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CAMBIO- AND XYLOPHAGOUS INSECTS INFESTING SCOTS PINE (*PINUS SYLVESTRIS* L.) CUT OFF TREE-TOPS AND BRANCHES LEFT IN THE FOREST AFTER THINNINGS AND FINAL CUTTINGS

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Abstract. The investigations were carried out in selected Scots pine (*Pinus sylvestris* L.) stands in Gidle, Koszęcin, and Złoty Potok forest districts (Regional Directorate of State Forests in Katowice). The majority (89.2%) of analyzed 212 Scots pine tree-tops and branches, left in the forest after cuttings, were infested by cambio- and xylophagous insects (*Curculionidae* – 19 species, *Cerambycidae* – 4 species). The mean number of brood galleries in a single piece of the examined material was 64. The following insect species were characterized by the highest values of dominance, frequency, and dominance structure: *Pityogenes bidentatus, Pogonocherus fasciculatus, Pissodes piniphilus, Pityogenes quadridens, Pityophthorus pityographus,* and *Magdalis frontalis*. Three different insect communities and 63 associations of a definite dominance structure were distinguished. Also preferences of the most abundant species in respect of diameter and bark thickness of 0.5-meter-long sections of tree-tops and branches were determined. The majority of insect species infested top and branch segments 2.6-4.5 cm in diameter with the bark 2 mm thick. Treatments aiming at reduction of reproduction of secondary insect pests on Scots pine cut off tree-tops and branches are proposed.

Key words: secondary insect pests, *Pinus sylvestris*, communities, associations, thinning, final cutting

INTRODUCTION AND STUDY AIM

Logging residues left in the forest after various kinds of cuttings, such as clear cutting, selection cutting, thinning, and cleaning, as well as tree-tops and branches left after removal of trap trees, windfalls, and windbreaks, become a potential breeding base for some species of cambio- and xylophagous insects [Bilczyński 1974, Koehler and Kolk

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1974, Starzyk 1979, 1999, Mazur 1994, Michalski and Mazur 1999]. These logging residues include tops, branches, blocks, split wood etc. In such a material, insects, which infested crowns of standing trees before their felling, may continue and terminate their development. On the other hand some cambio- and xylophagous species may also infest freshly cut material left on the ground. The list of cambio- and xylophagous insects feeding in crowns of standing living Scots pine trees, usually quite weakened, includes about 40 species [Nunberg 1981, Kolk and Starzyk 1996, Starzyk 1999]. Among them, beetles from the family *Cerambycidae* predominate (82.5%). Also quite abundant are *Curculionidae* (15.5%) including *Scolytinae* (12.5%). Still greater is the number of species infesting Scots pine cut off or broken off tops and branches left on the ground (62 species), including *Scolytinae* – 31 species, *Cerambycidae* – 28 species, *Alleculidae* – 2 species, and *Melandryidae* – 1 species [Karpiński and Strawiński 1948, Nunberg 1981, Kolk and Starzyk 1996, Starzyk 1999]. Some of them, called the secondary insect pests, may also infest and kill living, only little weakened, standing trees e.g. *Tomicus minor* (Hartig), *Ips acuminatus* (Gyll.), *Monochamus galloprovincialis* (Ol.), *Pityogenes bidentatus* (Herbst), *P. quadridens* (Hartig) etc.

In literature published hitherto there is a lack of detailed elaborations concerning the structure of communities and associations of cambio- and xylophagous insects infesting Scots pine cut off tree tops and branches. Only in the paper of Koehler and Kolk [1974] concerning the effect of summer logging on population dynamics of secondary insect pests more detailed data may be found, but they concern *Pityogenes bidentatus* (Herbst) only.

For this reason a wider research was undertaken in several Scots pine stands in which various kinds of cuttings (final cutting, early and late thinning) were conducted. The objectives of these studies were:

- to determine the species composition and abundance of cambio- and xylophagous insects infesting Scots pine cut off tree tops and branches,
- to describe the structure of communities and associations of cambio- and xylophagous insects,
- to determine preferences of insect species in respect of diameter and bark thickness of the infested material,
- to determine the economic importance of the most abundant species and recommend treatments aiming at protection of neighboring Scots pine stands against possible invasion of these insects.

DESCRIPTION OF THE STUDY AREA AND SAMPLE PLOTS

Field studies were carried out in selected Scots pine stands, or in stands with predominance of this tree species, in Gidle Forest District (2002), Koszęcin Forest District (2000-2001), and Złoty Potok Forest District (2001), all administered by the Regional Directorate of State Forests in Katowice.

The Gidle FD occupying the area of 20 201.25 ha is situated in three sub-regions (Dzielnica Łódzko-Opoczyńska, Wyżyna Woźnicko-Wieluńska, and Wyżyna Środkowopolska) of the Małopolska Natural Forest Region [Trampler et al. 1990]. Commer-

cial forests, about 50 years of age, prevail in this forest district with Scots pine (85.77% of the forest area) as the main forest tree species. There are 15 forest site types of which the following occupy the largest area: fresh coniferous forest (36.7%), fresh mixed coniferous forest (23.3%), moist coniferous forest (11.1%), and moist mixed coniferous forest (10.3%). From among the foliophagous insects occurring in this area the following species are the most important: *Panolis flammea* (Den. et Schiff.), *Bupalus piniaria* (L.), *Hyloicus pinastri* (L.), *Acantholyda posticalis* Mats., and *Neodiprion sertifer* (Geoffr.). However, no outbreak of any of them occurred lately. From among secondary insect pests of Scots pine *Tomicus piniperda* (L.) and *Phaenops cyanea* (Fabr.) are of the greatest importance. In Gidle FD 7 sample plots were established. Their description is given in Table 1.

