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Changes in communities of longhorn and buprestid beetles (*Coleoptera: Cerambycidae, Buprestidae*) accompanying the secondary succession of the pine forests of Puszcza Białowieska

Abstract. Results of a study of *Buprestidae* and *Cerambycidae* in the pine forests of Puszcza Białowieska (NE Poland) are presented. 16 and 49 species have been registered respectively. Succession of these taxons in four age classes of forest stand (culture, young stand, pole wood, mature stand) has been analysed, and conspicuous differences have been revealed in species composition, structure of dominance, abundance and diversity.

INTRODUCTION

Beetles of the families *Cerambycidae* and *Buprestidae* are mainly cambio- and xylophagous forms. 189 and 87 species of the respective families have been recorded in Poland to date. The number of species potentially associated with the fresh pine forest habitat and its plants is about 55 and about 25 respectively.

Fresh coniferous forests are the dominant habitat type of forest in Poland. The identification of their fauna, including xylo- and cambiophages, is, therefore, important from both the cognitive and practical point of view.

Puszcza Białowieska is a unique area of the best preserved forests in the entire European Lowlands. Studies conducted in Puszcza Białowieska make it possible to register facts that are not likely to be detected in other areas, more affected by anthropopression. Owing to this one may investigate relatively untransformed population structures of the species under study, thus serving as a frame of reference for the results of similar studies carried out in other regions of Europe.

The aim of this paper was to investigate the secondary succession of the *Cerambycidae* and *Buprestidae* fauna associated with forest stands growing in a fresh coniferous forest habitat in Puszcza Białowieska. This is further

associated with the identification of the trophic relations of individual species, their distribution in Puszcza Białowieska, community structure, etc.

The groups under study, and particularly *Buprestidae*, have never before been the subject of extensive succession-centred investigations in fresh pine forests. Papers written to date are concerned predominantly with the entomofauna of pine forests in general, not in terms of forest age classes, or deal with a particular age class, e.g. young stands.

Research over the entomofauna of different habitat types of forests, ranking among the first such enterprises in the world, was initiated in Puszcza Białowieska before World War II by J. KARPIŃSKI. He explored, among other taxons, *Cerambycidae* of this region, assigning each species to a forest type he himself had defined (KARPIŃSKI, 1949). In his study of *Pinetum typicum*, which may be considered a fresh coniferous forest in the current understanding of this term, he mentioned 21 species. Further analysis of the data provided by KARPIŃSKI (op. cit.) has been performed by SZUJECKI (1980).

The longhorn beetle fauna of various forest habitat types in Puszcza Niepołomicka has been described by STARZYK (1976), who noted 17 species in a fresh coniferous forest, but did not break the data down into age classes. The figure stands for 21.8% of the total number of species analysed, and, in comparison to 51 species recorded in the fresh mixed forest or 50 registered in the humid forest, is rather low.

TOMALAK (1984), who studied *Cerambycidae* of the pole wood and mature stands in the environs of Poznań, found 18 species of these beetles in a fresh coniferous forest, which corresponds to 29.5% of the total number of species recorded in the area under investigation. In a similar study of Puszcza Białowieska, GUTOWSKI (1985) found 40 species in fresh coniferous forests, equalling to 36.7% of the total number of species recorded. In comparison to other forest habitat types, the number of species was in the middle range as the greatest number of species (66) has been recorded in a fresh mixed forest and the smallest (11), in a boggy coniferous forest.

In his recently published paper on the Roztocze area, GUTOWSKI (1992) has analysed the occurrence of 38 *Cerambycidae* species of high abundance and frequency in 10 different habitats (including 8 phytosociological groups which are directly referrable to specific forest habitat types). 23 species were found in the subcontinental pine forest (*Peucedano-Pinetum*), the dominant forms being: *Acanthocinus aedilis*, *Anastrangalia sanguinolenta*, *Arhopalus rusticus*, *Corymbia rubra*, *Rhagium inquisitor*, *Spondylis buprestoides* and *Stenurella melanura*. Also in Roztocze, this habitat type accommodated a medium number of longhorn beetle species.

A description of the entire entomofauna associated with xylem and the subcortical environment in Wielkopolski National Park has been provided by BAŁAZY and MICHALSKI (1984). The authors recorded 14 *Cerambycidae* species in the fresh coniferous forest, listing *Arhopalus ferus*, *Pogonocherus decoratus*, *P. fasciculatus* and *Prionus coriarius* as characteristic of that habitat. *Buprestidae* found by the authors in fresh coniferous forests included *Anthaxia similis*,

Chalcophora mariana and *Phaenops cyanea*, all the species being characteristic of that habitat.

A study of the succession of longhorn beetles depending on the age of the stands has been carried out in Puszcza Niepołomicka by STARZYK (1977). The study, however, included all the forest habitat types of that region, where fresh coniferous forests constitute only 7.25% of the stand. It cannot be, therefore, determined which *Cerambycidae* species found, for example, on Scots pine (*Pinus sylvestris L.*), were registered in the habitat relevant to us or whether the preferences for trees of particular ages do not depend on the habitat type. It is still interesting to note that there were species which were shown to be affiliated with certain age classes (9 classes: I – 1–20 years, II – 21–40 years, etc). *Arhopalus rusticus* and *Rhagium inquisitor* were shown to occur most widely on pine (I–IX age class), while *Ergates faber* occurred only on trees of age class IV and V, and *Callidium aeneum* – age class III–V. Of the 28 species feeding on pine, 8 were recorded in age class I, 16 in age class II, and then: age class III – 22, IV – 19, V – 15, VI – 10, VII – 10, VIII – 5, and IX – 2.

Studies of the succession of selected animal groups in the fresh coniferous forest in Puszcza Białowieska have been conducted by WOŁK and GUTOWSKI (1984). Neither *Buprestidae* nor *Cerambycidae* were, however, described separately in the study, which concentrated only on invertebrates as a whole as well as on certain other groups of beetles.

There are a number of papers where fragmentary information relevant to the subject of this study may be found. For example, KINELSKI and SZUJECKI (1963) have presented the results of studies of secondary pests in young stands of pine (age class I and II) in Puszcza Piska, mentioning 6 species of *Cerambycidae* (*Rhagium inquisitor, Arhopalus rusticus, Callidium* sp., *Monochamus galloprovincialis pistor, Pogonocherus fasciculatus* and *Acanthocinus aedilis*) and 2 species of *Buprestidae* (*Anthaxia quadripunctata, Chrysobotris igniventris* [listed as *C. solieri*]).

WIĄCKOWSKI (1957) has examined the entomofauna of pine tree stumps in different stages of wood decomposition (from fresh – right after clear-cutting, to more than 10 years old) also in a fresh coniferous forest habitat. These data may be referred to the first succession stages of the forest stand – clearing and culture, where stumps are the basic source of food for the groups under study. Species associated with stumps at this stage included the longhorn beetle species of *Ergates faber* and *Arhopalus rusticus* and the buprestid *Chalcophora mariana*.

