

SPECIES COMPOSITION OF SECONDARY INVADERS AND ACCOMPANYING INSECTS ON THINNING BRUSH WOOD IN PINE STANDS

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Abstract. The aim of the study was to determine the dependency between the age of stand and species abundance of insects inhabiting parts of felled trees, such as stems and branches with diameters smaller than 7 cm. Investigations were conducted in central-western Poland, in pine stands aged 6-60 years. It was shown that the age of felled trees has an effect on the species composition and the number of insect species developing on thinning residue. The lowest number of insect species was found on brush wood left in stands aged up to 10 years, while the biggest number of insect species was recorded in stands aged 20-40 years. Moreover, species composition of entomophagous insects found in feeding grounds of certain secondary invaders was also determined.

Key words: *Pinus sylvestris*, entomophages, cambiohages, xylophages

INTRODUCTION

The effect of tending felling on the incidence and species diversity of forest insects has not been thoroughly investigated [Szujecki 1985]. Studies carried out so far aimed primarily at the determination of the effect of these tending interventions on insects belonging to the group of secondary invaders [Koehler and Kolk 1974, Sierpiński 1980, Starzyk 1995].

A significant reduction of stand density results on the one hand in a change of abiotic conditions contributing to increased susceptibility of trees to colonization by insects (e.g. *Phaenops cyanea*), but on the other hand it promotes the development of forest floor vegetation, undergrowth and underbrush, which may be advantageous for the maintenance of biologic stability of biocenoses. One of the primary tasks realized during tending interventions is to remove from the forest weakened, dying trees and those colonized by harmful insects, among other things in order to prevent excessive multiplication of these insects.

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This study was undertaken to investigate controversial issues originating in relation with the performance of thinning measures in forests. This pertains first of all to the handling of brush wood, which harvesting and haulage from the forest may not be cost-effective, while leaving even thin branches in the forest in sometimes considered a violation of the principles of the so-called forest hygiene. It is also emphasized that the removal from the forest or burning of all thinning brush wood is a controversial procedure, as it has an adverse effect on the soil, deteriorates site quality and may hardly be considered advantageous from the ecological point of view [Laurow 1993, Gornowicz 1996].

Thus it seems advisable to determine the species composition of insects developing on thinning residues in tree stands from individual age classes in order to forecast, on the basis of these data among other things, potential threats to stands and to develop appropriate trends in forest economy.

METHODS

Investigations were conducted in the years 1998-2000, in the forest districts of Babimost, Brynek, Dębno, Henryków, Konstantynowo, Koło, Oborniki, Osusznica, Potrzebowice, Trzciel and in the Murowana Goślina Forest Experimental Station. Observations were carried out in 21 thinning remaining stands aged 6-60 years.

The species composition of insects found on the thinning brush wood was determined on the basis of observations conducted on pine stem sections with a diameter smaller than 7 cm. The incidence of insects on tree stems was monitored on three 0.5 m long testing sections, of which the first was marked in the lower part of the stem, the second in the central part, while the third at the distance of 1 m from the top. Recorded taxa of insects were determined on the basis of mother galleries of bark beetles, as well as the presence of larvae, pupa cells and young beetles.

Data on the incidence of entomophages in feeding grounds of secondary invaders were partly collected during entomological field analyses of wood residue left behind after tending felling. However, the primary method to determine parasitic insects was insect culture under laboratory conditions. Wood material colonized by insects was placed in glass cylinders, which were subsequently sealed relatively tightly. Phytophages gnawing galleries in wood as well as entomophages were gathering in the upper part of cylinders, thus facilitating their removal. Collected insects were classified and counted.

RESULTS

A total of 27 insect species classified as secondary invaders were found in experimental plots. In tree stands aged up to 10 years there were nine species of these insects (Table 1). In most experimental plots the incidence of the two-toothed pine beetle, *Pityogenes bidentatus* was recorded, usually in large numbers. Frequently found, although less numerous species were *Pissodes castaneus* and *Pissodes pini*. Species from genera *Anthaxia*, *Magdalis* and *Pogonocherus* were recorded very rarely and in scarce numbers.