Table 1. Characteristics of sample plots in Gidle Forest District
Tabela 1. Charakterystyka powierzchni próbnych w Nadleśnictwie Gidle

Sample plot no Numer powierzchni próbnej	Forest range Leśnictwo	Forest stand type Typ gospodarczy drzewostanu	Forest site type Siedliskowy typ lasu	Age of pine years Wiek sosny lat	Type of cutting Zabieg gospodarczy
1	Żytno	Pine – So	Fresh mixed coniferous forest BMśw	60	late thinning trzebież późna
2	Żytno	Pine – So	Fresh mixed coniferous forest BMśw	65	late thinning trzebież późna
3	Żytno	Oak-Pine Db-So	Fresh coniferous forest Bśw	95	final cutting cięcia rębne
4	Żytno	Oak-Pine Db-So	Fresh coniferous forest Bśw	95	final cutting cięcia rębne
5	Niesulów	Larch-Oak-Pine Md-Db-So	Fresh mixed coniferous forest BMśw	85	late thinning trzebież późna
6	Niesulów	Oak-Pine Db-So	Fresh coniferous forest Bśw	60	late thinning trzebież późna
7	Sowin	Pine – So	Moist coniferous forest BMw	30	early thinning trzebież wczesna

The Koszęcin FD occupying the area of 20 367.17 ha is situated in the Wyżyna Woźnicko-Wieluńska sub-region of the Małopolska Natural Forest Region [Trampler et al. 1990]. Scots pine (85.9% of the forest area) is the main forest tree species, and its stands are 52 years old on the average. The following forest site types prevail: fresh mixed coniferous forest (27%), moist mixed coniferous forest (24.2%), and fresh coniferous forest (23.5%). *Acantholyda posticalis* Mats. is the most dangerous foliophagous insect species in this area. In this forest district 10 sample plots were established (Table 2).

Table 2. Characteristics of sample plots in Koszęcin Forest District
Tabela 2. Charakterystyka powierzchni próbnych w Nadleśnictwie Koszęcin

Sample plot no Numer powierzchni próbnej	Forest range Leśnictwo	Forest stand type Typ gospodarczy drzewostanu	Forest site type Siedliskowy typ lasu	Age of pine years Wiek sosny lat	Type of cutting Zabieg gospodarczy
1	Kamienica	Birch-Pine Brz-So	Fresh coniferous forest Bśw	85	final cutting cięcia rębne
2	Piasek	Beech-Pine Bk-So	Fresh mixed coniferous forest BMśw	85	final cutting cięcia rębne
3	Strzebiń	Birch-Pine Brz-So	Fresh coniferous forest Bśw	85	final cutting cięcia rębne
4	Strzebiń	Birch-Pine Brz-So	Fresh coniferous forest Bśw	65	late thinning trzebież późna
5	Strzebiń	Beech-Pine Bk-So	Fresh mixed coniferous forest BMśw	80	final cutting cięcia rębne
6	Lipowiec	Beech-Pine Bk-So	Fresh mixed coniferous forest BMśw	40	early thinning trzebież wczesna
7	Lipowiec	Beech-Pine Bk-So	Fresh mixed coniferous forest BMśw	35	early thinning trzebież wczesna
8	Dubiele	Beech-Pine Bk-So	Fresh mixed coniferous forest BMśw	80	final cutting cięcia rębne
9	Dubiele	Birch-Pine Brz-So	Fresh mixed coniferous forest BMśw	55	late thinning trzebież późna
10	Dubiele	Birch-Pine Brz-So	Moist coniferous forest Bw	45	early thinning trzebież wczesna

The Złoty Potok FD occupying the area of 17 621.76 ha is situated in three subregions (Wyżyna Woźnicko-Wieluńska, Wyżyna Krakowsko-Częstochowska, and Wyżyna Środkowomałopolska) of the Małopolska Natural Forest Region [Trampler et al. 1990]. About 50-year-old pure even-aged one-storey Scots pine stands (77.3% of the forest area), sometimes with admixture of European birch and common beech, prevail in this forest district. From among 17 forest site types distinguished in this area fresh coniferous forest (36.4%), fresh mixed coniferous forest (21.8%), and moist mixed coniferous forest (10.3%) occupy the largest area. Description of 10 sample plots established in this forest district is presented in Table 3.

Table 3. Characteristics of sample plots in Złoty Potok Forest District
Tabela 3. Charakterystyka powierzchni próbnych w Nadleśnictwie Złoty Potok

Sample plot no Numer powierzchni próbnej	Forest range Leśnictwo	Forest stand type Typ gospodarczy drzewostanu	Forest site type Siedliskowy typ lasu	Age of pine years Wiek sosny lat	Type of cutting Zabieg gospodarczy
1	Dębowiec	Pine So	Fresh coniferous forest Bśw	45	early thinning trzebież wczesna
2	Dębowiec	Pine So	Fresh coniferous forest Bśw	65	late thinning trzebież późna
3	Dębowiec	Pine So	Fresh coniferous forest Bśw	65	late thinning trzebież późna
4	Zielona Góra	Oak-Birch-Pine Db-Brz-So	Fresh mixed broadleaf forest LMśw	45	early thinning trzebież wczesna
5	Zielona Góra	Oak-Pine Db-So	Fresh mixed coniferous forest BMŚw	55	late thinning trzebież późna
6	Zielona Góra	Oak-Pine Db-So	Upland broadleaf forest Lwyż	55	late thinning trzebież późna
7	Zielona Góra	Pine So	Fresh mixed coniferous forest BMśw	65	late thinning trzebież późna
8	Zielona Góra	Beech-Oak-Pine Bk-Db-So	Upland mixed broad-leaf forest LMwyż	65	late thinning trzebież późna
9	Kręciwilk	Birch-Pine Brz-So	Fresh coniferous forest Bśw	45	early thinning trzebież wczesna
10	Kręciwilk	Pine So	Fresh coniferous forest Bśw	65	late thinning trzebież późna