BRAUNS (1975) has listed insects occurring on pine in different age classes. One may suppose (the author did not make it clear) that the study was conducted chiefly in fresh coniferous forests. The following species of longhorn beetles were mentioned as characteristic of tree nurseries, cultures, young stands, pole wood and mature stands: *Pogonocherus fasciculatus* (from cultures to mature stands), *Tetropium castaneum, T. fuscum, Monochamus sartor* (FABR.), *M. sutor* and *Acanthocinus aedilis* (pole wood and mature stands). The only *Buprestidae* species mentioned was *Phaenops cyanea*, characteristic of pole wood and mature stands.

Research over the insects of the pine forests in Byelorussia is also presented by Litvinova et al. (1985).

There are numerous papers by European authors dealing with longhorn or buprestid beetle communities of various age classes of Scots pine – the main stand-forming species in fresh coniferous forests. Most of them, however, do not contain information on the habitat type where the studies were conducted, which renders them useless from the viewpoint of the present analysis. Scots pine is also abundantly found in the dry, humid and boggy coniferous forest as well as in mixed forests and is also planted in more fertile forest habitats.

Comprehensive studies of the entomofauna of fresh coniferous forests, conducted since 1986 in Puszcza Białowieska and other localities by the Institute of Zoology PAS. and the Forest and Wood Protection Institute of Warsaw Agricultural University, have not included the groups discussed in this paper (BAŃKOWSKA 1993).

AREAS OF STUDY, MATERIAL, METHODS

Areas of study

Puszcza Białowieska occupies an area of about 1,500 sq. km. Its western part, belonging to Poland, extends over 624 sq. km. (SOKOŁOWSKI 1994). Fresh coniferous forests are represented in Puszcza Białowieska by two phytosociological associations (SOKOŁOWSKI 1979): *Vaccinio vitis-idaeae-Pinetum* and *Vaccinio myrtilli-Piceetum*. The former, with the stand consisting mainly of Scots pine, is further classified into two subassociations: *cladonietosum* (a drier one with a high proportion of xerothermal species) and *myrtilletosum* (slightly more humid with *Vaccinium myrtillus* L. in the herb layer). This association is seen mainly in the districts of Browsk, Starzyna, Ladzka Puszcza and in a small area in the Białowieża National Park. It is more abundant in the Byelorussian part of the forest. MATUSZKIEWICZ (1982) has classified associations of this type into *Peucedano-Pinetum*.

The *Vaccinio myrtilli-Piceetum* association, where the stand is composed of spruce and there is rarely a small addition of pendula birch and, sporadically, of pine. It is distributed in small patches throughout Puszcza Białowieska and in the Białowieża National Park. Unlike the former association, which is in retreat, the latter is expansive in this area; it has not been separated by MATUSZKIEWICZ (op. cit.).

In terms of area, the fresh coniferous forest is not amply represented in the Polish part of Puszcza Białowieska, occupying only 6.3% of the region (Referat... 1994).

Material and methods

The study was conducted in the pine forest situated throughout Puszcza Białowieska in 1979–1994. The eastern (Byelorussian) part was explored to a much smaller extent, and only in the years 1991–1993.

The faunal material necessary to compile maps of the distribution of individual species of longhorn and buprestid beetles was collected using various methods. Most specimens were collected by "stalking" on tree stems and stumps, cordwood and flowers etc. For *Buprestidae*, all of the individuals spotted were caught, while in *Cerambycidae*, if the specimen could be species-determined on the site, it was not caught, and only the name of species, the number of specimens and other details about the site were noted. Other methods included sweeping the herb layer and tree and shrub branches with a sweeping net as well as collecting specimens into Barber's and Moericke's pitfall traps, foil window-traps, and decoying the insects with an artificial source of light etc. Searches for *Buprestidae* and *Cerambycidae* based on analysis of potential breeding material of their larvae turned out to be extremely efficient. In such cases, the larvae and pupae or the feeding grounds served as a basis for recognizing species. In order to confirm the finding, larvae and pupae were sometimes raised up to the imago stage.

In order to trace the succession of longhorn and buprestid beetles in stands of various ages in fresh coniferous forests, 3 different corpora of materials were used. The first corpus is a small, but interesting, collection of *Cerambycidae* (66 individuals) caught in 1986 by researchers from the Institute of Zoology P.A.S. in Warsaw and given to me for the sake of this paper. The beetles were collected in young stands, the pole wood and mature stands into Moericke's pitfall traps hung in tree canopies. The catches were conducted in the south-eastern part of Puszcza Białowieska, throughout the vegetational season, the traps (5 at each site) being emptied every two weeks. More detailed information concerning the premises of and methods used in these studies may be found in a paper by BAŃKOWSKA (1993).

Another corpus of materials comes from analyses of deadwood trees in two fixed areas, 0.25 ha each, situated in division 519 D (pole wood 55 years old) and 494 C (natural mature stands 120–150 years old). In both developmental stages, the stand was formed of pine, which is a prominent dominant there, with an addition of spruce and individual specimens of pendula birch. The herb layer is composed mainly of *Vaccinium myrtillus* and *V. vitis-idaea* L. Both areas belong to the *Vaccinio vitis-idaeae-Pinetum* association. In the years 1988–1994, naturally-forming deadwood was monitored in these areas twice a year (May/June and October/November). The decaying trees were cut down and analysed in consecutive sections, notes being made of the inhabitant species and numbers of specimens. Moreover, every year in autumn "autumn searches" for pests of pine were performed under the canopies of average trial trees. The pests were searched for thoroughly in the litter and the surface layer of the soil. The total number of *Cerambycidae* individuals collected in this way was 153 in the pole wood and 287 in mature stands.

The third and largest corpus of material comes from a study specially designed for the sake of this paper and carried out in division 539 C (*Vaccinio vitis-idaeae-Pinetum* association), where broad belts of stands (100–160 m) of different ages grow side by side (2–year-old culture, 15–year-old young stand,

38–year-old pole wood, 120–150-year-old mature stand). 781 *Cerambycidae* species and 177 *Buprestidae* specimens were collected in the study in 1994.

