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BIOLOGY OF *PHELLINUS PINI* (BROT.: FR.) A. AMES ON *PINUS SYLVESTRIS* L. (OPOLE PROVINCE, SW POLAND)

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ABSTRACT: Scots pines' *(Pinus sylvestris)* monocultures often support uncontrolled spreading of parasitic species, including fungi. One of these species is red ring rot pathogen *(Phellinus pini)*. The aim of this paper is to present biology of *Phellinus pini* (rot spreading, symptoms of disease, methods of stands' protection). The 62-year-old Scots pine, which had grown in the Kup Inspectorate, was cut. Then, additional cutting was carried out (into 43 smaller fragments, in longitudinal and cross plane). Based on obtained sections, it can be concluded that: 1) It was confirmed that red ring rot pathogen causes white pocket rot in Scots pine's wood. The white pocket rot attacks only heartwood of the tree; 2) The white pocket rot spread over 91% of trunk; from the forest management point of view, the most valuable part of wood raw material was destroyed; 3) The only reliable external symptom of infection is the occurrence of fruit bodies. Less reliable signs of infection are: occurrence of hollows, wounds on tree e.g. after incorrect cuts or hollow heart phenomenon.

KEY WORDS: *Phellinus pini*, parasitic fungi, red ring rot pathogen, white pocket rot, wood decay.

Introduction

The Scots pine *(Pinus sylvestris)* is the most common tree species in Poland (it occurs on 60.9% of The State Forest Holding area) and in the Kup Inspectorate where researches were conducted – it covers ca. 80% of its area (Milewski 2015, Nadleśnictwo Kup 2015). This species creates natural pine mixed forests (where, besides pines, deciduous trees also occur) and single-species artificial forests. In the first case biocentric balance is maintained, but in the second case it is disturbed. Pines' monocultures often support uncontrolled spreading of parasitic species, including fungi. One of these species is the red ring rot pathogen *(Phellinus pini*, Basidiomycota, Hymenochaetales*)*. It causes the white rot of heartwood which lower economic value of wood. It is estimated that each year, in Poland about 8% of obtained pines' wood is a hub wood (Mańka 2005). For example, on the protected area ,"Nart'' in Kampinoski National Park, half of pines above 200 years old are infected by *Phellinus pini* (Piętka and Dobrowolska 2009). Whereas in selected Scots' pine stands in Narol Forest District, 70% of Scots pine exceeding the III age class (41 – 60 years) were affected by the white pocket rot (Szewczyk 2008). *Phellinus pini* has status R – rare, on the Checklist of Polish Larger Basidiomycetes (Wojewoda 2003). However, as it result from presented data, nowadays economic importance of this species is significant, because lower and middle parts of the trunk (the most valuable source) are being destroyed (Szwałkiewicz 2009).

Mańka (2005) described many symptoms of *Phellinus pini* infection. In the present study I would like to confirm this results and expand knowledge about *Phellinus pini* biology (rot spreading, symptoms of disease) and methods of stands' protection. This researches were conducted on the 62 – year – old Scots pine (*Pinus sylvestris*). Obtained information might be useful for faster infection symptoms' detection in the future. In perspective it can also contribute to lower economic losses in the wood raw material.

Materials and methods

During the researches four Scots pines which were infected by the red ring rot pathogen were cut. Trees were initially cut to exclude concomitant infections and to choose the most infected pine. In all cases fungi species were indicated and pattern of the rot spreading was checked. For detailed researches one tree, which meets criteria (presented above) the best, was chosen. Selected Scots pine was growing on the Kup Inspectorate area, Brynica forestry, 132 section (opolskie voivodeship, Regional State Forest Directorate in Katowice 50 º48'27,12"N; 17 º57'12,04"E). It was artificial planting, pine monoculture which had full treetop cover. Young mountain – ashes (*Sorbus aucuparia*) and blueberry (*Vaccinium myrtillus*) were growing in the undergrowth. Outwardly, except symptoms of *Phellinus pini* infection on the trunk, pine did not differ from other trees from the same species which were growing in 6.0–8.0 m distance. Pine's trunk, except numerous knags and dry branches just under the treetop, was cleaned quite good. The tree was 62 years old (the trees' average age on the Kup Inspectorate area is 56 years), its circuit on the breast height (130 cm) was 139 cm. The height of the tree was 19.5 m.