METHODS

In selected stands 27 sample plots with Scots pine cut off tree-tops and branches left in the forest after early thinning (7 plots), late thinning (13 plots), and final cutting (7 plots) were established. The field investigations were carried out in Koszęcin FD in 2000-2001, in Złoty Potok in 2001, and in Gidle FD in 2002, a year after cutting. On randomly chosen tops and branches a detailed qualitative and quantitative entomological analysis was carried out in 0.5-meter-long sections, after their debarking. The following data were recorded on special forms: plot number, date, length of the examined piece of material (m), diameter at its base (cm), and state of foliage. For each 0.5-meter-

long section the following were determined and recorded: diameter at beginning of the section (cm), bark thickness (mm), degree of covering with bark, state of bark, degree of phloem and cambium decomposition, species composition and developmental stage of cambio- and xylophagous insects, and number of brood galleries of each species.

Field investigations were supplemented with laboratory rearing of bark covered sections of tops and branches in rearing boxes (photoeclectors) to obtain adults in order to secure a proper identification of insect species.

The collected study material was analysed statistically using the following ecological indexes adapted to aims of this study: dominance (D), frequency (F), structure of dominance (Q), density of brood galleries (G), and the infestation percentage of top or branch length (W) [Kasprzak and Niedbała 1981, Szujecki 1980, Starzyk 1996].

Dominance (D), %

$$D = n_a/n \cdot 100$$

where:

n_a – number of brood galleries of a given insect species,
n – number of brood galleries of all insect species.

Frequency (F), %

$$F = N_a/N \cdot 100$$

where:

N_a – number of sections in which a given species was present,
N – number of all sections examined.

Structure of dominance (Q)

$$Q = \sqrt{F \cdot D}$$

Density of brood galleries (G), galleries·dm^{-2}

$$G = N_g/P$$

where:

N_g – number of brood galleries of a given insect species in a 0.5-meter-long section of the top or branch,
P – surface area of the examined section.

Percentage of infestation of the top or branch length (W), %

$$W = l/L \cdot 100$$

where:

l – length of the top or branch segment infested by a given insect species,
L – total length of the top or branch.

RESULTS

In total 212 Scots pine cut off tree-tops and branches were analysed, out of which 89.2% were infested by cambio- and xylophagous insects (Gidle FD – 70 pieces including 68 infested, Koszęcin FD – 40 pieces all infested, Złoty Potok FD – 100 pieces including 99 infested).

The selected parameters of the breeding material examined were as follows:
- mean length – 2.5 m (Gidle FD – 1.8 m, Koszęcin FD – 2.6 m, Złoty Potok FD – 3.3 m),
- diameter at a thicker end – 5.4 cm (Gidle FD – 2.9 cm, Koszęcin FD – 6 cm, Złoty Potok FD – 7.1 cm),
- mean bark thickness – 2.9 mm (Gidle FD – 3.0 mm, Koszęcin FD – 2.2 mm, Złoty Potok FD – 3.1 mm).

The total number of examined 0.5-meter-long sections was 806 including 759 (94.2%) sections infested by cambio- and xylophagous insects.

There were 23 species of *Coleoptera* found on the examined material including 4 species of *Cerambycidae* and 19 species of *Curculionidae.* Among the latter ones *Scolytinae* prevailed (16 species). In total 16 030 brood galleries were found, and the mean number of galleries per a single piece of the examined material was 64 (Gidle FD – 19, Koszęcin FD and Złoty Potok FD – 127).

Communities of cambio- and xylophagous insects found on Scots pine tree-tops and branches

The species composition and characteristics of communities of cambio- and xylophagous insects infesting Scots pine cut off tree-tops and branches are presented in Tables 4-6.

Table 4. Characteristics of the community of cambio- and xylophagous insects infesting Scots pine cut off tree-tops and branches in Gidle Forest District

Tabela 4. Charakterystyka zgrupowania owadów kambio- i ksylofagicznych zasiedlających odcięte wierzchołki i gałęzie sosnowe w Nadleśnictwie Gidle

Species – Gatunek	N	D	F	Q	G	W
Pityogenes bidentatus (Herbst)	1 169	D_6	F_4	91.9	1.8	98.2
Pogonocherus fasciculatus (Deg.)	45	D_3	F_2	6.2	0.4	47.5
Pissodes piniphilus (Herbst)	43	D_3	F_2	6.1	0.5	35.1
Pityogenes quadridens (Hartig)	23	D_2	F_1	3.2	0.7	42.5
Pissodes pini (L.)	8	D_1	F_1	0.8	0.7	41.7
Pityogenes chalcographus (L.)	6	D_1	F_1	0.9	0.3	30.5
Crypturgus cinereus (Herbst)	4	D_1	F_1	0.8	1.3	37.5
Monochamus galloprovincialis (Ol.)	2	D_1	F_1	0.4	0.1	33.3
Orthotomicus laricis (Fabr.)	1	D_1	F_1	0.2	0.3	50.0
Pityophthorus lichtensteinii (Ratz.)	1	D_1	F_1	0.2	0.4	33.3

N – number of brood galleries, D – dominance (D_6 – superdominant, D_3 – subdominants, D_2 – recedent, D_1 – subrecedents), F – frequency (F_4 – euconstant, F_2 – accessory species, F_1 – accidents), Q – index of dominance structure, G – mean index of gallery density (dm^2), W – mean percentage of infestation of the tree-top or branch length.

