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BEETLES (*Coleoptera*) OCCURRING ON HAZEL (*Corylus* L.) IN DIFFERENT HABITAT CONDITIONS

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Abstract. The aim of the study was to recognise the species composition of beetles (*Coleoptera*) population occurring on hazel shrubs. Three-year studies were carried out on three ecosystems: on the cultivated hazelnut plantation, on an unprotected one and on shrubs of common hazel in the forest. The presence of 63 species was detected. The smallest number of species (22) and individuals (535) was noted in the protected plantation and the highest number in an unprotected one (46 species and 2787 individuals). In the forest the presence of 46 species and 1317 individuals was observed. The dominant species among beetles on hazel plantation in south-eastern Poland are from weevils' family (*Curculionidae*). *Curculio nucum* and leaf-eaters from *Phyllobius* sp. genus were most often collected. The remaining species that were observed are non-economic pests of hazelnut, but giving up suitable chemical pest control and horticultural treatment results in an increase of their number. At that situation the number of species characteristic of common hazel growing in the forest increased on large-fruited hazel too. The species composition, number, dominance and the topic and trophic groups of *Coleoptera* adults are given in this paper.

Key words: *Coleoptera*, beetles, hazelnut, protected and unprotected plantation, forest

INTRODUCTION

Among the studies on the wide range of beetle species inhabiting hazel shrubs, most concerned about the occurrence and control of nut weevil – *Curculio nucum*. This beetle from the family of weevils (*Curculionidae*) is common on production plantations in Poland and also in other European countries. It can contribute to considerable losses in the yield that is why it requires annual chemical treatments [Łęska 1973, Toth 1984, Pucci 1992]. Other beetle species connected with hazel are scarcely described and refer exclusively to its wild form (*Corylus avellana* L.) occurring in the forest environment [Bartkowska 1975, Szmidt and Stachowiak 1980, Stachowiak 1984, Holecova 1993]. The aim of the studies was to compare the species composition and the quantitative structure of beetles inhabiting the shrubs of cultivated and common hazel depending on environment conditions and the intensity of protection.

MATERIAL AND METHODS

The studies were carried out in 1994–1996 in three localities situated in the Lublin area. The first was a plantation of hazel protected according to the recommendations worked out by the Institute of Plant Protect in Poznań (tab. 1). The second was a plantation of large-fruited hazel, where protective treatments were given up altogether. The third was made up of hazel shrubs growing in a mixed dry ground forest. All the three objects were distributed within 20 km from Lublin. Twenty five hazel shrubs were selected in each locality and every two weeks beetles were shaken off from them to an entomological umbrella. The species composition and the number of individuals were determined in the collected material.

Table 1. List of pesticides used on a protected hazel plantation from 1994–1996

Year	Name of plant protection chemical	Treatment date	Dose per 1 ha
1994	1. Thiram Granuflo 80 WG Zolone 35EC	25.05	4.5 kg 1.8 l
	2. Pencozeb 75 WG Owadofos pł. 50	10.06	4.5 kg 2.0 l
1995	1. Thiram Granuflo 80 WG Zolone 35EC	27.05	4.0 kg 2.0 l
	2. Dithane M-45 Metathion pł. 50	2.06	5.0 kg 2.0 l
1996	1. Owadofos pł. 50	30.05	2.0 l
	2. Pencozeb 75 WG Zolone 35 EC	11.06	4.0 kg 2.0 l
	3. Dithane M-45 Owadofos pł. 50	8.07	4.0 kg 2.0 l

The papers by Gurieva [1965], Medvedev and Szapiro [1965] and Warchałowski [1971, 1973] were used while designating the species. Beetle species from the weevils were determined by Professor Jacek Łętowski from the Maria Curie-Skłodowska University of Lublin. Here, the authors wish to thank Professor Łętowski for his help. Five domination classes were isolated on the basis of the numbers of beetle groups, namely eudominants, dominants, subdominants, recedents and subrecedents. Besides, indexes of species composition similarity were determined using the formula of Marczewski-Steinhaus (MS) for the beetles living in the three studied environments. Species variability was characterized on the basis of the calculated values of Shannon index (H') [Hutcheson 1970, Górny and Grum 1981]. Beetle species were divided according to food preferences into poly-, oligo- and mono-phagous and arbicolous, arbi-herbicolous and herbicolous species [Brown and Hyman 1986, Holecova 1993].