Table 1. Dendrophagous insect species colonizing analysed thinning material in terms of age of felled trees

Tabela 1. Gatunki dendrofagicznych owadów zasiedlające analizowany materiał potrzebieżowy w zależności od wieku wyciętych drzew

Taxon Takson	Age of trees, years Wiek drzew, lat			
	1-10	11-20	21-40	41-60
<i>Tomicus piniperda</i> (L.)		+	+	+
<i>Tomicus minor</i> (Hrtg.)		+	+	+
<i>Pityogenes bidentatus</i> (Hrbst)	+	+	+	+
<i>Pityogenes quadridens</i> Htg.	+	+	+	
<i>Pityogenes chalcographus</i> (Hrbst)				+
<i>Orthotomicus laricis</i> (F.)		+	+	+
<i>Carphoborus minimus</i> F.	+	+	+	
<i>Crypturgus pusillus</i> Gyll.		+	+	+
<i>Hylurgops palliatus</i> Gyll.			+	+
<i>Hylastes</i> spp. Er.			+	
<i>Pityophthorus pityographus</i> Ratz.			+	
<i>Ips acuminatus</i> Gyll.			+	
<i>Xyloterus lineatus</i> (Oliv.)			+	
<i>Ernobius nigrinus</i> Sturm				+
<i>Rhagium inquisitor</i> (L.)		+	+	+
<i>Tetropium fuscum</i> (F.)			+	
<i>Monochamus galloprovincialis</i> (Oliv.)		+	+	+
<i>Pogonocherus fasciculatus</i> Deg.	+	+	+	
<i>Spondylis buprestoides</i> L.			+	
<i>Acanthocinus aedilis</i> (L.)		+		
<i>Pissodes pini</i> (L.)	+	+	+	+
<i>Pissodes castaneus</i> (Deg.)	+	+	+	+
<i>Pissodes piniphillus</i> (Hrbst.)		+	+	+
<i>Hylobius abietis</i> (L.)	+	+	+	+
<i>Magdalis</i> spp.	+	+	+	
<i>Buprestidae</i>		+		
<i>Anthaxia</i> spp.	+		+	
Total – Razem	9	17	23	15

In tree stands aged 11-20 years a total of 17 insect species classified as secondary invaders were recorded (Table 1). It needs to be stated that at the age of 20 years pine trees of class III have breast height diameter of 4.9 cm and height of 6.2 m [Czuraj 1997], thus very many trees felled as part of late cleaning are classified as brush wood over their entire length. At this age bark over a considerable length of the stem is already dark, cracked and relatively thick. This creates advantageous conditions for the colonization of brush wood lying on the ground by species of secondary invaders developing under thick bark, such as *Tomicus piniperda*, *Rhagium inquisitor*, or *P. pini*. In the central part of felled stems of thin trees *Monochamus galloprovincialis* may be found. Almost the entire length of stems is sometimes colonized by *Pogonocherus fasciculatus* and *Pityogenes bidentatus*. Stems and stumps lying on the ground were colonized by *Hylobius abietis*, recorded in small numbers.

The biggest numbers of secondary invaders were found on thinning brush wood in stands aged 20-40 years. Brush wood from stands of this age is relatively diverse in terms of types of bark. Sometimes bark over the entire length of the brush wood part of the stem is smooth, but frequently in the lower section of this part of the stem it is cracked and dark. For this reason relatively many insect species may develop on thinning residue. A total of 23 secondary invaders were recorded in experimental plots (Table 1). *Pityogenes bidentatus* and *Pissodes piniphillus* were dominant species in terms of population size. At times three weevil species, i.e. *P. pini*, *P. castaneus* and *P. piniphillus*, were recorded in the same part of the stem, with *P. pini* being numerous in the bottom part of lying stems, while *P. piniphillus* was found in the upper part. *Monochamus galloprovincialis* was common, but generally found in small numbers. Among species belonging to family *Cerambycidae* the most common species was *R. inquisitor*. It was several times more abundant than all the other species of family *Cerambycidae* considered jointly.

The entomofauna of branches in terms of the number of taxa was much poorer than the entomofauna of stems. For example insects from genus *Pissodes* were not found on branches of trees felled at the age of 21-40 years, while the dominant species was *P. bidentatus*.

In case of stands aged 41-60 years thinning brush wood consisted of tops of pine trees distributed throughout the stand at a much lower density than in younger age classes. This type of material over its entire length had smooth and relatively thin bark, and for this reason it did not promote the development of those insect species which are found in the lower part of stems and under thick cracked bark. Thus the total number of species recorded in stands aged 41-60 years was slightly lower than in younger stands, i.e. those aged 21-40 years (Table 1). *Tomicus minor* was scarcely found in experimental plots. In stands with an admixture of spruce, apart from *P. bidentatus*, also *Pityogenes chalcographus* was recorded in pine tree tops lying on the ground.

Summing up it may be stated that the biggest number of secondary invader species was recorded on thinning residue in stands aged 21-40 years, while the lowest number on material remaining after interventions performed in plantations and sapling stands. *Phaenops cyanea*, a species very dangerous for pine stands, was not found on thinning residue, whereas *T. minor* was scarce. *Pityogenes bidentatus* was dominant in each age class. It was the most abundant and most common secondary invader species recorded in pine stands.

