegmatica*. In pole wood and mature stands, however, the sequence is reversed with *R. attelaboides* functioning as dominant and *B. pineti*, as subdominant. Both species are associated with pine, but *R. attelaboides* develops in inflorescence, while *B. pineti* develops in young pine needles. Since pine growing in density reaches full generative maturity at an age of about 30–40 years (OBMIŃSKI 1977), one should suppose that at this age the species developing in inflorescence may

Table I. Abundance index (nm) of the various weevil species found in forest stands of different age in selected forest complexes in Poland. index nm – number of weevils caught into 10 Moericke's traps in 10 days.

No.	Forest complex / stand's age / species	Puszcza Białowieska				Puszcza Biała				Bory Tucholskie			
		young stand	middle age stand	mature stand	all age stand	young stand	middle age stand	mature stand	all age stand	young stand	middle age stand	mature stand	all age stand
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	*Rhinomacer attelaboides* F.	1.44	4.91	3.87	3.38	2.23	24.05	11.76	12.13	0.30	1.02	1.41	0.90
2	*Doydirhynchus austriacus* (Oliv.)	0.04	0.37	0.30	0.23		0.18	0.19	0.12		0.02	0.10	0.04
3	*Pselaphorhynchites longiceps* (Thoms.)	0.02			0.01								
4	*Pselaphorhynchites nanus* (Payk.)	0.04	0.06	0.06	0.05		0.02		0.01		0.02		0.01
5	*Byctiscus betulae* (L.)						0.02		0.01				
6	*Deporaus betulae* (L.)	0.06	0.12	0.14	0.10	0.04	0.04	0.06	0.05			0.02	0.01
7	*Deporaus mannerheimii* (Humm.)	0.02			0.01								
8	*Attelabus nitens* (Scop.)	0.64	0.23	0.43	0.44						0.02	0.02	0.01
9	*Apoderus coryli* (L.)	0.06	0.02	0.02	0.03								
10	*Apion curtirostre* Germ.	0.02			0.01			0.02	0.01				
11	*Apion vicinum* Kirby						0.04		0.01				
12	*Apion austiacum* Wagn.										0.02		0.01
13	*Apion vorax* Herbst						0.02		0.01				
14	*Apion simile* Kirby	0.09	0.12	0.10	0.10	0.04	0.04	0.08	0.06		0.05	0.02	0.02
15	*Apion virens* Herbst			0.04	0.01						0.02		0.01
16	*Apion fulvipes* (Geofr.)	0.17	0.06	0.06	0.10	0.04	0.02	0.02	0.03			0.02	0.01
17	*Otiorhynchus ovatus* (L.)	0.02			0.01								
18	*Phyllobius pyri* (L.)							0.02	0.01				
19	*Phyllobius argentatus* (L.)										0.02		0.01
20	*Phyllobius arborator* (Herbst)	0.06	0.04		0.03								

1	2	3	4	5	6	7	8	9	10	11	12	13	14
21	*Polydrusus pallidus* (Gyll.)	0.06	0.04		0.03	0.04	0.04	0.13	0.07	0.05	0.03	0.03	0.04
22	*Polydrusus pilosus* Gredl.			0.02	0.01								
23	*Brachyderes incanus* (L.)	0.02		0.02	0.01	0.17	0.09	0.10	0.12	0.51	0.03		0.19
24	*Strophosoma capitatum* (Deg.)	0.77	0.39	0.36	0.51	1.20	0.20	0.36	0.61	0.35	0.05	0.28	0.23
25	*Strophosoma fulvicorne* (Walt.)									0.05			0.02
26	*Sitona griseus* (F.)									0.02			0.01
27	*Sitona crinitus* (Herbst)											0.02	0.01
28	*Sitona humeralis* Steph.									0.02			0.01
29	*Sitona lepidus* Gyll.										0.03		0.01
30	*Sitona lineatus* (L.)			0.04	0.01						0.03		0.01
31	*Hypera zoilus* (Scop.)		0.02		0.01								
32	*Hypera arator* (L.)					0.02		0.02	0.01				
33	*Hypera postica* (Gyll.)									0.02			0.01
34	*Hypera nigrirostris* (F.)	0.02			0.01			0.02	0.01				
35	*Sibinia potentillae* Germ.					0.02		0.02	0.01				
36	*Anthonomus phyllocola* (Herbst)	0.79	2.01	1.74	1.50	0.10	0.42	0.34	0.28	0.07	0.10	0.24	0.14
37	*Brachonyx pineti* (Payk.)	5.23	4.31	3.38	4.32	2.32	2.50	1.72	2.18	0.99	4.17	2.33	2.48
38	*Curculio rubidus* Gyll.	0.02	0.02		0.01								
39	*Curculio pyrrhoceras* Marsh.	0.11	0.10	0.04	0.08						0.02		0.01
40	*Pissodes notatus* (F.)					0.02			0.01				
41	*Pissodes pini* (L.)					0.04		0.02	0.02				
42	*Pissodes piniphilus* (Herbst)						0.02		0.01				
43	*Magdalis exarata* (Bris.)	0.02		0.02	0.01								
44	*Magdalis phlegmatica* (Herbst)	0.52	0.33	0.06	0.31	0.38	0.75	0.06	0.39	0.60	0.80	0.21	0.54