RESULTS

In the period of three vegetation seasons, totally 4,639 beetles were collected which belonged to 63 species and 35 genera. Five overfamilies were isolated, among which *Curculionoidea* were most numerous (38 species and 2,512 individuals). They consti-

tuted over 54% of all the collected individuals. According to the numbers, *Chrysomeloidea* (1,182 individuals) occupied the second place among representatives of *Coleoptera*, after the weevils, and they made up 25% of the whole population of beetles. They were represented by 15 species.

Environment conditions shaped the species composition and the number of beetles. The smallest numbers of individuals, namely 535 and species, namely 22, were collected on the protected plantation. There, beetles from the chrysomelid family dominated and they constituted 43% of the total number of the collected *Coleoptera*. On the other hand, the greatest number of individuals, namely 2,787 and species, namely 46, were collected on the plantation that was extensively managed. The weevils constituted more than a half. A similar number of species and a lower number of individuals as compared to the non-protected plantation characterized the entomofauna of beetles in the forest environment. The weevils made up 67% of the collected beetles (tab. 2). The studied habitats also differed in respect of the domination structure. Considering only the arboreal species of beetles, no species in the plantation of protected hazel reached the rank of eu- and dominants, while the subdominants included only *Curculio nucum*. *Strophosoma capitatum* dominated on the extensively managed plantation, and subdominants included *Agelastica alni* and *Phyllobius maculicornis*. A clear eudominant in the forest was *Strophosoma capitatum*, *Phyllobius arborator* was a dominant, and the subdominants were *Altica brevicollis* and *Phyllobius glaucus* (tab. 2).

Totally, 33 species of arboreal beetles were determined which can inhabit hazel. Among them there were 27 polyphagous, 5 olyphagous and 1 monophagous biologically connected with hazel, namely *Curculio nucum*. The proportional content of three trophic groups was similar in the non-protected plantation and in the forest. It is remarkable to note a relatively big proportion (36%) of nut weevil on protected hazel, and its small proportion on the non-protected plantation and in the forest: 3.9 and 0.9%, respectively (fig. 1). The olygophagous group was made up of *Altica brevicollis*, *Apoderus coryli*, *Curculio glandium*, *C. rubidus* and *Dorytomus taeniatus*. They occurred in the forest and on non-protected hazel. The two latter ones were collected only from non-protected shrubs.

Besides arboreal species, beetles connected with herbaceous plants were collected. Those were first of all the following species: *Meligethes*, *Subcoccinella* and *Olibrus* from the overfamily of *Cucujoidea*, *Oulema* and *Phyllotreta* from *Chrysomeloidea* and *Apion* and *Sitona* from *Curculionoidea*. During the studies also there were observed seasonal changes in the numbers of the collected beetles depending on the studied site (fig. 1). On the protected plantation, the species of arboreal and arbo-herbophyllous beetles prevailed in spring months, while in the later months the species inhabiting herbaceous plants clearly dominated. Both on the non-protected plantation and in the forest, the arboreal species occurred throughout the period of vegetation, and their maximum numbers were found in June and October.

Throughout the vegetation period the studies showed two maximum number of beetles, namely in spring-summer and in spring-autumn (fig. 2). In July there was a clear refraction of the population curve. The spring-summer peak included the following species: *Agelastica alni*, *Phyllobius maculicornis*, *Phyllobius argentatus*, *Polydrusus picus*, *Strophosoma capitatum*, *Curculio nucum*, *Altica brevicollis*, *Melolontha me-*