Mature pine forest stand with an addition of Norway spruce *Picea abies* (L.) KARST. and pendula birch *Betula pendula* ROTH forms naturally. The brushwood is composed of spruce, and more rarely, oak, while the understorey, apart from spruce, consists of individual trees of *Quercus robur* L., *Sorbus aucuparia* L., *Frangula alnus* MILLER, *Juniperus communis* L. and *Salix caprea* L. The most abundant species in the herb layer are *Vaccinium myrtillus*, *V. vitis-idaea* and *Agrostis tenuis* SIBTH. The mature stand is adjacent to a culture established after a clear-cutting and renewed with pine, with individual examples of *Betula pendula*, *Quercus robur*, *Populus tremula* (L.), *Sorbus aucuparia*, *Picea abies*, *Juniperus communis*, most of which were self-sown. The dominant species in the herb layer are *Senecio sylvaticus* L., *Rumes tenuifolius* (WALLR.) A'LÖVE, *Vaccinium myrtillus* and *Agrostis tenuis*. The basis for the development of the two beetle groups under study is provided by stumps of clear-cut trees and clear-cutting remains – fragments of trunks, boughs and branches, etc. The very dense 15–year-old young stand is composed of planted pine with an addition of self-sown pendula birch and individual small spruce trees. *Cytisus scoparius* (L.) LINK, *C. ruthenicus* (FISCH. ex WOŁ.) A. KLASK., *Populus tremula*, *Frangula alnus*, *Salix caprea*, *Quercus robur* and *Sorbus aucuparia* also occur sporadically. The very poor herb layer is composed of *Vaccinium myrtillus*, *V. vitis-idaea*, *Calluna vulgaris* (L.) HULL and other. The 38-year-old pole wood, separated by a band of thicket from the young stand, is a pine forest stand with a considerable addition of spruce, single specimens of pendula birch and, sporadically, oak. *Quercus robur*, *Picea abies*, *Betula pendula*, *Frangula alnus*, *Salix caprea*, *Sorbus aucuparia* and *Cytisus ruthenicus* occur in the understorey. The dominant species in the herb layer include: *Vaccinium myrtillus*, *V. vitis-idaea*, *Pteridium aquilinum* (L.) KUHN and *Calluna vulgaris*.

In each of the four age classes of the stand, 9 Moericke's pitfall traps (3 x 3) were hung at a height of 1 m. They remained in place from April 26 to June 5 1994 and were emptied every two weeks, resulting in 5 sampling series. Moreover, "stalking" was conducted 10 times in half-an-hour "sessions" and sweeping nets (10 x 25 sweeps) were used 4 times at each site. However, the most abundant material was obtained by analysis of potential food reasurces in 100–meter-long transects (each stump, dry branch, tree trunk in a belt 2 m wide was barked, split and analysed) at each site.

In order to characterise the groups under study in each forest stand age class, statistical calculations were done concerning the structure of the fauna. The empirical distributions were compared to theoretical models: the geometrical progression series, logarithmic series, lognormal series, random resource division model and binomial negative distribution. Species diversity indices were also calculated according to Shannon and Weaver (H) and Simpson (I). More detailed information on these model and indices are to be found in a paper by TROJAN (1992). In order to investigate the similarity (P) between *Buprestidae* and *Cerambycidae* communities in the culture, young stand, pole wood and mature stand stages, the "percentage" version of Sørensen's formula was employed.

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RESULTS AND DISCUSSION

Faunistical analysis

49 *Cerambycidae* species were recorded in the fresh coniferous forests of Puszcza Białowieska (Tab. I). This corresponds to 41.2% of the total number of longhorn beetle species registered in this area. All the species were collected in the Polish part of Puszcza Białowieska, and 44 of them were also identified in the Byelorussian part. 46 species were found in Białowieża National Park.

The following conventional symbols were used to describe the abundance and frequency of the beetles in the entire Puszcza Białowieska (Tab. I and II) respectively: l – abundant, n – not abundant, c – frequent, r – rare. The following boundary values were assumed: 30 individuals and 7 sites (a site corresponded to a forest division, an approximately 1 x 1 km square) for *Cerambycidae* and 10 individuals and 5 sites for *Buprestidae*. The *Cerambycidae* recorded include genuine faunal rarities on a European scale, such as *Acmaeops marginata*, *A. septentrionis*, *Stictoleptura variicornis* and *Grammoptera abdominalis*. One of them – *Monochamus urussovii* – has actually been recorded in Central Europe only from Puszcza Białowieska.

Table I. Catalogue of longhorn beetles (*Coleoptera, Cerambycidae*) of the fresh coniferous forests of Puszcza Białowieska (BNP – Białowieża National Park, Bśw – fresh coniferous forests, l – abundant, n – not abundant, c – frequent, r – rare; further explanation – see text).

No	Species	Abundance and frequency in Bśw	Polish part (including BNP)	B N P	Byelorussian part
1	2	3	4	5	6
1	*Ergates faber* (L.)	n – r	•	•	•
2	*Prionus coriarius* (L.)	n – r	•	•	•
3	*Tetropium castaneum* (L.)	l – c	•	•	•
4	*Tetropium fuscum* (FABR.)	l – c	•	•	•
5	*Spondylis buprestoides* (L.)	l – c	•	•	•
6	*Arhopalus rusticus* (L.)	l – c	•	•	•
7	*Asemum striatum* (L.)	l – c	•	•	•
8	*Molorchus minor* (L.)	l – c	•	•	•
9	*Hylotrupes bajulus* (L.)	n – r	•	•	•
10	*Callidium aeneum* (DE GEER)	n – r	•	•	
11	*Callidium violaceum* (L.)	l – c	•	•	•

1	2	3	4	5	6
12	*Callidium coriaceum* PAYK.	l – r	*	*	*
13	*Phymatodes testaceus* (L.)	n – r	*	*	*
14	*Xylotrechus rusticus* (L.)	n – r	*	*	*
15	*Plagionotus arcuatus* (L.)	n – r	*	*	*
16	*Rhagium mordax* (DE GEER)	l – c	*	*	*
17	*Rhagium inquisitor* (L.)	l – c	*	*	*
18	*Oxymirus cursor* (L.)	n – r	*	*	*
19	*Pachyta quadrimaculata* (L.)	n – r	*	*	*
20	*Acmaeops septentrionis* (C. G. THOMS.)	n – r	*	*	
21	*Acmaeops marginata* (FABR.)	n – r	*	*	*
22	*Cortodera femorata* (FABR.)	l – r	*	*	*
23	*Grammoptera abdominalis* (STEPH.)	n – r	*	*	
24	*Pedostrangalia pubescens* (FABR.)	n – r	*	*	*
25	*Leptura quadrifasciata* L.	n – c	*	*	*
26	*Anastrangalia sanguinolenta* (L.)	l – c	*	*	*
27	*Corymbia rubra* (L.)	l – c	*	*	*
28	*Stictoleptura variicornis* (DALM.)	n – r	*	*	
29	*Brachyleptura maculicornis* (DE GEER)	n – c	*	*	*
30	*Judolia sexmaculata* (L.)	n – r	*	*	*
31	*Alosterna tabacicolor* (DE GEER)	n – r	*	*	*
32	*Pseudovadonia livida* (FABR.)	l – c	*	*	*
33	*Strangalia attenuata* (L.)	n – r	*	*	*
34	*Stenurella melanura* (L.)	l – c	*	*	*
35	*Stenurella bifasciata* (O. F. MÜLL.)	n – r	*	*	
36	*Stenurella nigra* (L.)	n – r	*	*	*
37	*Monochamus galloprovincialis pistor* GERM.	l – c	*	*	*
38	*Monochamus urussovii* FISCH.	n – r	*	*	*
39	*Monochamus sutor* (L.)	n – r	*	*	*
40	*Pogonocherus fasciculatus* (DE GEER)	l – c	*	*	*
41	*Pogonocherus decoratus* FAIRM.	l – c	*	*	
42	*Acanthoderes clavipes* (SCHRANK)	n – r	*	*	
43	*Acanthocinus griseus* (FABR.)	l – r	*	*	*
44	*Acanthocinus aedilis* (L.)	l – c	*	*	*
45	*Leiopus nebulosus* (L.)	n – r	*	*	*
46	*Tetrops praeusta* (L.)	n – r	*	*	*
47	*Saperda perforata* (PALL.)	n – r	*	*	*
48	*Saperda scalaris* (L.)	n – r	*	*	*
49	*Saperda populnea* (L.)	n – r	*	*	*
	Total		49	46	44