On the tree's surface a few longitudinal scars closely covered with bark which did not show any necrotic changes were visible. These scars had lenticular shape, in their hollows three fruit bodies which grew separately were noticed. They occurred in irregular distance (first fruit body occurred on 2.8 m height, second on 3.3 m height and third on 5.8 m height). All fruit bodies had South-West orientation in terms of directions of the world.

The tree was cut on the 27th of May 2014. It was cut into 2.8–4.0 m long fragments in order to ease the transport. Then, additional cutting was carried out (into 43 smaller fragments of 5–60 cm; length depended on local disease development, cuts in longitudinal and cross plane). Domański's publication (1954) was a kind of model work for this article.

The fruit bodies were indicated based on host and macro- and micromorphological features. In the case of genus *Phellinus* fungi's species is closely correlated with host (in Poland *Phellinus pini* mostly occurs on *Pinus sylvestris).* Characteristic macromorphological features for this species are: tough, perennial fruit body with sharp edge, sulcate and cracked surface of the fruit body; big, irregular, angular pores, tough, cork, brown flesh. To micromorphological features, which can clearly define the species, it can be classify: spherical or slightly ovoid spores 5–6.5 × 4.5–5.5μm size; occurrence of numerous, brown, large (30–55 × 7–10 μm) – in comparison with other species – setae; dimictic hyphae system characteristic for most species from this genus (Ryvarden 1978).

In order to check if the fertility of habitat have influence on *Phellinus pini* occurrence on Scots pine, the stable areas were set up. Areas were set up in 2014 on the Kup Inspectorate area. Research and control area were singled out (50 Scots pines occurred on each area). Research area was situated in the Kup forestry, 38 section, mixed fresh forest, 61–100 years old Scots pines. The researched agent on this area was the occurrence of *Phellinus pini* in optimal conditions in terms of soil fertility. The control area was set up in the Ładza forestry, 144 section, pine forest, 61-100 years old Scots pines. The researched agent was the occurrence of the *Phellinus pini* in optimal conditions in terms of ground fertility. On the stable areas the assessment of tree condition by visual method was conducted e.g.: the fruit bodies' amount, their orientation in terms of the directions of the world and height of occurrence on the tree; signs of decay; losses on the trunk; old injuries; dead branches. Approximate tree's height, its age and treetop cover were noticed. Photos of damages and positioning of trees by GPS device were made. The data were compared in the spreadsheet program (Excel 2003).

Location of the positions was conducted with the GPS Garmin eTrex 30 with 3 m accuracy. The circuit on the breast height was measured on the 1,30 m height above ground level according to accepted standards. It was measured by tape measure with 1 cm accuracy. The amount of fruit bodies and hollows was evaluated by visual method. Their orientation in terms of directions of the world was evaluated by compass. The height of fruit bodies and hollow occurrence was measured with the use of telescopic leveling rod Nivel System TS – 70 which maximum height was 7.0 m. The occurrence of decay's signs, losses on the trunk, old injuries and dead branches were evaluated with visual method. The height of the tree was measured by electronic theodolite NEDO ET – 5 with 0.5 m accuracy. Approximate age of the tree was evaluated on the base of circuit on the breast height according to age's table elaborated by Majdecki (Majdecki 1980-86). The treetop cover was evaluated on the base of standards accepted in Forest Management Plan (State Forests National Forest Holding 2011). These researches are the part of ecological researches conducted under Ph.D. thesis. The monitoring of other agents is also conducted.

Results and discussion

Morphology, longitudinal and cross extent of rot in the trunk

Based on longitudinal and cross sections it can be concluded that in infected part of the trunk two morphologically different stages of decay – early and late occurred (similarly like in literature – Mańka 2005). From sections, it followed that decay attacked only heartwood, while lignin and cellulose decomposition was uneven (Fig. 1).

Based on cuts it can be undoubtedly said that in the researched tree the white pocket rot occurred, also called light, spongy, pocket, corrosion, gaudy (Ślęzak 2010) or selective delignification (Fig. 2) (Schwarze et al. 2000).