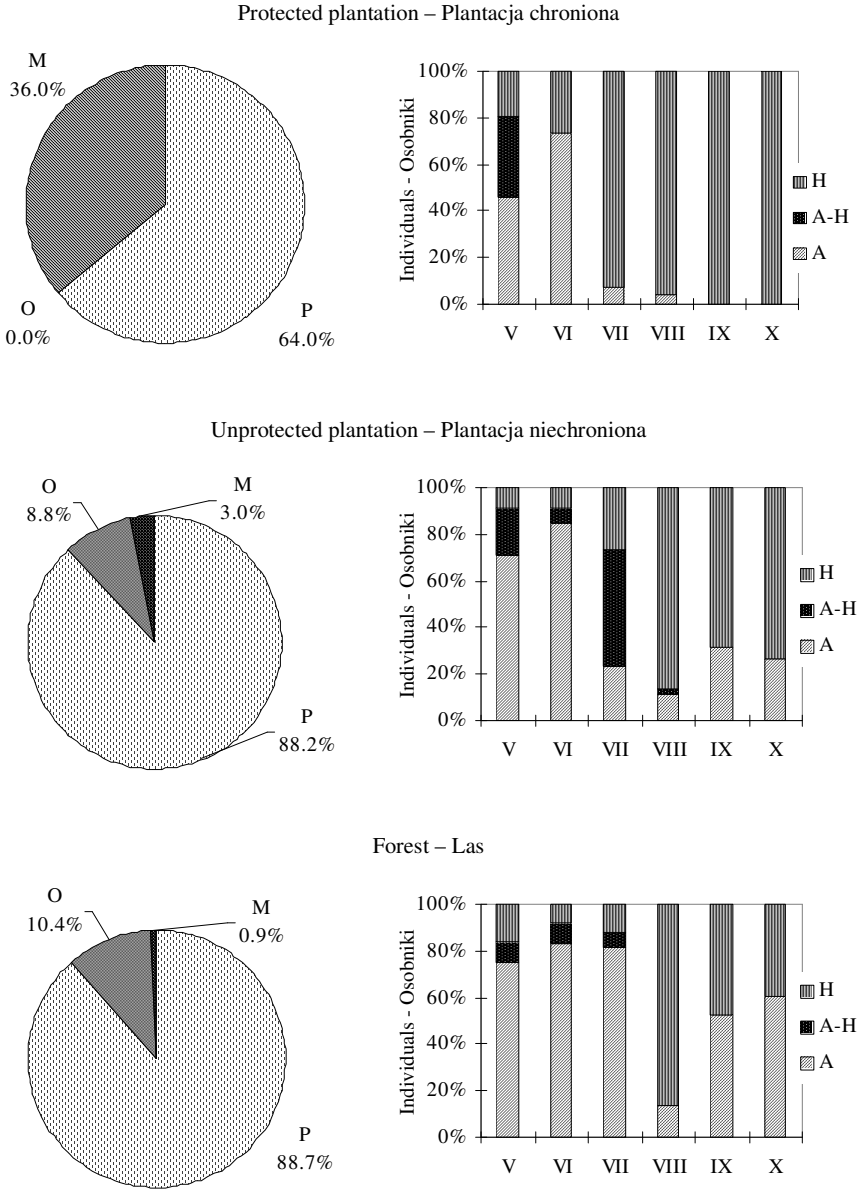
Table 2. General survey of *Coleoptera* species found in crowns of *Corylus* L. in three investigated localities

Species	Protected plantation		Unprotected plantation		Forest		Total	Month of occurrence	Topic and trophic group	
	N	**D**	**N**	**D**	**N**	**D**	**N**			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	
Scarabaeoidea										
Scarabaeidae										
Phyllopertha horticola L.	11	2.1 R	15	0.5 SR	1	0.1 SR	27	V	A	P
Melolontha melolontha L.	1	0.2 SR	34	1.2 R	12	0.9 SR	4	V	A	P
Cetonia aurata L**.**					4	0.3 SR	4	V	H	
Elateroidea										
Elateridae										
Dalophius marginatus L.					32	2.4 R	32	V–VI	A-H	P
Dalophius spp.			85	3.1 R			85	V–VIII	A-H	P
Athous haemorrhoidalis	15	2.8 R	126	4.5 R			141	V	A-H	P
Athous (*Orthathous*) *jejunus* Ksw.					25	1.9 R	25	V–VI	A-H	P
Cucujoidea										
Nitidulidae										
Meligethes aeneus Fabr.	14	2.6 R	47	1.7 R	42	3.2 R	103	V–VII	H	
Coccinellidae										
Subcoccinella vigintiquatuorpunctata L.	6	1.1 R	161	5.8 SD	11	0.8 SR	178	VIII–X	H	
Phalacridae										
Olibrus spp.	77	14.4 D	209	7.5 SD	17	1.3 R	303	VIII–X	H	
Chrysomeloidea										
Bruchidae										
Bruchus sp.	6	1.1 SR			20	1.5 R	26	V	H	
Chrysomelidae										
Oulema gallaeciana (Heyden)	25	4.7 R	15	0.5 SR	49	3.7 SK	89	V, VII–IX	H	
Gonioctena quinquepunctata Fabr.					10	0.8 SR	10	V, VII	A	P
Altica brevicollis Foundr.			48	1.7 R	92	7.0 SD	140	V–IX	A	O
A. oleracea L.			24	0.9 SR			24	V–VI	H	
Phyllotreta vittula Redt.	20	3.7 R	86	3.1 R	22	1.7 R	128	V, VIII–IX	H	
Ph. atra Fabr.	9	1.7 R	89	3.2 R	3	0.2 SR	101	V, VII–IX	H	