Table II. Catalogue of buprestid beetles (*Coleoptera, Buprestidae*) of the fresh coniferous forests of Puszcza Białowieska (BNP – Białowieża National Park, Bśw – fresh coniferous forests, l – abundant, n – not abundant, c – frequent, r – rare; further explanation – see text).

No	Species	Abundance and frequency in Bśw	Polish part (including BNP)	BNP	Byelorussian part
1	*Chalcophora mariana* (L.)		l – r		•
2	*Buprestis rustica* L.	l – c	•	•	•
3	*Buprestis haemhorroidalis* HERBST	n – r	•	•	•
4	*Buprestis octoguttata* L.	n – r	•	•	•
5	*Buprestis novemmaculata* L.	l – r	•	•	
6	*Phaenops cyanea* (FABR.)	l – r	•	•	
7	*Anthaxia similis* SAUND	n – r	•		
8	*Anthaxia quadripunctata* (L.)	l – c	•	•	•
9	*Anthaxia submontana* OBENB.	l – c	•	•	•
10	*Anthaxia funerula* (ILL.)	n – r	•		
11	*Chrysobotris igniventris* REITT.	n – r	•	•	
12	*Agrilus sulcicollis* LACORD.	n – r	•	•	
13	*Agrilus angustulus* (ILL.)	n – r	•	•	•
14	*Agrilus betuleti* RATZ.	n – r	•		
15	*Agrilus antiquus sperkii* SOL.	n – r	•	•	
16	*Trachys minuta* (L.)	l – c	•	•	•
	Total		16	9	11

16 *Buprestidae* species were found in the fresh coniferous forests of Puszcza Białowieska (Tab. II), accounting for about 40% of the buprestid fauna of the entire area. All the 16 species occurred on the Polish side and 11 on the Byelorussian side. Only 9 species were found in the Białowieża National Park, which is mainly due to the fresh coniferous habitat being hardly represented within the strict reserve. It is interesting to note the presence of the extremely rare thermophilous species, such as *Anthaxia funerula*, *Chrysobotris igniventris* and *Agrilus antiquus sperkii*. The third one is new to the fauna of Puszcza Białowieska.

According to the literature mentioned in the introduction and the author's own estimates, the number of species registered in Puszcza Białowieska is much higher than in other fresh coniferous forests of Poland. This is due to the unique flora of the coniferous forests in Puszcza Białowieska, their richness (besides pine, there is a high proportion of spruce and other species in the forest stand and understorey), good preservation (large areas, the presence of every age class of the forest stand and every stage of wood decay), the continuation of the forest

dating back to prehistorical times and a low degree of transformation owing to low environmental pollution.

Succession analysis

In our discussion of the stand-age-related diversification of *Cerambycidae* and *Buprestidae* communities, the three corpora mentioned above will be considered.

Table III contains the results of the 1986 catches of *Cerambycidae* into Moericke's traps. The material was too scarce to allow to determination of various population indices. It is, nevertheless, interesting enough to be presented here. The numbers of species caught in young stands, the pole wood and mature stands were similar. The number of individuals, however, is 4 times higher in older stands in comparison to young stands. Surprisingly, the dominant form is *Cortodera femorata* (41 individuals) – a generally rare species usually found as single specimens. All the specimens of this species were caught in the pole wood and mature stand. It should also be noted that *Pogonocherus decoratus* was quite abundant (11 individuals), while the related *P. fasciculatus* was completely absent. Data from literature reveal that the quantitative relations between the two species are reversed in other forests. Other species were represented by individual specimens. The presence of rare *Grammoptera abdominalis* and *Acmaeops marginata* should also be noted.

Table III. Species composition, abundance and percentages of *Cerambycidae* species in three developmental stages of fresh coniferous forests in Puszcza Białowieska on the basis of material collected into Moericke's pitfall traps in 1986 (n – abundance, % – percentage)

No	Species	Developmental stage					
		young stand		pole wood		mature stand	
		n	%	n	%	n	%
1	*Molorchus minor* (L.)	1	14.3	–	–	–	–
2	*Callidium aeneum* (De Geer)	–	–	1	3.4	1	3.3
3	*Rhagium inquisitor* (L.)	–	–	2	6.9	–	–
4	*Acmaeops marginata* (Fabr.)	–	–	1	3.4	–	–
5	*Cortodera femorata* (Fabr.)	–	–	19	65.6	22	73.3
6	*Grammoptera abdominalis* (Steph.)	1	14.3	–	–	–	–
7	*Anastrangalia sanguinolenta* (L.)	–	–	1	3.4	–	–
8	*Corymbia rubra* (L.)	3	42.8	–	–	–	–
9	*Brachyleptura maculicornis* (De Geer)	–	–	–	–	1	3.3
10	*Pseudovadonia livida* (Fabr.)	–	–	–	–	1	3.3
11	*Pogonocherus decoratus* Fairm.	1	14.3	5	17.3	5	16.8
12	*Tetrops praeusta* (L.)	1	14.3	–	–	–	–
	Total no. of specimens	7	100.0	29	100.0	30	100.0
	Total no. of species	5		6		5	

Table IV shows the results of examinations of deadwood and litter searching in the pole wood and mature stands in 1988–1994. The natural mature forest accommodates more species (17) of *Cerambycidae* than the pole wood (12). Their abundance is also higher in the older stand. In the pole wood the dominant forms were: *Acanthocinus griseus* – 44.4%, *Rhagium inquisitor* – 22.2% and *Pogonocherus decoratus* – 17.6%. In mature stand the dominant group consisted of *Rhagium inquisitor* – 17.4%, *Molorchus minor* – 16.7%, *Tetropium fuscum* – 13.9%, *Pogonocherus fasciculatus* – 10.5% and *Tetropium castaneum* – 10.5%.