Early stage of decay was characterized by tint from pale pink through red to dark brown. The decay evolved faster along with higher intensity of tint. It was connected with higher decomposition of lignin which discolored in darker tint. In places, where intensive discoloration was observed, first lumens filled with white cellulose occurred. Pattern of decay on cross section was uneven. Wood in more advanced stage of decay took crescent shape and red – brown tint (Fig. 1). During this stage infected wood did not differ significantly from uninfected wood. Also mechanical properties, e.g. susceptibility for breaking, were similar.

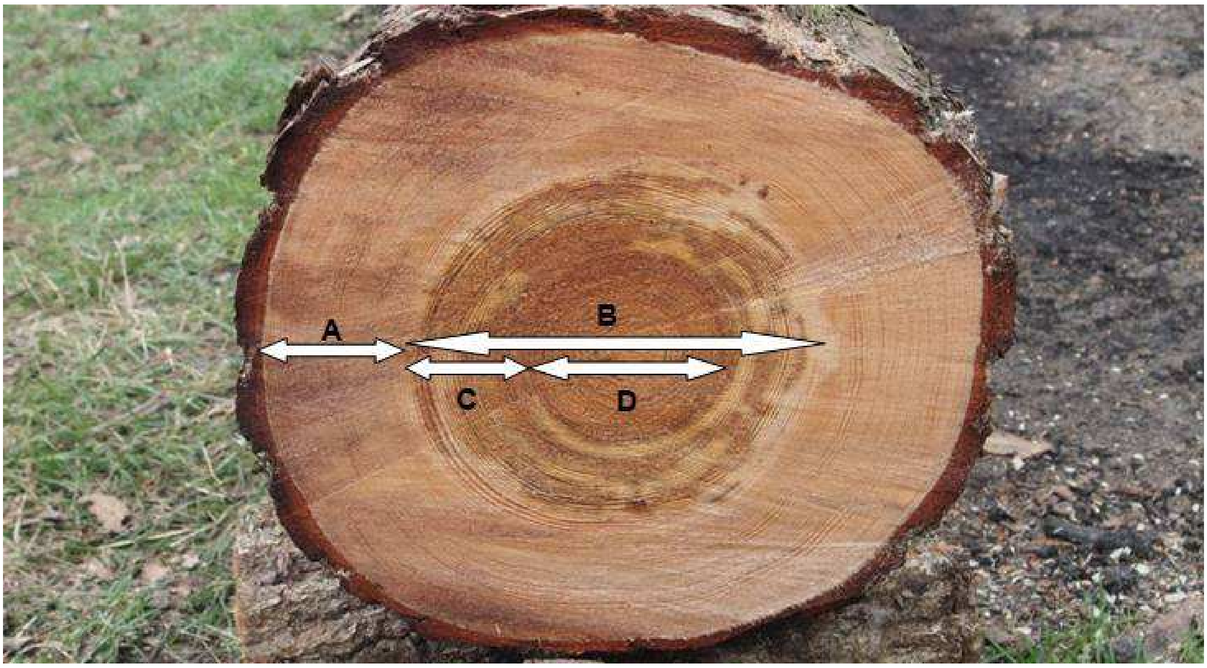

Fig. 1. The Scots pine’s cross section on the 3,20 m height. By arrows there were tagged: A – uninfected sapwood, B – infected heartwood, C – early decay, D – late decay. Area infected by the early decay is covered with characteristic darker crescent pattern – the effect of lignin decomposition.

Late stage of decay was characterized by dark brown or cocoa tint of infected heartwood. In this stage cracks along rings and numerous lumens filled with cellulose occurred – their quantity and size grew with decay’s spreading. It was possible to crush the wood between fingers to smaller splinters. In the stage of maximum decomposition it was crushing like a gypsum. Wood in the late stage of decay is not qualified in any utility categories (Mańka 2005).

Longitudinal spreading of decay is shown on Fig. 3. On the researched tree decay was spreading incessantly on the 17.7 m length (from 1.2 m to 19.1 m height of the tree). It was 91% of Scots pine’s height which was nearly entire surface of the trunk. Only butt and top of the tree were not infected. Early decay was observed in lower and apical part of the trunk (in these places it was not accompanied with late decay) and on the external part of heartwood on the whole length of decay’s occurrence. Late decay was visible from 2.2 m to 14.2 m height. Its higher intensity occurred in places where the fruit bodies where placed or where the “blind” fruit body was found – on the 13.3 m height (Fig. 4).