Ph. nigripes Fabr.			61	2.2 R	19	1.4 R	80	VIII–X	H	
Ph. undulata Kutsh.	122	22.8 ED	57	2.1 R			179	VII–VIII	H	
Ph. nemorum L.			51	1.8 R			51	VII–VIII	H	
Longitarsus lycopii Foundr.	25	4.7 R	11	0.4 SR	7	0.5 SR	43	VIII–IX	H	
Chaetocnema concinna Marsh.	24	4.5 R	29	1.0 SR	12	0.9 SR	65	VIII–IX	H	
Leptinotarsa decemlineata Say			6	0.2 SR			6	V	H	
Agelastica alni L.			190	6.8 SD	35	2.7 R	225	V	A	P
Chrysomela populi L.					15	1.1 R	15	V	A	P
Curculionoidea										
Attelabidae										
Deporaus betulae (L.)			22	0.8 SR	2	0.2 SR	24	V–VII	A	P
Apoderus coryli (L.)			63	2.3 R	9	0.7 SR	72	V–VIII	A	O
Apionidae										
Apion haematodes Kirby			15	0.5 SR			15	VII–IX	H	
A. curtirostre Germ.	9	1.7 R	15	0.5 SR			24	VII–IX	H	
A. radiolus Marsch	13	2.4 R	9	0.3 SR			22	IX–X	H	
A. dispar Germ.			6	0.2 SR			6	X	H	
A. seniculus Kirby	4	0.8 SR					4	IX	H	
A. viciae (Payk)					12	0.9 SR	12	VIII–X	H	
A. craccae L.	26	4.9 R	14	0.5 SR	18	1.4 R	58	V, IX, X	H	
A. pomonae Fabr.			7	0.3 SR	6	0.5 SR	13	**X**	H	
A. subulatum Kirby					1	0.1 SR	1	VII	H	
A. virens (Herbst)	5	0.9 SR	8	0.3 SR	6	0.5 SR	19	V, VII. IX	H	
A. apricans Herbst					7	0.5 SR	7	V, IX	H	
A. fulvipes (Geoffr)	50	9.4 SD	372	13.4 D	25	1.9 R	447	V–X	H	
Curculionidae										
Otiorhynchus raucus (Fabr.)			7	0.3 SR	8	0.6 SR	15	VII	A-H	P
O. ovatus L.			8	0.3 SR			8	V	A-H	P
Phyllobius oblongus L.	15	2.8 R	25	0.9 SR	24	1.8 R	64	V	A-H	P
Ph. arborator (Herbrt.)					169	12.8 D	169	VI–VII	A	P
Ph. glaucus (Scop.)					82	6.2 SD	82	V–VI	A	P
Ph. maculicornis Germ.	22	4.1 R	256	9.2 SD	2	0.2 SR	280	V–VI	A	P
Ph. argentatus L.			70	2.5 R	8	0.6 SR	78	V–VI	A	P
Ph. pyri (L.)					7	0.5 SR	7	V	A	P
Ph. vespertinus Fabr.			23	0.8 SR			23	V	A-H	P
Polydrusus cervinus (L.)			16	0.6 SR			16	V	A	P
P. picus (Fabr.)			72	2.6 R	16	1.2 R	88	V–VI	A	P
P. tereticollis (Deg.)			21	0.8 SR			21	V	A	P