Table IV. Species composition, abundance and percentages of *Cerambycidae* species in two developmental stages (pole wood, mature stand) of fresh coniferous forests in Puszcza Białowieska on the basis of analysis of breeding material of the larvae and litter searches in 1988–1994 (n – abundance, % – percentage).

No	Species	Developmental stage			
		pole wood		mature stand	
		n	%	n	%
1	*Tetropium castaneum* (L.)	–	–	30	10.5
2	*Tetropium fuscum* (Fabr.)	–	–	40	13.9
3	*Spondylis buprestoides* (L.)	1	0.6	–	–
4	*Arhopalus rusticus* (L.)	2	1.3	11	3.8
5	*Asemum striatum* (L.)	1	0.7	1	0.4
6	*Molorchus minor* (L.)	3	2.0	48	16.7
7	*Callidium aeneum* (De Geer)	5	3.3	8	2.8
8	*Callidium violaceum* (L.)	3	2.0	10	3.5
9	*Rhagium inquisitor* (L.)	34	22.2	50	17.4
10	*Acmaeops septentrionis* (C. G. Thoms.)	–	–	7	2.5
11	*Cortodera femorata* (Fabr.)	–	–	5	1.7
12	*Monochamus galloprovincialis* (Oliv.)	4	2.6	5	1.7
13	*Monochamus urussovii* Fisch.	–	–	2	0.7
14	*Monochamus sutor* (L.)	–	–	13	4.5
15	*Pogonocherus fasciculatus* (De Geer)	3	2.0	30	10.5
16	*Pogonocherus decoratus* Fairm.	27	17.6	2	0.7
17	*Acanthocinus griseus* (Fabr.)	68	44.4	10	3.5
18	*Acanthocinus aedilis* (L.)	2	1.3	15	5.2
	Total no. of specimens	153	100.0	287	100.0
	Total no. of species	12		17	

The quantitative data on the abundance of each species occurring in the pole wood and mature forest were arranged according to ranks and tests were subsequently performed to see whether the empirical distribution was

compatible with any of the theoretical models. It was revealed that the distribution estimated for the mature stand was compatible with the negative binomial distribution since with k = 10 degrees of freedom $\chi^2 = 6.68$. Tables show (TROJAN 1992) that $\chi_0^2 = 18.31$ (for p = 0.05) so 6.68 < 18.31. The probability of concurrence of the distributions is p = 0.75, which is a relatively high value, permitting to state that the two distributions are compatible.

For the lognormal series, $\chi^2 = 6.81$ (k = 5), and $\chi_0^2 = 11.07$. Atthough $\chi^2 < \chi_0^2$ (for p = 0.05), which would imply that the two series are compatible, for the given χ^2 we have p = 0.23, which indicates that the hypothesis that the distributions are compatible should be rejected. It could only be accepted with p > 0.05 (TROJAN 1992).

In the pole wood, none of the theoretical distributions is compatible with empirical data.

The estimated number of species in the mature stand equals 17.92 so that one more species should be expected to live there. In the pole wood, the estimated number of species is 18.17, according to which six more species could be detected.

Shannon and Weaver's index of species diversity is H = 3.5346 (H_{max} = 4.0875) for the mature stand. The variance var (H) = 0.0043, corresponding to only 0.12% of the estimated value of H, is not high. Simpson's index of species diversity is I = 0.0022.

For the pole wood, Shannon and Weaver's index is H = 2.4319, and H_{max} = 3.5850. The variance var(H) = 0.0159, accounting for≈0.7% of the estimated value, is small. Simpson's index is I = 0.0416.

The succession of *Buprestidae* in the four age classes of forest stand in fresh coniferous forests is presented in Table V. Representatives of this group are usually collected in small numbers. In the pine forest sere under study, 12 species were found, the greatest number (9) occurring in mature stand and culture. The greatest number of individuals by far (131) was collected in culture, which is due to the exceptional photo- and thermophilous nature of this group. The imagines of certain species would also fly to the culture to feed on flowers, which were much more abundant in this open and well-insolated area. The dominants in the culture stage were *Anthaxia quadripunctata* (52.8%) and *A. submontana* (38.2%). According to calculations, the anticipated number of species is 18.5. Shannon and Weaver's index of species diversity is H = 1.6956, and H_{max} = 3.1699. The variance var(H) = 0.0177 is small, accounting for only about 1% of the estimated value of H. Simpson's index is I = 0.0966.

The number of *Buprestidae* species caught in young stands was only 5 with 22 individuals. The dominants were the same species as in the culture stage and accounted respectively for 54.5% and 31.8% of the community. The anticipated number of species is 14.7. Shannon and Weaver's index is H = 1.7583, and H_{max} = 2.3219. The variance var(H) = 0.0596 accounts for 3.4% of the estimated value of H. Simpson's index is I = 0.0899.

Table V. Species composition, abundance and percentages of *Buprestidae* species in four developmental stages of fresh coniferous forests in Puszcza Białowieska (n – abundance, % – percentage)

No	Species	Developmental stage							
		culture		young stand		pole wood		mature stand	
		n	%	n	%	n	%	n	%
1	*Chalcophora mariana* (L.)	–	–	1	4.5	–	–	2	14.3
2	*Buprestis haemhorroidalis* HERBST	1	0.8	–	–	–	–	1	7.2
3	*Buprestis novemmaculata* L.	1	0.8	–	–	–	–	–	–
4	*Buprestis octoguttata* L.	1	0.8	1	4.5	–	–	–	–
5	*Buprestis rustica* L.	3	2.3	–	–	1	10.0	2	14.3
6	*Phaenops cyanea* (FABR.)	–	–	–	–	1	10.0	–	–
7	*Anthaxia quadripunctata* (L.)	69	52.7	12	54.6	4	40.0	3	21.5
8	*Anthaxia similis* SAUND	–	–	–	–	–	–	1	7.1
9	*Anthaxia submontana* OBENB.	50	38.1	7	31.9	1	10.0	2	14.3
10	*Agrilus angustulus* (ILL.)	2	1.5	1	4.5	1	10.0	1	7.1
11	*Agrilus sulcicollis* LACORD.	2	1.5	–	–	–	–	1	7.1
12	*Trachys minuta* (L.)	2	1.5	–	–	2	20.0	1	7.1
	Total no. of specimens	131	100.0	22	100.0	10	100.0	14	100.0
	Total no. of species	9		5		6		9	

6 species of *Buprestidae* were caught in the pole wood with 10 individuals. *A. quadripunctata* was the dominant again (40.0%). The anticipated number of species is 19.6. Shannon and Weaver's index is H = 2.4251, and H_{max} = 2.5850. The variance var(H) = 0.0597 equals 2.5% of the estimated value of H. Simpson's index is I = 0.0183.