1	2	3	4	5	6	7	8	9	10	11	12	13	14
45	*Magdalis nitida* (GYLL.)	0.02		0.02	0.01						0.02		0.01
46	*Magdalis linearis* (GYLL.)	0.47	0.72	0.41	0.53	0.27	1.60	0.90	0.89	0.23	0.71	0.50	0.48
47	*Magdalis frontalis* (GYLL.)						0.02		0.01	0.02			0.01
48	*Magdalis violacea* (L.)			0.06	0.02								
49	*Magdalis duplicata* GERM.	0.06	0.19	0.06	0.10		0.02		0.01	0.07	0.05	0.05	0.06
50	*Hylobius abietis* (L.)		0.12	0.02	0.04	0.02	0.09	0.42	0.17	0.18	0.07	0.05	0.10
51	*Pelenomus quadricorniger* (COLONN.)		0.02		0.01	0.02			0.01				
52	*Rhinoncus bruchoides* (HERBST)	0.04			0.01								
53	*Rhinoncus castor* (F.)	0.04			0.01	0.04		0.04	0.03	0.03	0.02		0.02
54	*Coeliodes rubicundus* (HERBST)		0.04	0.02	0.02								
55	*Ceutorhynchus pleurostigma* (MRSH.)	0.02			0.01								
56	*Ceutorhynchus assimilis* (PAYK.)	0.06	0.04		0.03						0.02		0.01
57	*Ceutorhynchus contractus* (MARSH.)									0.02			0.01
58	*Ceutorhynchus erysimi* (F.)		0.02	0.02	0.01								
59	*Ceutorhynchus punctiger* GYLL.			0.02	0.01								
60	*Creutorhynchus floralis* (PAYK.)	0.02			0.01		0.04		0.01	0.10	0.03	0.05	0.06
61	*Trichosirocalus barnevillei* (GRENIER)					0.02			0.01				
62	*Anoplus plantaris* (NAEZ.)	0.02	0.08	0.04	0.04	0.02			0.01		0.03		0.01
63	*Rhynchaenus avellanae* (DONOV.)	0.04			0.01								
64	*Rhynchaenus rusici* (HERBST)	0.06	0.06		0.04								
65	*Rhynchaenus stigma* (GERM.)	0.02			0.01	0.02			0.01				
66	*Rhamphus pulicarius* (HERBST)			0.02	0.01						0.09		0.03
	Total	11.05	14.40	11.40	12.27	7.04	30.26	16.31	7.29	3.61	7.50	5.35	5.47

occur in greater numbers. It should also be stressed that the abundance index of this species was greater in middle age stands than in mature stands. This is probably attributable to the ageing of the forest stand and the resultant reduction of its ability to propagate generatively and of the ability to bloom. Other abundant species include: *Magdalis linearis*, *Anthonomus phyllocola* and *M. phlegmatica* (pole wood); *A. phyllocola* and *M. linearis* (mature stands) (Tab. III).

Table II. Parameters of weevil communities dominant structure in forest stands of different age

ALL FOREST COMPLEXES

	young stand	middle age	mature stand
nm	7.2	17.4	11.0
N	48	41	38
$\overline{H}$	3.164	2.162	2.422

PUSZCZA BIAŁOWIESKA

	young stand	middle age	mature stand
nm	11.1	14.4	11.4
N	35	26	28
$\overline{H}$	2.995	2.797	2.775

PUSZCZA BIAŁA

	young stand	middle age	mature stand
nm	7.0	30.3	16.3
N	21	21	20
$\overline{H}$	2.613	1.280	1.697

BORY TUCHOLSKIE

	young stand	middle age	mature stand
nm	3.6	7.5	5.3
N	18	26	16
$\overline{H}$	3.274	2.396	2.494

nm – abundance index, N – number of species, $\overline{H}$ – index of species diversity

Table III. Abundance (nm) index of the various weevil species found in forest stands of different age. index nm – number of weevils caught into 10 Moericke's traps in 10 days

No.	stands' age / species	young	middle	mature
1	2	3	4	5
1	*Pselaphorhynchites longiceps* (TOMS.)	0.02		
2	*Deporaus mannerheimii* (HUMM.)	0.02		
3	*Ortiorhynchus ovatus* (L.)	0.02		
4	*Strophosoma fulvicorne* (WALT.)	0.05		
5	*Sitona griseus* (F.)	0.02		
6	*Sitona humeralis* STEPH	0.02		
7	*Hypera postica* (GYLL.)	0.02		
8	*Pissodes notatus* (F.)	0.02		
9	*Rhinoncus bruchoides* (HERBST)	0.04		
10	*Ceutorhynchus pleurostigma* (MRSH.)	0.02		
11	*Ceutorhynchus contractus* (MARSH.)	0.02		
12	*Trichosirocalus barnevillei* (GRENIER)	0.02		
13	*Rhynchaenus avellanae* (DONOV.)	0.04		