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	
Brachyderes incanus (L.)					4	0.3 SR	4	V	A	P
Strophosoma capitatum (Deg.)			318	11.4 D	447	33.9 ED	765	V–X	A	P
Sitona lepidus Gyll.			1	0 SR	4	0.3 SR	5	VIII	H	
Chlorophanus viridis (L.)			12	0.4 SR			12	VII	A-H	P
Dorytomus taeniatus (Fabr.)			8	0.3 SR			8	V	A	O
Anthonomus pomorum (L.)			6	0.2 SR	8	0.6 SR	14	X	A	P
Curculio glandium Marsh.			6	0.2 SR	6	0.5 SR	12	VI–VIII	A	O
C. nucum L.	36	6.7 SD	58	2.1 R	9	0.7 SR	103	V–VII	A	M
C. rubidus (Gyll.)			5	0.2 SR			5	VIII	A	O
Magdalis ruficornis (L.)					3	0.2 SR	3	V	A	P
Rhinoncus castor Hbst.					3	0.2 SR	3	V	H	
Ceutorhynchus floralis (Payk.)					3	0.2 SR	3	VII	H	
Number of individuals	**535**		**2787**		**1317**		**4639**			
Number of species	**22**		**46**		**45**		**63**			
Number of genera	**14**		**25**		**31**		**35**			

N – number of individuals
D – domination
ED – eudominant
D – dominant
SD – subdominant
R – recedent
SR – subrecedent
H – herbicoles
A-H – arbi-herbicoles
A – arbicoles
M – monophagous
O – oligophagous
P – polyphagous



M – monophags, O – oligophags, P – polyphags, A – arbicoles, A-H – arbi-herbicoles, H – herbicoles

Fig. 1. Trophic groups and seasonal changes in representation of topic groups of *Coleoptera* imagines in crown of *Corylus* L. in three localities