N – liczba żerowisk, D – dominacja (D_6 – superdominant, D_3 – subdominanty, D_2 – recedent, D_1 – subrecedenty), F – frekwencja, częstość występowania (F_4 – eukonstant, F_2 – gatunki akcesoryczne, F_1 – akcydenty), Q – wskaźnik struktury dominacji, G – średni wskaźnik zagęszczenia żerowisk (dm^2), W – średni procent zasiedlenia długości wierzchołka lub gałęzi.

Table 5. Characteristics of the community of cambio- and xylophagous insects infesting Scots pine cut off tree-tops and branches in Koszęcin Forest District
Tabela 5. Charakterystyka zgrupowania owadów kambio- i ksylofagicznych zasiedlających odcięte wierzchołki i gałęzie sosnowe w Nadleśnictwie Koszęcin

Species – Gatunek	N	D	F	Q	G	W
Pissodes piniphilus (Herbst)	984	D_6	F_2	36.3	2.4	61.4
Pityogenes bidentatus (Herbst)	614	D_5	F_3	27.4	1.1	71.1
Pityogenes quadridens (Hartig)	130	D_4	F_1	8.1	0.6	81.0
Pityophthorus lichtensteinii (Ratz.)	93	D_3	F_1	7.9	0.9	69.4
Pityogenes chalcographus (L.)	73	D_3	F_1	11.5	0.5	82.8
Pogonocherus fasciculatus (Deg.)	53	D_3	F_1	5.2	0.3	34.9
Pityophthorus pityographus (Ratz.)	46	D_3	F_1	8.5	0.7	91.0
Tomicus minor (Hartig)	42	D_2	F_1	4.2	0.3	37.0
Crypturgus pusillus (Gyll.)	39	D_2	F_1	5.6	0.7	72.7
Molorchus minor (L.)	24	D_2	F_1	2.8	0.4	61.7
Ips acuminatus (Gyll.)	15	D_1	F_1	0.7	0.6	45.8
Tomicus piniperda (L.)	12	D_1	F_1	0.1	0.2	35.0
Rhagium inquisitor (L.)	7	D_1	F_1	1.3	0.3	34.0
Monochamus galloprovincialis (Ol.)	5	D_1	F_1	1.6	0.3	31.3
Orthotomicus longicollis (Gyll.)	3	D_1	F_1	3.0	0.3	42.5
Hylastes ater (Payk.)	1	D_1	F_1	0.2	0.2	16.0
Ips sexdentatus (Börn.)	1	D_1	F_1	0.2	0.1	14.0

N – number of brood galleries, D – dominance (D_6 – superdominant, D_5 – eudominant, D_4 – dominant, D_3 – subdominants, D_2 – recedents, D_1 –subrecedents), F – frequency (F_3 – constant, F_2 – accessory species, F_1 – accidents); remaining symbols as in Table 4.

N – liczba żerowisk, D – dominacja (D_6 – superdominant, D_5 – eudominant, D_4 – dominant, D_3 – subdominanty, D_2 – recedenty, D_1 – subrecedenty), F – frekwencja, częstość występowania (F_3 – konstant, F_2 – gatunek akcesoryczny, F_1 – akcydenty); pozostałe objaśnienia jak w tabeli 4.

The community in Gidle FD was composed of 10 species. The following species were characterized by the highest values of dominance, frequency, and structure of dominance: *Pityogenes bidentatus, Pogonocherus fasciculatus,* and *Pissodes piniphilus*. The highest mean values of gallery density were calculated for *P. bidentatus, Crypturgus cinereus, Pityogenes quadridens,* and *Pissodes pini*, while the highest mean values of the percentage of infestation of the material length were calculated for *P. bidentatus, Orthotomicus laricis, P. fasciculatus, P. quadridens,* and *P. pini* (Table 4).

The community in Koszęcin FD was composed of 17 species. The following species dominated: *P. piniphilus*, *P. bidentatus*, *P. quadridens*, *Pityophthorus lichtensteinii*, *Pityogenes chalcographus*, *P. fasciculatus*, and *Pityophthorus pityographus*. *P. bidentatus* and *P. piniphilus* were characterized by the highest frequency. These two species, beside *P. chalcographus*, were also characterized by the highest values of the index of

Table 6. Characteristics of the community of cambio- and xylophagous insects infesting Scots pine cut off tree-tops and branches in Złoty Potok Forest District

Tabela 6. Charakterystyka zgrupowania owadów kambio- i ksylofagicznych zasiedlających odcięte wierzchołki i gałęzie sosnowe w Nadleśnictwie Złoty Potok