1	2	3	4	5
14	*Rhynchaenus stigma* (GERM.)	0.04		
15	*Phyllobius arborator* (HERBST)	0.06	0.04	
16	*Curculio rubidus* GYLL.	0.02	0.02	
17	*Magdalis frontalis* (GYLL.)	0.02	0.02	
18	*Pelenomus quadricorniger* (COLONN.)	0.02	0.02	
19	*Ceutorhynchus assimilis* (PAYK.)	0.06	0.06	
20	*Rhynchaenus rusici* (HERBST)	0.06	0.06	
21	*Rhinomacer attelaboides* F.	3.96	29.98	17.04
22	*Doydirhynchus austriacus* (OLIV.)	0.04	0.56	0.59
23	*Pselaphorhynchites nanus* (PAYK.)	0.04	0.10	0.06
24	*Deporaus betulae* (L.)	0.09	0.16	0.22
25	*Attelabus nitens* (SCOP.)	0.64	0.25	0.45
26	*Apoderus coryli* (L.)	0.06	0.02	0.02
27	*Apion simile* KIRBY	0.13	0.21	0.20
28	*Apion fulvipes* (GOFR.)	0.21	0.08	0.10
29	*Polydrusus pallidus* (GYLL.)	0.14	0.12	0.16
30	*Brachyderes incanus* (L.)	0.70	0.12	0.12
31	*Strophosoma capitatum* (DEGD.)	2.31	0.64	0.99
32	*Hylobius abietis* (L.)	0.20	0.27	0.49
33	*Anthonomus phyllocola* (HERBST)	0.95	2.53	2.32
34	*Brachonyx pineti* (PAYK.)	8.55	10.98	7.42
35	*Curculio pyrrhoceras* MARSH.	0.11	0.11	0.04
36	*Magdalis linearis* (GYLL.)	0.97	3.03	1.82
37	*Magdalis phlegmatica* (HERBST)	1.50	1.88	0.33
38	*Magdalis nitida* (GYLL.)	0.02	0.02	0.02
39	*Magdalis duplicata* GERM.	0.12	0.27	0.11
40	*Rhinoncus castor* (F.)	0.11	0.02	0.04
41	*Ceutorhynchus floralis* (PAYK.)	0.12	0.08	0.05
42	*Anoplus plantaris* (NAEZ.)	0.04	0.11	0.04
43	*Byctiscus betulae* (L.)		0.02	
44	*Apion vicinum* KIRBY		0.04	
45	*Apion austiacum* WAGN.		0.02	
46	*Apion vorax* HERBST		0.02	
47	*Phyllobius argentatus* (L.)		0.02	
48	*Sitona lepidus* GYLL.		0.03	
49	*Hypera zoilus* (SCOP.)		0.02	
50	*Pissodes piniphilus* (HERBST)		0.02	
51	*Apion virens* HERBST		0.02	0.04
52	*Sitona lineatus* (L.)		0.03	0.04
53	*Coeliodes rubicundus* (HERBST)		0.04	0.02
54	*Ceutorhynchus erysimi* (F.)		0.02	0.02
55	*Rhamphus pulicarius* (HERBST)		0.09	0.02
56	*Phyllobius pyri* (L.)			0.02
57	*Polydrusus pilosus* GREDL.			0.02
58	*Sitona crinitus* (HERBST)			0.02
59	*Magdalis violacea* (L.)			0.06
60	*Ceutorhynchus punctiger* GYLL.			0.02
61	*Apion curtirostre* GERM.	0.02		0.02
62	*Hypera nigrirostris* (F.)	0.02		0.02
63	*Hypera arator* (L.)	0.02		0.02
64	*Sibinia potentillae* GERM.	0.02		0.02
65	*Pissodes pini* (L.)	0.04		0.02
66	*Magdalis exarata* (BRIS.)	0.02		0.02
Total		21.70	52.14	33.04
average in the forest complex		7.23	17.38	11.01

Puszcza Białowieska

46 weevil species were identified in this area with 35 species found in young stands, 26 in middle age stands and 28 in mature stands (Tab. II). Total abundance indices in this area are not diversified being only slightly increased in middle age stands as compared with stands of other age classes. *Brachonyx pineti* was the dominant in young stands in Puszcza Białowieska, and was followed by *Rhinomacer attelaboides* whose abundance index was four times as high (Fig. 1). In middle age stands and mature stands, the dominant species was *R. attelaboides*. Its abundance index was only a little higher than that of *B. pineti* (Tab. I). In canopies of trees in all age classes of forest stands, the third most abundant species was *Anthonomus phyllocola*, a species which also develops in inflorescence. As in the case of *B. pineti*, this species was also most abundant in middle age stands, a little less abundant in mature stands, while in young stands its abundance was 2.5 times lower than in middle age stands. Other species abundant in young stands include: *Strophosoma capitatum*, *Attelabus nitens*, *Magdalis linearis* and *M. phlegmatica*. In middle age stands and mature stands the group of the most abundant species consisted chiefly of the same species as in young stands, but their sequence was different. One more species to be mentioned is *Doydirhinchus austriacus*, which, like *R. attelaboides*, develops in inflorescence, and *Magdalis duplicata*, which develops in decaying wood of pines.