The role of the so-called natural enemies of secondary invaders, including among others predatory and parasitic insects, has been investigated in studies conducted for

several years now in numerous research centers [Kleine 1944, Mazur 1985, Michalski and Ratajczak 1989]. The findings of these studies are of great importance. The species composition of insect groups accompanying feeding grounds of cambio-phages and xylophages, especially economically important species (*Tomicus* spp., *Ips typographus*, etc.), and the role of individual parasitoid species in the regulation of host populations (primarily bark beetles) were determined.

Several issues concerning relations between xylophages and their entomophages on the one hand, and the environment on the other hand, still need to be clarified, thus any information on those subjects is of great cognitive value.

Species of predatory and parasitic insects recorded in this study are presented in Table 2.

In the group of predatory insects only beetles are found in large numbers, while predatory larvae of *Rhaphidides* were scarce. Predatory beetles found in insect galleries of secondary invaders on thinning residue are constant, although rather infrequent elements accompanying groups of underbark insects, due to their population size being of no economic importance.

Among recorded beetles a considerable number of species feed on decomposing plant residues or fungi, and only occasionally on small insects and mites (e.g. *Phloeopora testacea*). Moreover, the small body size of these species practically excludes them from the class of effective predators, capable of reducing the population of xylophages. Only the ant beetle (*Clerus formicarius*) and the rove beetle (*Nudobius lentus*) may be considered effective predators. However, on the basis of the observations conducted within this study, these species seem to prefer older stands and thus thicker trees.

Only locally the number of beetles was large, e.g. *Corticium linearis*, recorded in the Potrzebowice forest district (cultivation on a site of a fire) in the total number of 37 specimens wintering in insect galleries of *Pityogenes bidentatus*. However, in this case this species played a rather significant role on the site burnt by the fire, colonizing dying out young trees on a massive scale. For this reason the large population size of this species needs to be associated with an increasing number of *P. bidentatus* specimens.

Similarly as in case of beetles, locally the number of parasitoids was large. From the material coming from the Konstantynowo forest district over 700 specimens were obtained of parasitic hymenopterans from genus *Spathius* (including *Spathius rubidus*) and from family *Pteromalidae*. These hymenopterans are exoparasites of bark beetles from genera *Ips* spp., *Pityogenes* spp., *Pityophthorus* spp. and other xylophages, such as e.g. *Pissodes* spp.

In relation to hosts bred from the same material, i.e. bark beetles (*Pityogenes chalcographus* and *P. bidentatus*), parasitoids constituted approx. 35% population of bark beetles. These insects winter in feeding grounds of hosts.

Moreover, it was found that these parasitoids brood also from core rolls, which indicates that this operation does not kill at least some parasitic forms.

The above statement is connected with the unresolved issue concerning the advisability and significance of leaving wood material in the forest – even in the form of thinning residue – not only as a brooding ground for harmful insects, but primarily for their entomophages. Under local conditions the number of entomophages in relation to the host population may reach several dozen per cent (the above observations indicate a 35% share of parasitoids, while some literature data report an almost 60% share) [Nunberg 1930, Mazur 1996].

Table 2. Predatory and parasitic insect species recorded in feeding grounds of secondary invaders and found under bark of pine residue left in the forest

Tabela 2. Drapieżne i pasożytnicze gatunki owadów stwierdzone w żerowiskach szkodników wtórnych i pod korą pozostawionych w lesie pozostałości po drzewach sosny