Species – Gatunek	N	D	F	Q	G	W
Pityogenes bidentatus (Herbst)	9 579	D_6	F_3	724	5.1	83.7
Pityophthorus pityographus (Ratz.)	1 382	D_5	F_1	17.6	2.0	50.0
Magdalis frontalis (Gyll.)	651	D_3	F_1	11.4	0.9	49.3
Pissodes piniphilus (Herbst)	455	D_3	F_1	9.5	0.6	43.3
Pogonocherus fasciculatus (Deg.)	231	D_3	F_1	6.1	0.4	37.9
Pityogenes chalcographus (L.)	86	D_1	F_1	2.0	0.4	39.4
Tomicus minor (Hartig)	81	D_1	F_1	1.8	0.4	32.4
Molorchus minor (L.)	53	D_1	F_1	1.5	0.3	36.6
Crypturgus cinereus (Herbst)	28	D_1	F_1	0.7	0.5	20.8
Ips acuminatus (Gyll.)	22	D_1	F_1	0.5	0.3	25.8
Rhagium inquisitor (L.)	12	D_1	F_1	0.1	0.3	21.9
Hylurgops palliatus (Gyll.)	3	D_1	F_1	0.3	0.2	16.7
Xyloterus lineatus (Ol.)	3	D_1	F_1	0.2	0.1	25.0

N – number of brood galleries, D – dominance (D_6 – superdominant, D_5 – eudominant, D_3 – subdominants, D_1 – subrecedents), F – frequency (F_3 – constant, F_1 – accidents); remaining symbols as in Table 4.

N – liczba żerowisk, D – dominacja (D_6 – superdominant, D_5 – eudominant, D_3 – subdominanty, D_1 – subrecedenty), F – frekwencja, częstość występowania (F_3 – konstant, F_1 – akcydenty); pozostałe objaśnienia jak w tabeli 4.

structure of dominance. The highest mean density of brood galleries was found in the case of *P. piniphilus*, *P. bidentatus*, and *P. lichtensteinii*. These three species as well as *P. pityographus*, *P. chalcographus*, and *P. quadridens* were also characterized by the highest mean values of the percentage of infestation of the top or branch length (Table 5).

The community in Złoty Potok FD was composed of 13 species with *P. bidentatus, P. pityographus, Magdalis frontalis, P. piniphilus,* and *P. fasciculatus* as dominant species. *P. bidentatus* was characterized by the highest index of frequency. This species together with *P. pityographus* and *M. frontalis* was also characterized by the highest values of the index of structure of dominance and the index of density of brood galleries. These three species together with *P. piniphilus* infested the highest percentage of the top or branch length (Table 6).

Associations of cambio- and xylophagous insects found on Scots pine cut off tree-tops and branches

Only scarce tops and branches (56, i.e. 29.6%) were infested by a single species, i.e. *Pityogenes bidentatus* (23.1%), *Pissodes piniphilus* (3.2%), *Pityphthorus pityographus*

(1.1%), *Pityogenes chalcographus, Pityophthorus lichtensteinii*, or *Tomicus minor* (0.5% each). The remaining material was infested by associations of cambio- and xylophagous insects composed of 2-9 species (Fig. 1 a-e). They were characterized by a definite structure of dominance and microsuccession order.