Puszcza Biała

33 weevil species were identified in pine canopies in Puszcza Biała, including 21 recorded in young stands and middle age stands and 20 found in mature stands (Tab. II). The highest weevil abundance index was obtained for middle age stands. It was 4 times as high as in young stands and twice as high as in mature stands. The structure of dominance parallels that in Puszcza Białowieska. In young stands, *B. pineti* was the dominant and was closely followed by *R. attelaboides* (Fig. 2), while the latter species was the most abundant one in pole wood. The abundance index of this species was the highest one in all the forest areas studied, exceeding the index obtained for middle age stands canopies in Puszcza Białowieska 6 times and doubling that obtained for the mature stands in Puszcza Biała (Tab. I). *B. pineti* was another species numerously occurring in this area. The two species: *R. attelaboides* followed by *B. pineti*, were also the most abundant ones in mature stands. Apart from these two species, which are dominant in this region as they are in Puszcza Białowieska, several other species were abundant in the area, including: *Strophosoma capitatum*, *Magdalis phlegmatica*, *M. linearis* and *Brachyderes incanus* (young stands); *M. linearis*, *M. phlegmatica*, *Anthonomus phyllocola*, *S. capitatum* and *D. austriacus* (middle age stands); *M. linearis*, *Hylobius abietis*, *S. capitatum* and *A. phyllocola* (mature stands) (Tab. I). All the above species, except the polyphagous *S. capitatum*, are associated with pine. Moreover, most of them develop or feed in canopies. Only in this forest area, *H. abietis* was abundant in pine canopies, though this species

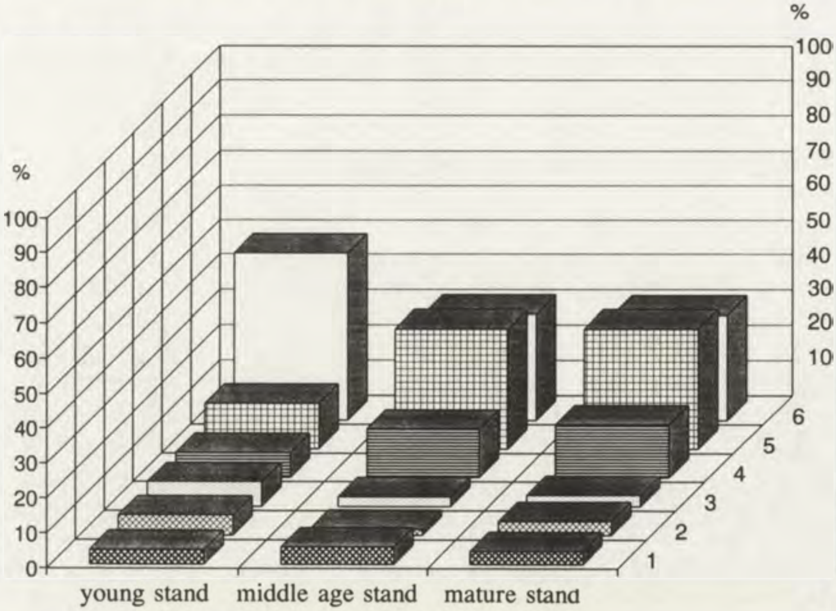

Fig. 1. Dominant structure of *Curculionidae* communities in stands of different age situated in Puszcza Białowieska. 1. *Magdalis linearis*, 2. *Attelabus nitens*, 3. *Strophosoma capitatum*, 4. *Anthonomus phyllocola*, 5. *Rhinomacer attelaboides*, 6. *Brachonyx pineti*.

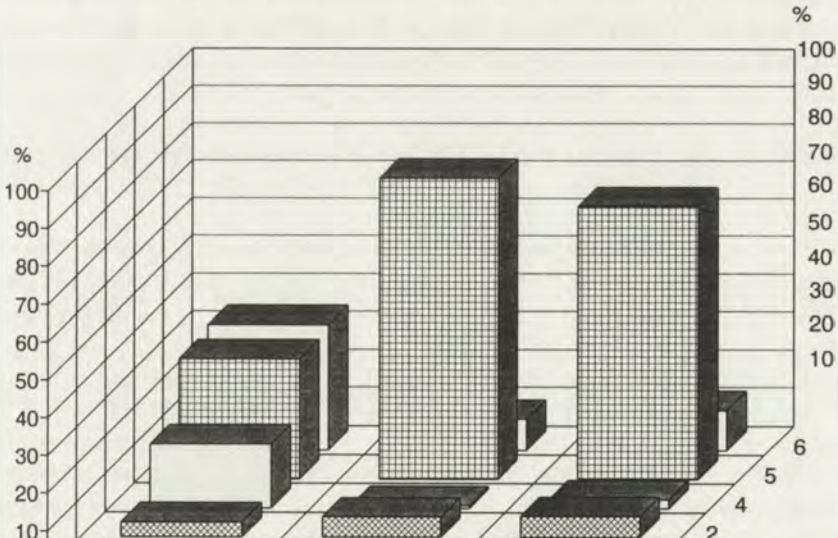

Fig. 2. Dominant structure of *Curculionidae* communities in stands of different age situated in Puszcza Biała. 1. *Anthonomus phyllocola*, 2. *Magdalis linearis*, 3. *Magdalis phlegmatica*, 4. *Strophosoma capitatum*, 5. *Rhinomacer attelaboides*, 6. *Brachonyx pineti*.

is more characteristic of forest crops. Its occurrence was most probably due to the fact that one of the study sites in a mature stand was located near a forest crop.