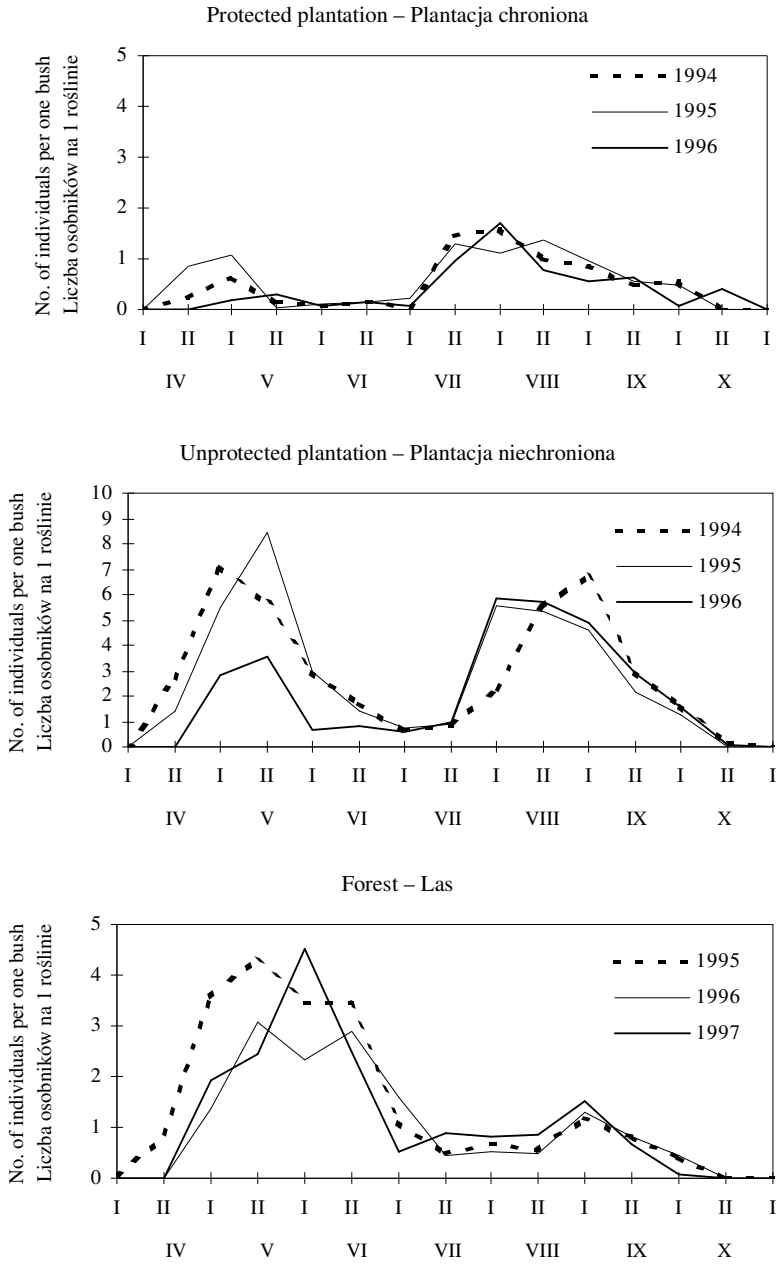


Fig. 2. Seasonal dynamics of *Coleoptera* communities in leaf bearing crowns of *Corylus* L. on three localities

lolontha, *Phyllopertha horticola*. During the summer-autumn peak, herbophyllous species were mostly collected together with *Strophosoma capitatum*, an arboreal species that was numerous on the non-protected plantation and in the forest.

Table 3. Composition of the groups of *Coleoptera* species (MS) and their differences based on Shannon formula on protected plantation (1), unprotected one (2) and in the forest (3)

Locality	1	2	3
1	3.8	42%	34%
2	X	3.9	47%
3	X	X	4.5

MS

H`

The species analysis of beetles inhabiting particular sites points at a lack of homogenity. The coefficient of species variability (H') reached its highest value – 4.5, on the non-protected plantation. A low value of this coefficient, i.e. 3.8, on the protected plantation resulted from controlling the hazelnut entomofauna. The index of similarity of species composition MS was 34% for the species composition of beetles collected on the protected plantation and in the forest, while for the non-protected plantation and the forest environment it reached the value of 47% (tab. 3).

DISCUSSION

Three-year-long studies conducted on cultivated and common hazelnut found out 63 beetle species totally. For 33 of them, hazel was the host plant. They included 27 polyphagous, 5 olyphagous and 1 monophagous representatives. The remaining 32 species were connected with the community of herbaceous plants and they appeared on hazel only accidentally. So far, only the beetle species occurring on common hazelnut (*Corylus avellana* L.) have been described in the forest environment [Cmoluch and Kowalik 1963, Szmidt and Stachowiak 1980, Holecova 1993]. The richest fauna of beetles characterises hazel, like pedunculate oak and willow. The species from the *Curculionoidea* family inhabiting hazel constituted 54% of all beetles. A twice as low number of species from this family was found out in apple orchards [Wariabieda et al. 1995]. The species that damaged the leaves and fruit of hazel and can be considered to be dominating included *Altica brevicollis*, *Agelastica alni*, *Phyllobius arborator*, *P. glaucus*, *P. maculicornis*, *Strophosoma capitatum* and *Curculio nucum*. Similar numbers of *Phyllobius maculicornis* and *P. oblongus* were observed on common hazel by Holecova [1993] in Slovakia and by Stachowiak [1984] in Poland.

The main factor distinguishing the entomofauna of beetles, both regarding the species and the quantities, was the specific character of the environment associated with different degrees of anthropopressure. This is most clearly seen on the example of arboreal beetles whose numbers increased from 6 on the protected plantation to 27 in the forest environment. The species common for the studied habitats included *Phylloperha horticola*, *Melolontha melolontha*, *Athous haemorrhoidalis*, *Pyllobius oblongus*, *P. maculicornis* and *Curculio nucum*. The enumerated taxons can be considered as a constant element of hazelnut fauna.