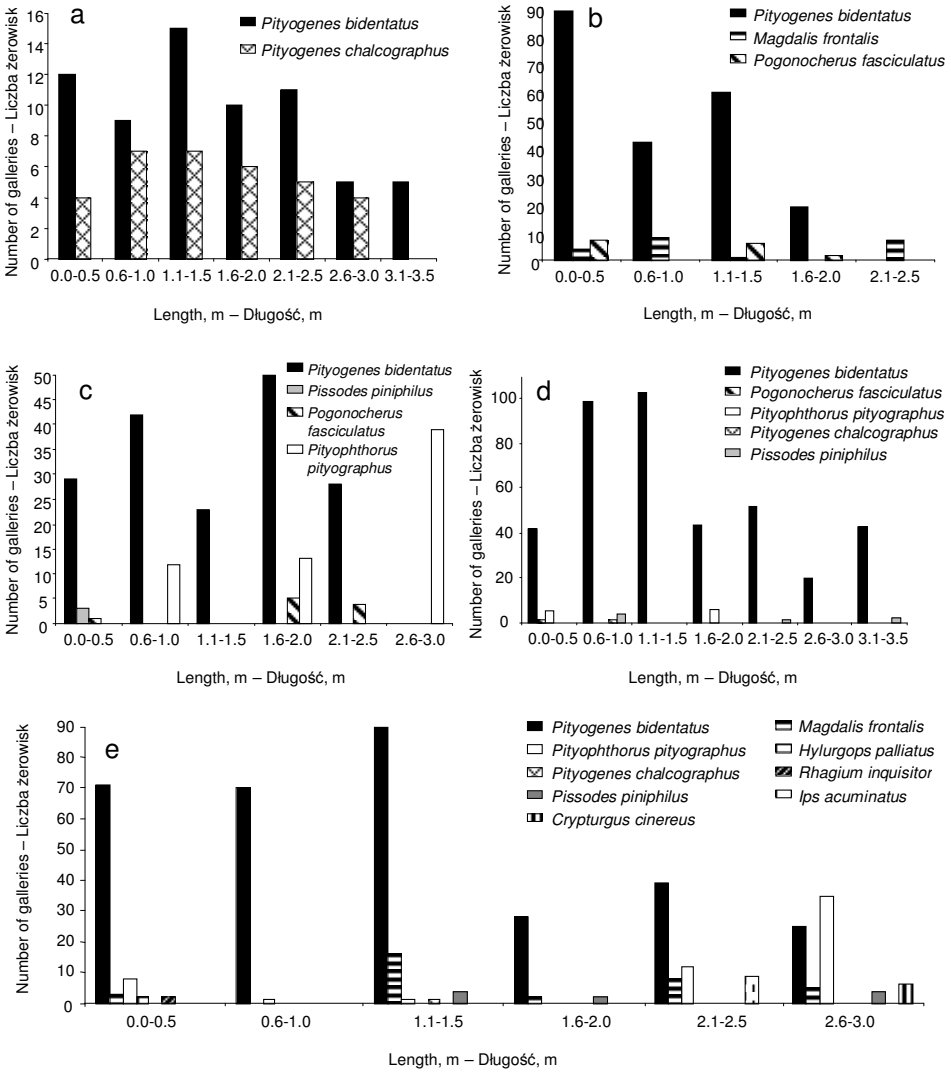

Fig. 1. Selected associations of cambio- and xylophagous insects on analysed Scots pine cut off tree-top and branches: a – 2-species association, b – 3-species, c – 4-species, d – 5-species, e – 9-species

Rys. 1. Wybrane zespoły owadów kambio- i ksylofagicznych na analizowanych wierzchołkach i gałęziach sosnowych: a – 2-gatunkowy, b – 3-gatunkowy, c – 4-gatunkowy, d – 5-gatunkowy, e – 9-gatunkowy

In Gidle FD 15 different associations were found, including seven 2-species, two 3--species, and six 4-species associations. The following associations were most common:

– *Pityogenes bidentatus* + *Pogonocherus fasciculatus* (60%),
– *P. bidentatus* + *Pissodes piniphilus* (40%),
– *P. bidentatus* + *Pityogenes chalcographus* (20%),
– *P. bidentatus* + *Pityogenes quadridens* + *P. piniphilus* + *P. fasciculatus* (20%).

In Koszęcin FD tree-tops and branches were infested by 32 different associations composed of two (16 associations), three (11 associations), four (3 associations), and five (2 associations) species of cambio- and xylophagous insects. The following 2--species association was most frequently found:

– *P. bidentatus* + *Pissodes piniphilus* (12.5%).

In Złoty Potok FD as many as 59 different associations of cambio- and xylophagous insects were found on Scots pine tree-tops and branches, including associations composed of two (13 associations), three (11), four (15), five (10), six (7), seven (2), and nine (1) species. The associations most frequently found were:

– *P. bidentatus* + *Pissodes piniphilus* (10.2%),
– *P. bidentatus* + *Pityophthorus pityographus* + *Magdalis frontalis* + *Pogonocherus fasciculatus* (8.5%),
– *P. bidentatus* + *M. frontalis* + *P. fasciculatus* + *P. pityographus* + *P. piniphilus* (8.5%),
– *P. piniphilus* + *P. bidentatus* + *P. pityographus* + *P. fasciculatus* (6.8%).

In most associations *P. bidentatus* was a superdominant species (D_6). Less frequently this level of dominance was attained by: *Ips acuminatus*, *P. piniphilus*, *P. fasciculatus*, *P. quadridens*, *P. pityographus*, *P. lichtensteinii*, *P. chalcographus*, *Tomicus minor*, *M. frontalis*, and *Crypturgus pusillus.*

Frequency of selected species of cambio- and xylophagous insects depending on diameter of sections of Scots pine tree-tops and branches and bark thickness

It was found that the occurrence of some species of cambio- and xylophagous insect depended on diameter of 0.5-meter-long sections of Scots pine tops and branches. The distribution of diameter classes was as follows: 0.5-2.5 cm (21.7%), 2.6-4.5 cm (37.1%), 4.6-6.5 cm (29.2%), 6.6-8.5 cm (10.6%), and 8.6-10.5 cm (1.4%). Only 11 most abundant species were taken into account. Sections 2.6-4.5 cm in diameter were most frequently infested by: *Pityogenes bidentatus*, *Pityophthorus pityographus*, *Pogonocherus fasciculatus*, *Pityogenes chalcographus*, and *Ips acuminatus.* While sections 4.6-6.5 cm in diameter were preferred by: *Pissodes piniphilus*, *Pityogenes quadridens*, *Pityophthorus lichtensteinii*, and *Molorchus minor*, and sections 4.6-10.5 cm in diameter by *Tomicus minor* (Fig. 2).

Also the occurrence of some cambio- and xylophagous insects depended on bark thickness. The bark thickness measured in 0.5-meter-long sections varied from 1 to 5 mm, and its distribution was as follows: 1 mm – 38.9% of sections, 2 mm – 32.4%, 3 mm – 20.1%, 4 mm – 7.4%, and 5 mm – 1.2%. Most of the species infested most frequently the fragments of Scots pine tops and branches with the bark 2 mm thick, while sections with the bark 1 mm thick were preferred by *Magdalis frontalis* and *Pityophthorus pityographus*, and with the bark 2-3 mm thick by *Ips acuminatus* (Fig. 3).