Bory Tucholskie

35 species were recorded in this area, including 18 in young stands, 26 in middle age stands and 16 in mature stands (Tab. II). Just as in the other forest areas studied, the highest abundance index was noted for middle age stands, while the lowest one was obtained for young stands. As in young stands of the other forests, *B. pineti* was the dominant species in stands of all age classes (Fig. 3). Its abundance was the highest in middle age stands, exceeding 4 times its lowest abundance (young stands). Other species abundant in young stands include: *M. phlegmatica*, *B. incanus*, *S. capitatum*, *R. attelaboides* and *M. linearis*. In middle age stands, *R. attelaboides* was the second most abundant species, before *M. phlegmatica* and *M. linearis*. All the other species recorded have low abundance indices (Tab. II). In the mature stands, as in middle age stands, the group of abundant species consisted of *B. pineti*, *R. attelaboides*, *M. linearis*, *M. phlegmatica* and *S. capitatum* (in the order of decreasing abundance).

DIVERSIFICATION OF WEEVIL COMMUNITIES

Some authors (ODUM 1977) posit that in the process of ecosystem succession, its increasing stability is accompanied by an increase in species diversity. Others do not observe such relationships (PIELOU 1966). The results of our study do not confirm the first thesis. No significant relationship has been observed between stand stability and increases in species diversity of weevils in the systems studied.

The weevils occurring in pine forests have been divided into certain biotic groups, on the basis of where the larvae and imagines feed (CHOLEWICKA-WIŚNIEWSKA 1993)*.

As far as the different age classes of forest stands are concerned, young stands had the greatest number of weevil species and the lowest weevil abundance indices. In middle age stands, the number of species decreased slightly, but there was a major increase in the abundance of the beetle communities (Tab. II).

In each of the forest areas studied, the abundance index of weevils in middle age stands and mature stands was the highest in Puszcza Biała, while in young stands it was the highest in Puszcza Białowieska. The lowest abundance indices were obtained for Bory Tucholskie in all age classes (Tab. II). The index of species diversity obtained for each forest area was the highest in young stands. In Puszcza Biała and Bory Tucholskie it was the lowest in middle age stands, while in Puszcza Białowieska the lowest values were obtained for mature stands.

* Due to much more numerous number of species in paper Cholewicka-Wiśniewska 1993, there was distinguished eleven biotic group while in this paper only ten.

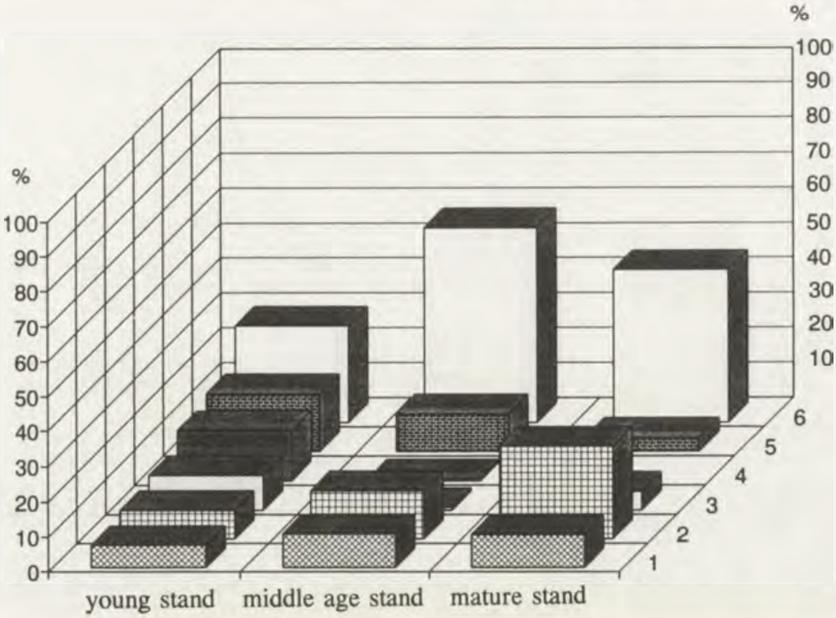

Fig. 3. Dominant structure of *Curculionidae* communities in stands of different age situated in Bory Tucholskie. 1. *Magdalis linearis*, 2. *Rhinomacer attelaboides*, 3. *Strophosoma capitatum*, 4. *Brachyderes incanus*, 5. *Magdalis phlegmatica*, 6. *Brachonyx pineti*.