The mature stand with 9 species and 14 individuals was characterized by the most uniform distribution of abundance. The presence of *Anthaxia similis* should be noted as this species is extremely rare in Puszcza Białowieska. The anticipated number of species is 15.9. Shannon and Weaver's index is H = 3.0945, and H_{max} = 3.1699. The variance var(H) = 0.0210 accounts for 0.7% of the estimated value of H. Simpson's index is I = 0.0014.

The empirical abundance distributions in *Buprestidae* communities of the four forest stand age classes studied do not correspond to any of the theoretical distributions tested.

Analysis of Shannon and Weaver's indices shows that the species diversity of *Buprestidae* community is the lowest in the culture stage (the greatest difference between H_{max} and H). The parameter gradually increases as the forest grows older. Similar conclusions may be derived from analysis of Simpson's indices.

Similarity indices (P) for *Buprestidae* communities (after Sørensen) are given in Table VI.

The succession of *Cerambycidae* in the four developmental stages of fresh coniferous forests is presented in Table VII. The total number of species is 33, with a maximum (29) in mature stands and a minimum (12) in young stands.

Similar relationships can also be observed as far as the number of individuals is concerned. The dominant species in the culture stage are *Asemum striatum* – 16.5%, *Rhagium inquisitor* – 15.1%, *Acanthocinus aedilis* – 14.4%, *Arhopalus rusticus* – 12.2% and *Spondylis buprestoides* – 11.5%. The total number of individuals found in the culture stage was 131, belonging to 17 species. The anticipated number of species calculated for the culture stage is 22.28, indicating that 5 more species should be expected to live there. Shannon and Weaver's index of species diversity is H = 3.5267 and H_{max} = 4.0875, with the variance var(H) = 0.0085 (0.2% of the estimated value). Simpson's index of species diversity is I = 0.0020. The empirical distribution is compatible with the negative binomial distribution as $\chi^2 = 8.03$ and is smaller than $\chi_0^2 = 18.31$ (for p = 0.05). For k = 10, however, p = 0.630.5. There is also some overlap with the logarithmic series [$\chi^2 = 5.74$, $\chi_0^2 = 18.31$ (for p = 0.05), k = 10, p = 0.84].

Table VI. Diagram of similarities of buprestid beetle communities in the developmental stages of fresh coniferous forests studied in Puszcza Białowieska (u – culture, m – young stand, d – pole wood, s – mature stand).

	m	d	s
u	57%	67%	67%
m		55%	57%
d			67%

In young stands only 67 individuals of *Cerambycidae* (12 species) were found. The dominant species in that stage are *Pogonocherus decoratus* – 32.8%, *Corymbia rubra* – 25.3% and *P. fasciculatus* – 14.9%. The anticipated number of species calculated for the young stand stage is 21.3. Shannon and Weaver's index is H = 2.8718 and H_{max} = 3.5850, with the variance var(H) = 0.0267 (0.9% of the estimated value). Simpson's index of species diversity is I = 0.0151. The estimated index is compatible with the negative binomial distribution [χ^2 = 2.9224, $\chi_0^2 = 9.49$ (for p = 0.05), k = 4, p = 0.57] and with the geometrical progression series [$\chi^2 = 2.4573$, $\chi_0^2 = 9.49$ (for p = 0.05), k = 4, p = 0.65].

The pole wood was characterized by a greater number of individuals (248) and species (25) caught. The dominant species in that stage are *Corymbia rubra* – 15.0% and *Asemum striatum* – 12.1%, *Stenurella melanura* – 11.3% and

Table VII. Species composition, abundance and percentages of *Cerambycidae* species in four developmental stages of fresh coniferous forests in Puszcza Białowieska (n – abundance, % – percentage).

No	Species	Developmental stage							
		culture		young stand		pole wood		mature stand	
		n	%	n	%	n	%	n	%
1	*Prionus coriarius* (L.)	–	–	–	–	–	–	1	0.3
2	*Tetropium castaneum* (L.)	3	2.2	–	–	7	2.8	19	5.8
3	*Tetropium fuscum* (Fabr.)	1	0.7	–	–	2	0.8	4	1.2
4	*Spondylis buprestoides* (L.)	16	11.5	1	1.5	3	1.2	18	5.5
5	*Arhopalus rusticus* (L.)	17	12.2	1	1.5	14	5.6	31	9.5
6	*Asemum striatum* (L.)	23	16.5	3	4.5	30	12.1	2	0.6
7	*Molorchus minor* (L.)	–	–	–	–	27	11.0	35	10.7
8	*Callidium aeneum* (De Geer)	–	–	–	–	1	0.4	2	0.6
9	*Callidium violaceum* (L.)	9	6.5	1	1.5	1	0.4	8	2.4
10	*Callidium coriaceum* Payk.	–	–	–	–	1	0.4	1	0.3
11	*Rhagium mordax* (De Geer)	1	0.7	–	–	2	0.8	3	0.9
12	*Rhagium inquisitor* (L.)	21	15.1	5	7.5	14	5.6	58	17.7
13	*Pachyta quadrimaculata* (L.)	–	–	–	–	–	–	1	0.3
14	*Cortodera femorata* (Fabr.)	–	–	–	–	1	0.4	7	2.1
15	*Pedostrangalia pubescens* (Fabr.)	1	0.7	–	–	–	–	3	0.9
16	*Leptura quadrifasciata* L.	2	1.4	1	1.5	6	2.4	1	0.3
17	*Anastrangalia sanguinolenta* (L.)	4	2.9	–	–	5	2.0	9	2.8
18	*Corymbia rubra* (L.)	8	5.9	17	25.3	37	15.0	13	4.1
19	*Brachyleptura maculicornis* (De Geer)	5	3.6	–	–	4	1.6	5	1.5
20	*Judolia sexmaculata* (L.)	–	–	2	3.0	–	–	–	–
21	*Alosterna tabacicolor* (De Geer)	–	–	–	–	2	0.8	–	–
22	*Strangalia attenuata* (L.)	–	–	–	–	–	–	1	0.3
23	*Stenurella melanura* (L.)	6	4.3	2	3.0	28	11.3	43	13.1
24	*Stenurella nigra* (L.)	–	–	2	3.0	1	0.4	–	–
25	*Monochamus galloprovincialis* (Oliv.)	1	0.7	–	–	6	2.4	9	2.8
26	*Monochamus sutor* (L.)	–	–	–	–	1	0.4	2	0.6
27	*Monochamus urussovii* Fisch.	–	–	–	–	–	–	1	0.3
28	*Pogonocherus fasciculatus* (De Geer)	–	–	10	14.9	2	0.8	19	5.8
29	*Pogonocherus decoratus* Fairm.	–	–	22	32.8	13	5.2	14	4.3
30	*Acanthocinus griseus* (Fabr.)	–	–	–	–	18	7.3	13	4.1
31	*Acanthocinus aedilis* (L.)	20	14.4	–	–	–	–	3	0.9
32	*Leiopus nebulosus* (L.)	–	–	–	–	22	8.9	1	0.3
33	*Saperda populnea* (L.)	1	0.7	–	–	–	–	–	–
	Total no. of specimens	139	100.0	67	100.0	248	100.0	327	100.0
	Total no. of species	17		12		25		29	