Taxon Takson	Forest district Nadleśnictwo	Number of specimens Liczba osobników	Species found in insect holes Gatunek znaleziono w chodnikach
<i>Clerus formicarius</i> L.	Konstantynowo, oddz. 24 n	6	under the bark – pod korą
<i>Coeloides abdominalis</i> (Wesm.)	Henryków, oddz. 25 A	9	<i>Tomicus piniperda</i>
<i>Corticus linearis</i> (Fabr.)	Zielonka, oddz. 124	3	<i>Pityogenes bidentatus</i>
	Potrzebowice	37	<i>Pityogenes bidentatus</i>
	Konstantynowo, oddz. 24 n	11	<i>Pityogenes bidentatus</i>
	Konstantynowo, oddz. 24 m	1	<i>Pityogenes bidentatus</i>
<i>Cryptolestes duplicatus</i> (Waltl)	Henryków, oddz. 31 d	1	under the bark – pod korą
<i>Crypturgus pusillus</i> (Gyll.)	Konstantynowo, oddz. 25 c	54	under the bark – pod korą
<i>Epurea</i> sp.	Konstantynowo, oddz. 24 n	9	<i>Pityogenes bidentatus</i>
<i>Ichneumonidae</i>		1	<i>M. galloprovincialis</i>
Larvae – Larwy <i>Rhaphidia</i> sp.	Konstantynowo, oddz. 24 k	2	under the bark – pod korą
<i>Nudobius lentus</i> (Grav.)	Henryków, oddz. 31 d	1	<i>Tomicus piniperda</i>
<i>Paromalus</i> sp.	Henryków, oddz. 31 d	6	under the bark – pod korą
<i>Phloeodroma concolor</i> Kr	Konstantynowo, oddz. 24 k	3	<i>Pityogenes bidentatus</i>
<i>Phloeonomus minimus</i> (Er.)	Henryków, oddz. 31 d	21	under the bark – pod korą
<i>Phloeonomus pusillus</i> (Grav.)	Konstantynowo, oddz. 31 d	2	under the bark – pod korą
	Konstantynowo, oddz. 26 b	1	
	Konstantynowo, oddz. 25 c	13	
<i>Phloeopora testacea</i> (Mann.)	Konstantynowo, oddz. 24 n	4	<i>Pityogenes bidentatus</i>
	Konstantynowo, oddz. 26 b	3	
	Henryków, oddz. 31 d	6	
<i>Placusa depressa</i> Mäklin	Konstantynowo, oddz. 26 b	3	<i>Pityogenes bidentatus</i>
	Henryków, oddz. 31 d	1	
	Henryków, oddz. 25 A	4	
<i>Pteromalidae</i>		37	<i>Pityogenes bidentatus</i>
<i>Rhizophagus depressus</i> (Fabr.)	Henryków, oddz. 31 d	1	under the bark – pod korą
<i>Rhizophagus</i> sp.	Zielonka, oddz. 124	1	under the bark – pod korą
<i>Rugilus rufipes</i> (Grav.)	Konstantynowo, oddz. 25 c	1	under the bark – pod korą
<i>Sepedophilus testaceus</i> (Fabr.)	Henryków, oddz. 31 d	1	under the bark – pod korą
	LZD, oddz. 124	1	
	Oborniki	1	
<i>Siagonium quadricorne</i> Kirby	Konstantynowo, oddz. 25 c	1	under the bark – pod korą
<i>Silvanus bidentatus</i> (Fabr.)	Konstantynowo, oddz. 24 g	1	under the bark – pod korą
	Konstantynowo, oddz. 26 b	4	
<i>Spathius rubidus</i> Rossi	Konstantynowo, oddz. 24 n	700	<i>Pityogenes bidentatus</i>
<i>Spathius</i> spp.	Konstantynowo, oddz. 24 n	30	<i>Pityogenes bidentatus</i>

On the basis of the analysed material, the factor determining colonization rate seems to be the date of providing brooding material for insects. A very large number of bred parasitoids comes from pine rollers from thinning performed in June 1999.

CONCLUSIONS

1. The age of the tree stand affects the species composition of insects found on thinning brush wood. The lowest number of insect species was recorded on brush wood from trees aged up to 10 years, while the biggest number of species was found on brush wood from trees aged 21-40 years.

2. Species not recorded on brush wood from older trees were found in large numbers brush wood coming from stands aged 21-40 years. This probably resulted from the fact that on young trees dark, cracked and relatively thick bark covers stems over a considerable length, creating advantageous conditions for the development of such species as *Tomicus piniperda*, *Rhagium inquisitor*, or *Pissodes pini*.

3. A relatively smaller population size of insect species on thinning residue in stands aged 41-60 years may be explained by the fact that brush wood in those stands consists primarily of branches and top parts of stems, on which bark is thin and smooth.

4. *Pityogenes bidentatus* was a species found most abundantly and most commonly on thinning residue in stands aged 6-60 years.

5. Predatory insects probably do not play a considerable role in the control of secondary invaders on thinning brush wood. Parasitic insects may play a bigger role.

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SKŁAD GATUNKOWY SZKODNIKÓW WTÓRNYCH I OWADÓW IM TOWARZYSZĄCYCH NA DROBNICY POTRZEBIEŻOWEJ W DRZEWOSTANACH SOSNOWYCH

Streszczenie. Celem pracy było określenie zależności między wiekiem drzewostanu a bogactwem gatunkowym owadów zasiedlających części ściętych drzew takie, jak pnie i gałęzie o średnicy mniejszej niż 7 cm. Badania wykonano w środkowozachodniej Polsce, w drzewostanach sosnowych w wieku 6-60 lat. Wykazano, że wiek ściętych drzew wpływa na skład gatunkowy i liczbę gatunków owadów rozwijających się na pozostałościach potrzebieżowych. Najmniej gatunków owadów stwierdzono na drobnicy pozostawionej w drzewostanach w wieku do 10 lat, natomiast najwięcej gatunków owadów wykazano w drzewostanach w wieku 20-40 lat. Określono też skład gatunkowy owadów entomofagicznych występujących w zerowiskach niektórych szkodników wtórnych.

Słowa kluczowe: *Pinus sylvestris*, entomofagi, kambiofagi, ksylofagi

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