With the lowest abundance indices and a relatively large number of species, the young stands in Bory Tucholskie have the highest index of species diversity (3.27). In Puszcza Biała, forest stands of all age classes have the lowest indices of species diversity. In pole wood of this area, where relatively few species were found, but they were very abundant, the index is the lowest of all the study sites in all age classes (1.28) (Tab. II).

An analysis of species composition of weevil communities in the process of succession does not reveal any species characteristic of any of the succession stages (Tab. III). It should be stressed that such species belong mainly to two of the biotic groups established: group 1 – species whose imagines and larvae develop in canopies of coniferous trees, and group 2 – imagines and larvae develop in the canopies of undergrowth-forming trees (Tab. IV). An analysis of abundance, in turn, allows to say that the most abundant species are those which occur in all succession stages (Tab. V). These species account for about 97% of the total number of weevils found in canopies. Within this group, species from the first biotic group have the highest percentage. Their abundance is crucial to the abundance of weevils throughout the succession process. Species of this group were the most abundant in middle age stands, and the least abundant in young stands. However, if one considers the abundance indices of other biotic groups, excluding group 1, completely different tendencies will emerge (Tab. V). The highest abundance indices are obtained in young stands

(4.9) being nearly twice as high as in mature stands (2.9), while in middle age stands they are the lowest (2.3).

Table IV. Number of species of various weevils biotic group

stands' age \ biotic group	1	2	3	4	5	6	7	8	9	10	Total
young stand	1	4				2	1	2	2	2	14
young stand, middle age stand	1	2						1	1	1	6
young stand, middle age stand, mature stand 8	6		3	1	1	1	1		1	22	
middle age stand	1	1	1		1	1		2		1	8
middle age stand, mature stand	2				1		2			5	
mature stand	2					1	1			1	5
young stand mature stand	1	1	1						2	1	6
Total	14	16	2	3	2	6	3	8	5	7	66

Biotic group:
1. Larvae and imagines are living in coniferous canopy layer, 2. Larvae and imagines are living the undergtowth canopy layer, 3. Larvae and imagines are living on above ground part of herbs, 4. Larvae are feeding on the roots, imagines on above groumd part of coniferous trees, 5. Larvae are feeding on the roots, imagines in the canopy layer of undergrowth, 6. Larvae are feeding on the roots, imagines on the above ground part of herbs, 7. Polyphagous species, 8. Species are migrating for hibernation, 9. Species arrived accidentally, 10.Unknown development

The weevil species which were only caught in stands of one succession stage were represented by single specimens (Tab. III). The average abundance index for weevils occurring in one succession stage only equals 0.026. It is a little higher (0.036) for weevils occurring in two of the succession stages. Values as low as these indicate that the species are accidental in those environments and cannot be treated as characteristic species.

Table V. Abundance index (mn – for Moericke's traps) of the various weevils biotic group in forest stands of different age. (Number of biotic group the same as on Table IV)

stands' age / biotic group	young stand	middle age stand	mature stand	young stand	middle age stand	young stand	middle age stand	mature stand	middle age stand	mature stand	young stand	mature stand
1	0.02	0.02	0.08	0.02	0.02	16.11	49.25	29.65			0.04	0.02
2	0.12	0.02	0.02	0.08	0.08	1.07	0.85	0.99	0.13	0.04	0.02	0.02
3		0.02									0.02	0.02
4		0.02				1.04	0.51	0.77				
5		0.03										
6	0.04		0.02			0.11	0.02	0.04	0.03	0.04		
7	0.05		0.02			2.31	0.64	0.99				
8	0.04	0.06		0.06	0.06	0.33	0.16	0.15	0.04	0.06		
9	0.06			0.02	0.02						0.04	0.04
10	0.04	0.02	0.02	0.06	0.04	0.04	0.11	0.04			0.02	0.02
Total	0.37	0.19	0.16	0.24	0.22	21.01	51.54	32.63	0.20	0.14	0.14	0.12

The values of the index of species composition similarity calculated for the different succession stages of the forest stand are largely similar oscillating between 0.63 and 0.68 (Tab. VI), which indicates similar degrees of species composition diversity in each age class of the coniferous forests studied.

The values of the similarity index of weevil communities of stands of different age in each of the forest areas range from 0.37 to 0.78 (Tab. VI). While comparing differently-aged stands within one forest area, the greatest diversification can be observed in Puszcza Biała, while the smallest differences occur in Puszcza Białowieska. The most unique stand in terms of species composition is the young stand in Bory Tucholskie. The samples collected there contained such species as *Sitona griseus, S. humeralis, Hypera postica* – pests to papilionaceous plants, or *Ceutorhynchus contractus* feeding on plants of the mustard family (*Cruciferae*). While certain papilionaceous plants are characteristic of pine forests, *Cruciferae* were never present in the areas studied.