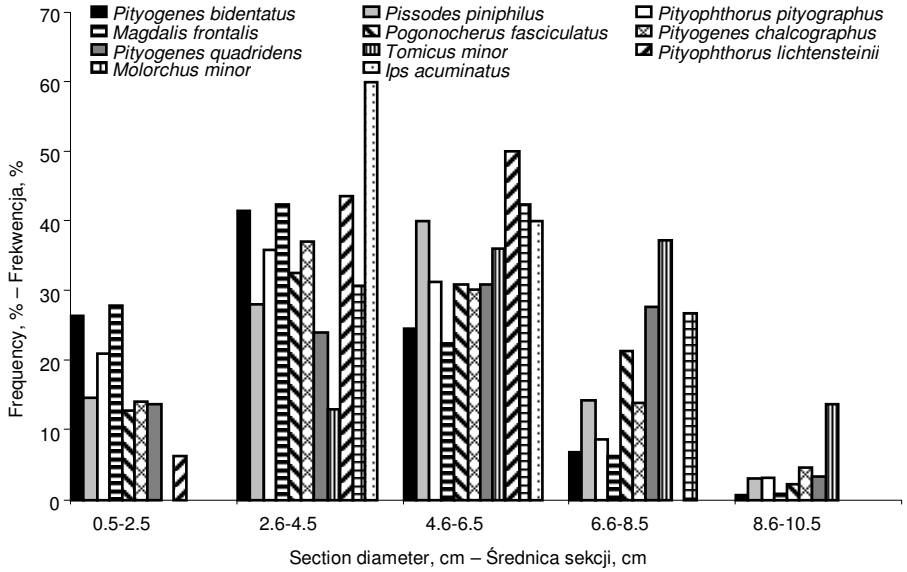

Fig. 2. Mean frequency of brood galleries of selected species of cambio- and xylophagous insects on Scots pine tree-tops and branches depending on their diameter

Rys. 2. Średnia frekwencja żerowisk wybranych gatunków owadów kambio- i ksylofagicznych na wierzchołkach i gałęziach sosnowych w zależności od ich średnicy

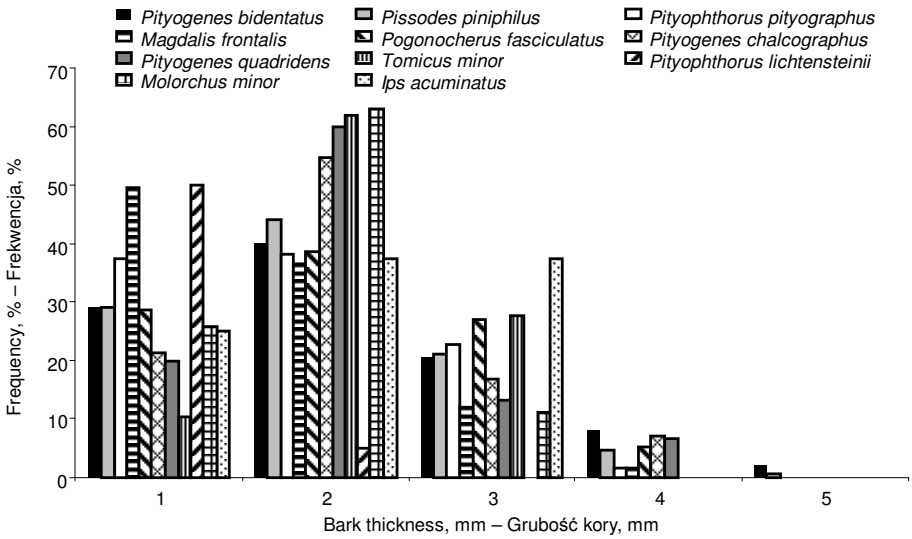

Fig. 3. Mean frequency of brood galleries of selected species of cambio- and xylophagous insects on Scots pine tree-tops and branches depending on bark thickness

Rys. 3. Średnia frekwencja żerowisk wybranych gatunków owadów kambio- i ksylofagicznych na wierzchołkach i gałęziach sosnowych w zależności od grubości kory

RECAPITULATION OF RESULTS AND DISCUSSION

The Scots pine cut off or broken off tree-tops and branches form a specific place of occurrence and development of cambio- and xylophagous insects. It is connected with relatively small length and diameter of this breeding material as well as with a thin bark and relatively fast drying up and decomposition of cambium, phloem and xylem tissues.

Hitherto no detailed research on cambio- and xylophagous insects infesting Scots pine cut off tree-tops and branches was carried out. Literature data concerning this problem are very general and almost exclusively are limited to the species composition of this group of insects [Karpiński and Strawiński 1948, Bilczyński 1974, Nunberg 1981, Starzyk 1979, 1999, Mazur 1994, Kolk and Starzyk 1996, Michalski and Mazur 1999]. Only in the paper of Koehler and Kolk [1974] some detailed data may be found, but they concern only *Pityogenes bidentatus* (Herbst).

The percentage of Scots pine tree-tops and branches infested by cambio- and xylophagous insects in the material examined during this study was very high, i.e. 89.2%. Among 23 cambio- and xylophagous species of *Coleoptera* found in the analyzed material *Curculionidae* dominated (19 species, i.e. 82.3%) including 16 species (69.6%) of *Scolytinae.* The mean density of brood galleries of cambio- and xylophagous insects was high, amounting to 64 galleries (19-127) per one piece of the examined material. Taking into account a large number of eggs laid by *Scolytinae* [Karpiński and Strawiński 1948, Nunberg 1981, Kolk and Starzyk 1996, Michalski and Mazur 1999] the number of adult beetles bred in a single cut off Scots pine top or branch, 2.5 m in length on average, varied from about 1300 to about 7100. Among 23 species of *Coleoptera* found in the material examined during this study no species under special protection or rare in Poland were present.