Molorchus minor – 11.0%. The anticipated number of species exceeds the actual number by 8 species (32.78). Shannon and Weaver's index is H = 3.9475 and H_{max} = 4.6439, with the variance var(H) = 0.0059 (0.1% of the estimated value). Simpson's index of species diversity is I = 0.0011. The estimate is compatible with the negative binomial distribution [χ^2 = 9.28, χ_0^2 = 21.03 (for p = 0.05), k = 12, p = 0.68] and with the logarithmic distribution [χ^2 = 8.50, χ_0^2 = 21.03 (for p = 0.05), k = 12, p = 0.74].

In the mature stand, 29 *Cerambycidae* species (327 individuals) were found. Only three species of all those registered in the present study did not occur in that stage. These are: *Judolia sexmaculata*, *Alosterna tabacicolor* and *Saperda populnea*, all of which are actually accidental to fresh coniferous forests, as they fly there from adjacent plant associations. The dominant species in that stage are *Rhagium inquisitor* – 17.7%, *Stenurella melanura* – 13.1% *Molorchus minor* – 10.7% and *Arhopalus rusticus* – 9.5%. The anticipated number of species calculated for the mature stand stage is 41.02. Shannon and Weaver's index is H = 4.0521 and H_{max} = 4.8580, with the variance var(H) = 0.0055 (0.1% of the estimated value). Simpson's index of species diversity is I = 0.0015. The estimated distribution is compatible with the negative binomial distribution [χ^2 = 4.32, χ_0^2 = 22.36 (for p = 0.05), k = 13, p = 0.99] and with the logarithmic series [χ^2 = 6.30, χ_0^2 = 22.36 (for p = 0.05), k = 13, p = 0.93].

Table VIII. Diagram of similarities of longhorn beetle communities in the developmental stages of fresh coniferous forests studied in Puszcza Białowieska (u – culture, m – young stand, d – pole wood, s – mature stand).

	m	d	s
u	55%	67%	70%
m		59%	49%
d			85%

Similarity indices (P) for *Cerambycidae* communities (after Sørensen) are presented in Table VIII.

It is difficult to find species characteristic of only one age class of the forest stand, i.e. those which are only present in either the culture, young stand, pole wood or mature stand. Rare species, caught as single individuals, cannot be

taken into account, since they may be present at a given site only accidentally. When analysing abundant or frequent species, it can be seen that some do prefer certain age classes. For example, *Acanthocinus aedilis* may be regarded as characteristic of mature stands and cultures, and *Cortodera femorata*, of pole wood and mature stands.

Analysis of Sørensen's indices obtained for every case described above shows that the pole wood and mature stand communities are the most similar. As has been mentioned, this is due to the fact that stumps and clearing remains in the culture serve as a kind of extension of the mature stand for the cambio- and xylophages described in this paper. The young stand is the stage most distinct from others.

Trophic relations

For most species of both *Buprestidae* and *Cerambycidae* registered in the study, their host plants were also discovered in the same area. Nearly all the species registered belong to the group of cambio- and/or xylophages. They develop in the bark (e.g. *Alosterna tabacicolor*), under the bark (e.g. *Rhagium inquisitor, Anthaxia quadripunctata*), or in the xylem of various trees and shrubs (e.g. *Oxymirus cursor, Chalcophora mariana*). The species inhabit different parts of their host plants, from the roots (e.g. *Pachyta quadrimaculata*), through the stem (e.g. *Acanthocinus aedilis, Buprestis rustica*), boughs (e.g. *Callidium violaceum, Chrysobotris igniventris*) to thin twigs (e.g. *Tetrops praeusta, Agrilus angustulus*). Different species also prefer different stages of bark, phloem and xylem decomposition. Out of the 16 *Buprestidae* species mentioned above, 10 develop on coniferous trees (*Pinus sylvestris, Picea abies*), while the others develop on deciduous trees (*Quercus robur, Betula pendula*) and shrubs (*Salix caprea, Cytisus ruthenicus*). Out of the 49 species of *Cerambycidae* known from fresh coniferous forests, 29 species develop on pine and (or) spruce, 4 develop on both coniferous and deciduous plants, and 15 on deciduous trees and shrubs (*Quercus robur, Betula pendula, Populus tremula, Frangula alnus, Carpinus betulus* et al.). One species, namely *Pseudovadonia livida*, develops in the soil, feeding on the mycelium of *Marasmius oreades* (BOLT.) FR. (BURAKOWSKI 1979). The bionomics of *Cortodera femorata* is also interesting. This species lays eggs into spruce cones high up in canopies. The larvae subsequently fall down with the cones onto the litter, and leave the cones before pupation occurs to complete the developmental cycle in the surface layer of the soil.

Of the *Buprestidae* species which are dominant in fresh coniferous forests, *Anthaxia quadripunctata* develops under the bark of insolated stems and branches of spruce, while *A. submontana* in the same parts of pine trees.

Of the dominant species of *Cerambycidae*, *Spondylis buprestoides* was most often found in the xylem in stumps and in the lower part of thick stems of pines, while *Acanthocinus aedilis*, under and in the bark. *Corymbia rubra, Arhopalus rusticus* and *Asemum striatum* develop in the xylem in stumps and the lower part of stems of spruce and pine, while *Rhagium inquisitor* develops under the

bark. Stems of young pine and spruce trees as well as branches of old trees of these species serve as a development place for *Pogonocherus decoratus* and *P. fasciculatus*. Dry upright trunks of pines and spruces, usually of middle age classes, accommodate developing individuals of *Acanthocinus griseus*.

The imagines of many species of buprestid and longhorn beetles feed on flower pollen. The buprestids belonging to this group include all species of the genus *Anthaxia*, which prefer yellow-coloured flowers, mostly of the families *Compositae* and *Ranunculaceae*. Anthophilous *Cerambycidae* include representatives of the genera *Acmaeops* and *Stenurella* as well as the following species: *Molorchus minor*, *Rhagium mordax*, *Pachyta quadrimaculata*, *Grammoptera abdominalis*, *Pedostrangalia pubescens*, *Leptura quadrifasciata*, *Anastrangalia sanguinolenta*, *Corymbia rubra*, *Stictoleptura variicornis*, *Brachyleptura maculicornis*, *Judolia sexmaculata*, *Alosterna tabacicolor*, *Pseudovadonia livida*, *Strangalia attenuata*. They prefer white-coloured flowers, mostly of the family *Umbelliferae*. Some species eat leaf blades and conifers, while for many others there are no data relating to this aspect.