All the habitat conditions and the intensity of hazel protection considerably shaped the number of beetles and the stability of their occurrence. The greatest similarity in respect of the species composition was found out between the entomofauna inhabiting shrubs in the forest and on the non-protected plantation. Extreme values of the basic ecological indexes were observed comparing the protected plantation and the natural eco-systems. The number of dominating species was almost three times as low, while the domination structure was the least differentiated. For example, the proportion of *C. nucum* among arboreal beetles on the protected plantation was 50%. The fact that beetles reached the lowest value of species variability on the protected plantation confirms the hypothesis according to which man's strong influence results in the formation of specific entomocenoses characterized by poor species composition and extremely high numbers of scarce species, usually resistant to insecticides. When the protective treatments and pesticides were given up, the studies observed a dynamic growth of phytophags, an example of which is the highest number of the collected beetle species. Some of them, occurring only in the forest [Bartkowska 1975, Stachowiak 1984], began to appear in considerable quantities on the non-protected plantation of large-fruited hazel. Those included *Strophosoma capitatum*, *Altica brevicollis*, *Apoderus coryli* and *Deporaus betulae*. In contrast to the forest, the non-protected plantation as a typical monoculture created by man and left without his influence, favoured considerable density of herbivorous populations and their gradation occurrence. An example is very numerous occurrence of *Agelastica alni*.

Finally, it should be stated that the dominating species among beetless on hazelnut plantations in south-eastern Poland are from the weevils family (*Curculionidae*). Arboreal species, namely *Curculio nucum* and leaf-eaters from *Phyllobius* sp. genus were most often collected. The remaining beetle species that were observed should be considered to have no economic significance on production plantations of large-fruited hazel. It is only when cultivation and protective treatments are given up when their numbers increase and the studies observe gradation occurrence of species characteristic for common hazel growing in the forest environment.

CONCLUSIONS

1. The main factor modifying occurrence of *Coleoptera* species feeding on hazelnut with respect species and quantitative composition was type of environment shaped by man in different ways.

2. The highest number of species was noted on the unprotected plantation and the smallest number on the protected one.

3. The dominant species among *Coleoptera* on hazelnut plantation in south-eastern Poland are from weevils family. *Curculio nucum* and leaf-eaters from *Phyllobius* sp. genus were most often collected.

4. The remaining species that were observed are non-economic pests of hazelnut, but giving up suitable chemical pest control and horticultural treatment results in an increase of species characteristic for common hazel growing in the forest.

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CHRZĄSZCZE (*COLEOPTERA*) WYSTĘPUJĄCE NA LESZCZYNIE (*CORYLUS* L.) W RÓŻNYCH WARUNKACH SIEDLISKOWYCH

Streszczenie. Badania dotyczące występowania chrząszczy (*Coleoptera*) na leszczynie (*Corylus* L.) prowadzono w trzech obiektach różniących się intensywnością użytkowania i warunkami siedliskowymi. Były to: plantacja leszczyny chronionej przed szkodnikami, plantacja leszczyny nie chronionej oraz krzewy leszczyny leśnej. W ciągu trzech lat badań zebrano ogółem 4639 osobników należących do 63 gatunków i 35 rodzajów. Warunki siedliskowe kształtowały skład

gatunkowy i liczebność chrząszczy. Najmniej gatunków (22) i osobników (535) odłowiono na plantacji chronionej, a najwięcej (46 gat. i 2787 osobn.) zebrano na plantacji prowadzonej ekstensywnie. Entomofauna chrząszczy w środowisku leśnym charakteryzowała się zbliżonym zestawem gatunków (45) i mniejszą w porównaniu z plantacją nie chronioną liczbą osobników (1317). Na plantacjach leszczyny w południowo-wschodniej Polsce dominującymi okazały się gatunki z rodziny ryjkowców (*Curculionidae*). Do chrząszczy najliczniej odławianych należały gatunki arborealne, a mianowicie *Curculio nucum* oraz liściojady z rodzaju *Phyllobius* sp. Pozostałe gatunki stwierdzonych chrząszczy należy zaliczyć do szkodników nie mających znaczenia gospodarczego na plantacjach produkcyjnych leszczyny wielkoowocowej. Dopiero zaniechanie zabiegów uprawowych i pielęgnacyjnych prowadzi nie tylko do wzrostu ich liczebności, ale również do gradacyjnych pojawów gatunków charakterystycznych dla leszczyny pospolitej rosnącej w lesie.

Słowa kluczowe: *Coleoptera*, chrząszcze, leszczyna, plantacja chroniona i niechroniona, las

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