The greatest differences in the similarity of dominance structures, expressed by Morisita's index, within one forest area were observed in Puszcza Biała, while the areas in Puszcza Białowieska were the most similar in this respect (Tab. VII). The middle age stands and mature stands in Puszcza Biała are characterized by a one-species dominance pattern with *R. attelaboides* constituting more than 70% of the communities. The index of dominance structure similarity for the two areas is as high as 0.99. In young stands, on the other hand, the abundance index of the dominant *B. pineti* is only a little lower than of the subdominant *R. attelaboides*. A result of such a structure of dominance in this forest area is a decreased index of similarity between the young stands and the stands of other age classes. In Puszcza Białowieska, the middle age stands and mature stands are characterized by very similar percentages of the three most numerous species: *R. attelaboides, B. pineti* and *A. phyllocola*. Since such a structure of dominance is not observed in the other areas compared, the index of dominance structure similarity for these stands is the highest (1.00). A high similarity of dominance structures is observed between the young stands in Puszcza Biała and the mature stands of Bory Tucholskie as well as between stands of different age classes in Puszcza Białowieska and the mature forests in Bory Tucholskie. *Curculionidae* communities in the above stands can be said to have two co-dominant species: *R. attelaboides* and *B. pineti* whose percentages are comparable and amount to 30–40%.

All the forest areas studied display a high degree of dominance structure similarity between middle age stands and mature stands weevil communities of the same forest. It is higher than the similarity between stands of the same age situated in different forests.

The process of forest stand growth is accompanied by changes in the species composition and dominance structure of weevil communities. These changes are due to various factors from the biotic and abiotic environment. In the case of herbivorous plants, the most important biotic factors include the nutritive value of leaves, which depends on the tree age. Leaves of young plants are more valuable (SZUJECKI 1980). The needle-eating *B. pineti* is a persistent pest to pine. It is now considered responsible for 40–80% of insect-induced needle damage.

Table VI. Degree of similarity of the species composition of weevil communities in each forest area (by Jaccard's and Söerensen's formula)

		Puszcza Białowieska			Puszcza Biała			Bory Tucholskie			All forest complexes		
		young stand	middle age stand	mature stand	young stand	middle age stand	mature stand	young stand	middle age stand	mature stand	young stand	middle age stand	mature stand
Puszcza Białowieska	young stand	×	0.59	0.50	0.50	0.54	0.55	0.40	0.63	0.55	0.84	0.66	0.66
	middle age stand	18	×	0.58	0.55	0.60	0.52	0.39	0.62	0.67	0.70	0.78	0.63
	mature stand	16	16	×	0.48	0.56	0.50	0.37	0.70	0.58	0.53	0.70	0.85
Puszcza Biała	young stand	14	13	12	×	0.57	0.78	0.49	0.51	0.59	0.61	0.48	0.58
	middle age stand	15	14	14	12	×	0.63	0.59	0.60	0.76	0.49	0.68	0.54
	mature stand	15	12	12	16	13	×	0.50	0.52	0.62	0.56	0.46	0.69
Bory Tucholskie	young stand	11	9	9	10	12	10	×	0.52	0.56	0.55	0.44	0.43
	middle age stand	19	16	19	12	14	12	12	×	0.62	0.62	0.78	0.63
	mature stand	14	14	13	11	14	12	10	13	×	0.47	0.53	0.59
All forest complexes	young stand	35	23	20	21	17	19	18	23	15	×	0.63	0.65
	middle age stand	25	26	24	15	21	14	13	26	15	28	×	0.68
	mature stand	24	20	28	17	16	20	12	20	16	28	27	×

Table VII. Similarity of dominance structure of weevil communities in each forest area (by Morisita's formula)

		Puszcza Białowieska			Puszcza Biała			Bory Tucholskie			All forest complexes		
		young stand	middle age stand	mature stand	young stand	middle age stand	mature stand	young stand	middle age stand	mature stand	young stand	middle age stand	mature stand
Puszcza Białowieska	young stand	×	0.83	0.82	0.86	0.33	0.38	0.79	0.96	0.95	0.97	0.60	0.66
	middle age stand		×	1.00	0.92	0.69	0.75	0.66	0.77	0.93	0.88	0.89	0.93
	mature stand			×	0.91	0.69	0.74	0.63	0.76	0.92	0.87	0.88	0.92
Puszcza Biała	young stand				×	0.64	0.69	0.76	0.80	0.93	0.93	0.83	0.86
	middle age stand					×	0.99	0.25	0.33	0.55	0.43	0.94	0.89
	mature stand						×	0.29	0.37	0.60	0.48	0.96	0.93
Bory Tucholskie	young stand							×	0.77	0.76	0.86	0.44	0.49
	middle age stand								×	0.94	0.92	0.56	0.60
	mature stand									×	0.97	0.77	0.81
All forest complexes	young stand										×	0.66	0.72
	middle age stand											×	0.99
	mature stand												×

In Puszcza Białowieska this species was definitely most abundant in young stands, while in Puszcza Biała and Bory Tucholskie it was more abundant in middle age stands. In non-transformed coniferous forests it is more often found in the earlier succession stages of forest stands, i.e. in young stands, while in mature stands it is quite rare. In areas transformed by industrial pollution (CHŁODNY 1982), this species is still dominant in mature stands, which may be interpreted as a "lack of maturity" of these weevil communities. The structure of both Puszcza Biała and Bory Tucholskie is visibly different from the original one preserved to a great extent in Puszcza Białowieska.