As far as anthophilous species are concerned, apart from food resources for the larvae, the abundance of food for imagines in certain habitats may also affect the "attractiveness" of these habitats for *Buprestidae* and *Cerambycidae*. The occurrence of certain flowers in the culture stage was probably one of the reasons why the groups under study, especially pollen-feeding species, were relatively abundant in that habitat.

CONCLUSIONS

1. The fresh coniferous forests of Puszcza Białowieska are characterized by high species richness of *Buprestidae* (16 species), and especially of *Cerambycidae* (49), in comparison with other natural objects of the same type in Central Europe. A comparative analysis of succession is not possible as there are no papers dealing with succession in other regions.

2. The fresh coniferous forests of the area under study function as refuges for certain species rarely found in Poland or even in entire Central Europe, such as *Acmaeops marginata*, *Cortodera femorata* and *Anthaxia funerula*.

3. Noticeable differences have been observed in the species richness of *Buprestidae* and *Cerambycidae* of the culture, young stand, pole wood and mature stand stage in a fresh coniferous forest habitat in Puszcza Białowieska.

4. Cultures of pine, especially 1–4-year-old cultures, are characterized by rich *Buprestidae* fauna and relatively rich *Cerambycidae* fauna, which is due to these cambio- and xylophages making use of stumps and clearing remains to develop in. The considerable insolation, which is particularly preferred by the exceptionally thermophilous *Buprestidae*, also plays a role here.

5. Young stands accommodate the lowest number of species of all the age classes under study. Decaying stumps are not appropriate for the breeding of most longhorn and buprestid beetles, and thin stems and branches are not a suitable food for a wider range of species.

6. The pole wood is characterized by a fauna of longhorn, and particularly buprestid beetles, that already bears some resemblance to the fauna of a natural mature forest.

7. Mature stands are the developmental stage of fresh coniferous forest which is the richest in the *Buprestidae* and *Cerambycidae* species. They also accommodate the greatest number of rare taxons and forms that are interesting from the zoogeographical viewpoint.

8. Species diversity of *Buprestidae*, as measured with Shannon and Weaver's and Simpson's indices, increases as the stand grows older. In *Cerambycidae* the model is similar except young stands, where the diversity is a little lower than in the culture stage. In the pole wood, however, *Cerambycidae* species diversity is definitely much higher, to reach maximum values in mature stands.

9. The similarity of *Buprestidae* and *Cerambycidae* communities, calculated according to Srensen's formula, is the highest for the pole wood and mature stands.

10. In forest stands planted after a clear cutting in a fresh coniferous forest habitats, the buprestid and longhorn beetle fauna reaches a stage similar to that observed in mature forests after 40–60 years. Some species, however, may only develop on older trees, e.g. *Stictoleptura variicornis, Pedostrangalia pubescens, Monochamus urussovii, Chalcophora mariana.*

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STRESZCZENIE

[Tytuł: Zmiany w zgrupowaniach kózkowatych i bogatkowatych (*Coleoptera: Cerambycidae, Buprestidae*) towarzyszące wtórnej sukcesji borów świeżych Puszczy Białowieskiej]

W latach 1979-1994 badano skład gatunkowy i strukturę zgrupowań *Buprestidae* i *Cerambycidae* różnych stadiów wzrostowych (uprawa, młodnik, drągowina, starodrzew) borów świeżych (*Vaccinio vitis-idaeae-Pinetum, Vaccinio myrtilli-Piceetum*) Puszczy Białowieskiej (polskiej i białoruskiej części). Zastosowano różne metody pozyskiwania materiału, takie jak metoda „na upatrzonego", analizy materiału lęgowego larw, pułapki Moericke'go zawieszone w koronach drzew oraz na wysokości 1m, analizy drzew posuszowych, czerpakowanie oraz tzw. jesienne poszukiwania szkodników sosny w drągowinie i w starodrzewiach.

W borach świeżych Puszczy Białowieskiej stwierdzono występowanie 16 gatunków chrząszczy z rodziny *Buprestidae* i 49 gatunków z rodziny *Cerambycidae*, w tym niektóre gatunki rzadkie w skali Polski czy Europy, jak np. *Acmaeops marginata, Cortodera femorata* i *Anthaxia funerula* (Tab. I, II). Wykazano wyraźne różnice w bogactwie gatunkowym badanych grup poszczególnych stadiów wzrostowych drzewostanów (Tab. III-V, VII).

Uprawy, zwłaszcza 1-4-letnie charakteryzują się bogatą fauną *Buprestidae* i stosunkowo bogatą fauną *Cerambycidae*, co wynika z wykorzystywania pniaków oraz resztek pozrębowych do swego rozwoju przez te kambio- i ksylofagi. Pewną rolę odgrywa też duża insolacja, preferowana zwłaszcza przez wyjątkowo ciepłolubne *Buprestidae*.

Młodniki mają najuboższą gatunkowo faunę badanych grup. Rozkładające się pniaki nie są już odpowiednim materiałem lęgowym dla większości kózkowatych i bogatkowatych, a cienkie pnie i gałęzie, przy dużym zacienieniu, nie są właciwą bazą pokarmową dla szerszego spektrum gatunków.

Drągowiny charakteryzują się fauną bogatkowatych, a zwłaszcza kózkowatych, zbliżoną do fauny naturalnego starodrzewia.

Najbogatszym w gatunki *Buprestidae* i *Cerambycidae* stadium rozwojowym borów świeżych w Puszczy Białowieskiej są starodrzewie. Grupują one te najwięcej gatunków rzadkich i interesujących z zoogeograficznego punktu widzenia.

Różnorodność gatunkowa *Buprestidae*, mierzona wskaźnikami Shannona i Weavera oraz Simpsona, wzrasta wraz z wiekiem drzewostanu. Dla *Cerambycidae* sytuacja jest podobna, z wyjątkiem młodnika, gdzie różnorodność jest nieco niższa niż na uprawie. Jednak w drągowinie różnorodność jest już zdecydowanie wyższa, a w starodrzewiu osiąga maksymalne wartości.

Podobieństwo zgrupowań *Buprestidae* i *Cerambycidae*, obliczone według wzoru Sørensena, najwyższe jest między drągowiną i starodrzewem (Tab. VI, VIII).

Fauna badanych rodzin chrząszczy w drzewostanach sadzonych na zrębach zupełnych na siedlisku boru świeżego osiąga stan zbliżony do obserwowanego w starodrzewiu po 40– 60 latach. Jednak niektóre gatunki mogą się rozwijać dopiero na drzewach jeszcze starszych, np. *Stictoleptura variicornis, Pedostrangalia pubescens, Monochamus urussovii, Chalcophora mariana.*

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