In insect communities distinguished during this study the following four species dominated: *Pityogenes bidentatus*, *Pissodes piniphilus*, *Pityophthorus pityographus*, and *Pityogenes quadridens.* These four species, and also *Pityogenes chalcographus, Magdalis frontalis*, and *Pityophthorus lichtensteinii*, were characterized by the highest values of the index of dominance structure. The highest mean densities of brood galleries were found for *P. bidentatus* (5.1 galleries·dm^{-2}), *P. piniphilus* (2.4 galleries·dm^{-2}), and *P. pityographus* (2.0 galleries·dm^{-2}). The mean values of the percentage of infestation of the top or branch length were the highest in the case of *P. bidentatus*, *P. pityographus*, *P. chalcographus*, *P. quadridens*, *Crypturgus pusillus*, *Molorchus minor*, and *P. piniphilus.* The majority of insect species found during this study, characterized by high values of dominance and frequency, most often infested sections of tree tops and branches having diameter 2.6-6.5 cm and bark thickness 2 mm.

Only 29.6% of Scots pine tree-tops and branches were infested by a single insect species. Most often this material was infested by associations of cambio- and xylophagous insects composed of 2-9 species and characterized by a definite structure of dominance. In total 63 different associations were distinguished, and the following two were the most common ones:

- *Pityogenes bidentatus* + *Pogonocherus fasciculatus*,
- *Pityogenes bidentatus* + *Pissodes piniphilus.*

Some of the species of cambio- and xylophagous insects developing in Scots pine tops and branches belong to the group of secondary insect pests. Therefore their high concentration in a relatively small area may create a serious threat to neighbouring

Scots pine stands. Some of the species, quite abundant on cut off Scots pine tree-tops and branches examined during this study, may also infest and kill living, sometimes only little weakened, standing trees, i.e. *P. bidentatus*, *P. fasciculatus*, *P. piniphilus*, *P. pityographus*, *Magdalis frontalis* (especially in stands being in sapling and pole-timber stages), *P. chalcographus*, *P. quadridens*, *Tomicus piniperda*, and *Ips acuminatus.* Also other species of secondary insect pests, not abundant on the studied material, may find favorable conditions for their development on Scots pine cut off tree-tops and branches, i.e. *Monochamus galloprovinciallis*, *Tomicus minor*, *Ips sexdentatus*, *Molorchus minor*, and *Xyloterus lineatus* [Bilczyński 1974, Starzyk 1979, 1999, Mazur 1994, Kolk and Starzyk 1996].

CONCLUSIONS

In places strongly endangered by secondary insect pests of Scots pine the cut off tree-tops and heavier branches should be removed from the forest before flight of these insects:

a) if they originate from winter cuttings – before 1st of March in lowlands and sub-mountain regions, and before 1st of April in mountains,
b) if they originate from spring and summer cuttings – two weeks after cutting at the latest.

This concerns not only branches over 5 cm in diameter as recommended by forest protection instructions [Instrukcja ochrony lasu 2004], but also branches 2.5-5 cm in diameter.

If it is impossible to remove cut off tree-tops and heavier branches from the forest before the dates stated above then one of the following treatments should be applied:

a) they should be left in sunny places for quick drying (but they should not be piled up),
b) they should be chipped (if possible),
c) they should be delimbed to the last whorl and the bark should be removed in two strips situated on opposite sides of the stem,
d) in exceptional situations (high insect pest hazard, large amount of tops and branches accumulated for example after the wind storm) they should be burned in the place of logging before snow melting or in summer during rainy weather,
e) large amount of accumulated tops and branches may be treated with chemicals, but in exceptional cases.

In the case of a little insect threat to the forest cut off tree-tops and branches should be left in the place of logging in order to render the development of predatory, parasitic, and wood decomposing insects.

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OWADY KAMBIO- I KSYLOFAGICZNE ZASIEDLAJĄCE ODCIĘTE WIERZCHOŁKI I GAŁĘZIE SOSNOWE POZOSTAJĄCE PO TRZEBIEŻACH I CIĘCIACH RĘBNYCH

Streszczenie. Badania przeprowadzono w wybranych drzewostanach sosnowych w Nadleśnictwie Gidle, Koszęcin i Złoty Potok (RDLP w Katowicach). Większość (89,2%) analizowanych 212 wierzchołków sosnowych była zasiedlona przez owady kambio- i ksylofagiczne (*Curculionidae* – 19 gatunków, *Cerambycidae* – 4 gatunki). Średnia liczba żerowisk w przeliczeniu na pojedynczy wierzchołek sosnowy wynosiła 64. Najwyższymi wskaźnikami dominacji, frekwencji i struktury dominacji cechowały się: *Pityogenes bidentatus*, *Pogonocherus fasciculatus*, *Pissodes piniphilus*, *Pityogenes quadridens*, *Pityophthorus pityographus* i *Magdalis frontalis.* Wyróżniono trzy odrębne zgrupowania i 63 zespoły o określonej strukturze dominacji. Określono preferencje najliczniejszych gatun-

ków owadów względem średnicy 0,5-metrowych sekcji oraz grubości kory wierzchołków i gałęzi sosnowych. Większość gatunków zasiedlało odcinki wierzchołków i gałęzi o średnicy 2,6-4,5 cm oraz grubości kory 2 mm. Podano zalecenia gospodarcze w celu ograniczenia wzmożonego rozrodu szkodników wtórnych na odciętych wierzchołkach i gałęziach sosnowych.

Słowa kluczowe: szkodniki wtórne, *Pinus sylvestris*, zgrupowania, zespoły, trzebieże, cięcia rębne

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