Another cause of increased abundance of the needle pest in mature as compared to young stands may be compromised pest resistance of trees. The degree of pine's resistance to herbivorous insects is depends mainly on the presence of sufficient amount of food substances in the soil, which stimulates the production of volatile oils, alkaloids and resin. Pine cultures growing on weak sandy soils, where these substances are not excreted in large amounts, are more vulnerable to pests (SZUJECKI 1980).

SUMMARY AND CONCLUSIONS

The study did not reveal any relationship between forest stand ageing and increases in species diversity of the systems studied. On the other hand, an opposite trend was observed: forest stand growth is accompanied by a decrease in the number of weevil species. Such a relationship, however, has not been discovered as far as abundance is concerned. The highest weevil abundance indices were obtained for middle age stands, and the lowest for young stands.

If one compares the similarity of dominance structure of weevil communities of different forest stand succession stages in each of the forests studied with the structure obtained for all the forests, one can see that the most similar communities usually inhabit stands belonging to one age class. Weevil communities of middle age stands and mature stands in Bory Tucholskie are the only exception since their structures of dominance are the most similar to the communities of young stands.

B. pineti, the dominant species in young stands of all forests studied, was also a dominant in middle age stands and mature stands in Bory Tucholskie.

An analysis of community diversification in stands of each growth stage did not reveal any species characteristic of such stages. The largest group of species comprised species occurring in all age classes. The total abundance of such beetles accounts for as much as 97% of all weevils caught in pine canopies.

Within one forest area, the greatest differences in both species composition and dominance structure similarity of *Curculionidae* communities was observed in Puszcza Biała. It indicates that systems of different levels of organization have different ecological conditions. The lowest values of the two indices obtained for Puszcza Białowieska weevil communities indicate a small degree of diversification of the various stages of forest stand development.

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Muzeum i Instytut Zoologii PAN
Wilcza 64
00-679 Warszawa, Poland

STRESZCZENIE

[Tytuł: Zgrupowania ryjkowców (*Coleoptera, Curculionidae*) w różnych wiekowo drzewostanach wybranych borów świeżych Polski]

Badaniami objęto zgrupowania ryjkowców uwzględniające gatunki zaliczane do następujących rodzin: *Attelabidae, Rhinomaceride, Apionidae* i *Curculionidae*.

Celem pracy była ocena stabilności zgrupowań ryjkowców w trakcie procesów sukcesji, przebiegających wraz z procesem starzenia się drzewostanów. Postawione zadania zrealizowano poprzez zbadanie składu gatunkowego, struktury dominacyjnej i zmian liczebności gatunków dominujących w młodnikach, drzewostanach III klasy wieku i w starodrzewach.

Badania prowadzono w trzech kompleksach borów sosnowych świeżych na terenie Polski: Puszczy Białowieskiej, Puszczy Białej i w Borach Tucholskich w drzewostanach różnowiekowych, gdzie stwierdzono występowanie 66 gatunków. Chrząszcze odławiano pułapkami Moerickego w koronach sosen w latach 1986–87.

Najwięcej gatunków występuje w młodnikach: ogółem 48 gatunków, na terenie drzewostanów III klasy wieku 41, a najmniej w starodrzewach 38 gatunków. Wskaźnik liczebności ryjkowców dla różnych klas wiekowych drzewostanów jest największy na terenie III klasy wieku, natomiast najniższy dla młodników.

Gatunkiem dominującym na terenie młodników jest *Brachonyx pineti*, którego liczebność jest ponad dwukrotnie większa od również licznie występującego, w drzewostanach tej klasy wieku, *Rhinomacer attelaboides*. Dominantem w starszych drzewostanach jest *R. attelaboides*, a subdominantem *B. pineti*. Biologia obu gatunków związana jest z sosną. Jednak *R. attelaboides* rozwija się w kwiatostanach, a *B. pineti* w młodych igłach.

Gatunki występujące na terenie borów świeżych podzielone zostały na 10 grup biotycznych w zależności od miejsca bytowania larw i imago. Rozpatrując skład gatunkowy ryjkowców w procesie sukcesji stwierdzono brak gatunków charakterystycznych dla poszczególnych stadiów. Najwięcej gatunków występuje we wszystkich klasach wieku. Należy podkreślić, że gatunki te stanowią głównie dwie, spośród wyróżnionych, grupy biotyczne: 1 – imago i larwa rozwijające się w koronach drzew iglastych oraz 2 – imago i larwa rozwijające się w koronach drzew podszytu. Natomiast rozpatrując liczebność gatunków stwierdzono, że w największych liczebnościach wystąpiły gatunki zaliczone do 1 grupy biotycznej. Największe wskaźniki liczebności gatunków zaliczonych do tej grupy wystąpiły w drzewostanach III klasy wieku, a najmniejsze w młodnikach.

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