Fig. 2. The Scots pine's longitudinal section on the 3.5 m height. View characteristic for non selective delignification: dark color of lignin on which variform lumens filled with white cellulose were visible.

Similar relationships were observed on the cross section of the trunk. 13 measurements of the decay's diameter were made on different height. First measurement was made on 0.5 m height. There were no signs of decay. First symptoms of decay's occurrence on the researched tree were on 1.2 m height where diameter of decay was 11 cm. On 2.4 m decay's diameter was 17 cm and on 3.6 m height it was 16 cm. From 3.6 m to 8.0 m measurement value of decay's diameter was constantly decreasing (e.g. on 6.9 m height diameter was 11 cm). On 8.0 m height decay's diameter was 14 cm and on 9.10 m height it was 13 cm. 15 cm – that was the value of decay's diameter on 13.0 m height. Value of diameter's measurement decreased under 10 cm on 16.2 m height. On 19.1 m, where penultimate measurement was made, the diameter of decay was 2 cm. On the top of the tree, on 19.5 m, there were no signs of decay's occurrence.

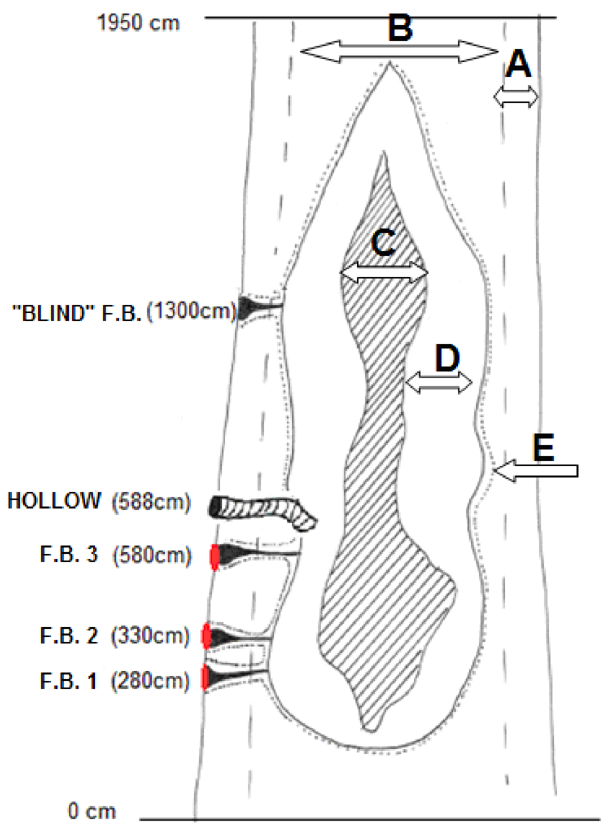

Fig. 3. Longitudinal spreading of each decay's stages caused by the red ring rot pathogen on the Scots pine: A – sapwood, B – heartwood, C – late decay, D – early decay, E – layer of resinous and polyphenolic substances which limits decay's spreading. Places of the fruit bodies occurrence were marked by red points. F.B. – fruit body.

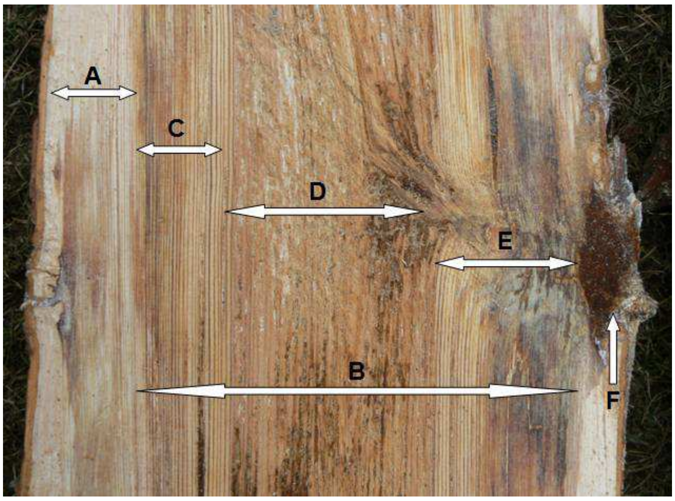

Fig. 4 The Scots pine's longitudinal section on the 13.0 m height: A – sapwood, B – heartwood, C – early decay, D – late decay, E – place of branch occurrence, dark colored area steeped with resin, F – dark colored slotted area filled with brown mycelium (the "blind" fruit body).

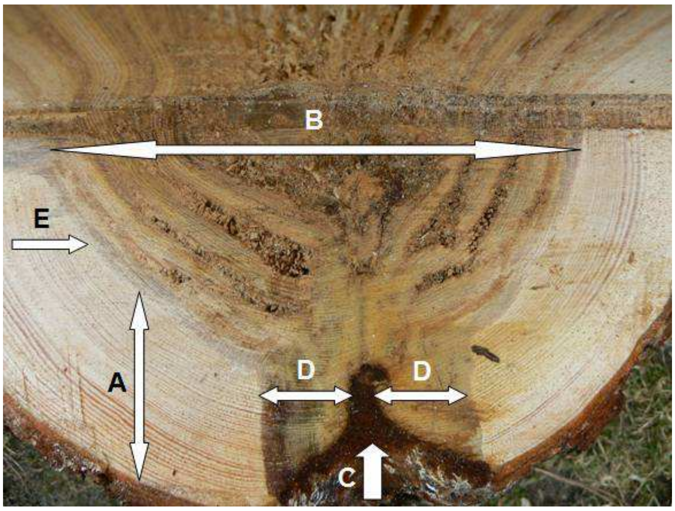

Fig. 5. The Scots pine's cross section on the 3.3 m height in the place of the red ring rot pathogen fruit body occurrence. A – sapwood, B – heartwood with symptoms of the late decay, C – infundibular area filled with dark brown mycelium, place of the fruit body's occurrence, D, E – grey layer of resinous and polyphenolic substances which limits mycelium growth.

Mycelium growth in sapwood, cambium and bark

The *Phellinus pini* fungi is a parasite which infects heartwood (e.g. Černý 1989; Schwarze et al. 2000; Mańka 2005; Sierota and Szczepkowski 2014). During cutting of the researched tree into longitudinal and cross sections, there were not any signs of decay in sapwood. After cross sections, in places of the fruit bodies occurrence, infundibular, brown marks of mycelium were observed in the sapwood. They showed the way of mycelium spreading from heartwood to sapwood, then to cambium and bark's tissues (Fig.5). Around the mycelium marks it was visible grey or grey-brown, layer (1–5 cm thickness) which limited mycelium spreading in the sapwood. Similar layer of 1.0–1.5 cm thickness was observed on the joint of the heartwood and the sapwood. It can be assumed that these tissues were suffused with nutrients which stop the decomposition process.

The sapwood, phloem and cambium are not attacked and inhabited by mycelium of this pathogen. That is why the tree may not show any symptoms of infection during whole life and all wood's destructions can be visible after cutting.

Enzymes which are produced by pathogen have negative influence on the sapwood and close cambium tissues (Domański 1954). However, this kind of influence has local character (necessity of the fruit body's occurrence) because in general the sapwood, the phloem and the cambium are not attacked and inhabited by the *Phellinus pini* mycelium. As a result of this process, lenticular, strongly elongate carcinomatosis, in the form of tissues' subsidence appeared on the trunk. In places where subsidences appeared, the fruit bodies usually occur.

Fig. 6. The photo on the left side: the red ring rot pathogen's fruit body on the Scots pine and the hollow on the 5.88 m height. The photo on the right side: the longitudinal section through the hollow on the 5.88 m height.

Sources of infection

The red ring rot pathogen produces huge amount of light ocher, spherical to ovoid basidiospores of size 4-6 × 4-5.5 μm (Ryvarden and Gilbertson 1994; Bernicchia 2005). The spore production is the most intensive during spring and autumn when temperature is about 10^{o}C (Mańka 2005). Usually it is a time when air humidity is quite high what promotes sprouting of spores. It is important because the infection occurs when the *Phellinus pini*'s spore encounters with host's heartwood. That is injury infection. Occurrence of broken – off or incorrectly cut stumps, wood cracks which reveal the heartwood are the agents which have influence on faster infection. On the cross section marks of knags were visible. At one time, branches were growing in these places. It is possible that the mycelium infection occurred after breaking of these branches. The mycelium spread through branches' heartwood. In pines it appears when the tree is about 20 years old. Further infection is possible when the trunk's heartwood occurs (it happens when the pine is about 30 years old). Spreading of mycelium in the pine's trunk is possible when branches' heartwood joins trunk's heartwood. Černý (1989) claims that first fruit bodies appear under remains of broken branches (infection spread through these branches into the trunk). Then, the fruit bodies occur along the trunk (they do not appear in the treetop), in the whorls' neighborhood of dead, often broken branches. They exist on pines' trunks for about 30, or even 35 years. Old fruit bodies crumble gradually.

External symptoms of infection

The only obvious symptom of infection on the researched pine was the occurrence of the fruit bodies. There were no other external signs of the red ring rot pathogen infection. General physiological condition of the tree did not remove from condition of other pines which were growing in the same stand, e.g. defoliation was not observed. It is probably connected with the fact, that infection attacks only the heartwood, which has mechanic function, and it does not attack the sapwood where processes of conduction and storage of spare substances take place.

To external symptoms which might have been indirect evidences of infection it can be include:

- occurrence of the hollow near to the fruit body on 5.88 m height (West orientation in terms of directions of the world) (Fig. 6),
- losses on the trunk (lenticular subsidence and in some of them fruit bodies),

- occurrence of a few dead branches under the treetop.

Detailed data which concern on changes and symptoms of disease on the researched Scots pine are presented in Tab. 1.

Following the examples of decays' diagnostic which are described in the literature (Piętka and Dobrowolska 2009) the attempt to check the hollow heart phenomenon on researched pine was undertaken. The main assumption was to find differences in acoustic reaction for tapping infected and uninfected trees by ax's head. 150 potentially uninfected trees (which did not show any external symptoms of infection and were growing in optimal conditions for this species) and 150 infected pines or those which were growing in neighborhood of infected trees (some of them have external symptoms of infection – fruit bodies, all of them were growing in suboptimal conditions for this species e.g. too humid soil, incompatibility of habitat, significant human interference) were evaluated. The trees were tapped using head of 2 kg ax on 1m height. In three-step scale (where 1 – lack of acoustic symptoms which indicate on the hollow heart phenomenon, 2- symptoms which indicate on beginning of the hollow heart phenomenon, 3- symptoms which indicate on advanced stage of the hollow heart phenomenon, it was evaluated if acoustic changes, which indicate on the hollow heart phenomenon, occurred. The researched pine, in the comparison with other trees, did not show any acoustic changes which indicate on the hollow heart phenomenon. Tapping the tree by ax's head was effective only when the fruit body/ fruit bodies were situated near (no more than 50 cm) to the tapped place.

There were no signs of influence of indicators which Mańka (2005) singled out as not unquestionable in diagnosis of *Phellinus pini* infection on *Pinus sylvestris*. These are: occurrence of thick branches and knags, local swells on the trunk which differ from standards, forms of decortication.

Fruit bodies

The red ring rot pathogen produces perennial, always sessile fruit bodies which are difficult to see in the first few years. In that time, the fruit bodies are thin and slightly protruding in a shape of little ,,beak''. On researched pine three well-developed fruit bodies of size 6 × 10 × 7 cm, 5 × 12 × 5 cm and 6 × 9 × 6 cm were observed. Cap surface was from grey-brown, through brown, to black tint. All fruit bodies had uneven, concentrically zoned upper surface which was radially cracked in some places. Surface of clearly visible and angular pores was from fair brown to russet tint.

Flesh of the basidiocarps was cork, woody with fair russet tint (Ryvarden and Gilbertson 1994; Łakomy and Kwaśna 2008). On the base of cross section it was possible to evaluate the approximate age of each fruit body (according to number of tube layers). The investigated basidiocarps were about 8, 12 and 5 years old. These fruit bodies were researched microstructurally. The hyphal system of the fruit bodies was dimitic (generative and skeletal hyphae occurred). Detailed microstructural data were presented in Tab. 2.

To external symptoms of infection it can be also include occurrence of the "blind" fruit bodies - those which usually appear in places where spores penetrate into wood e.g. knags, then these places overgrow by wood tissues'. After some time, when mycelium is more active, it is pulled under the wood tissues. In the result swelling appears. Accumulation of dark brown mycelium is situated under the swelling. In practice, the "blind" fruit body is usually visible after cutting of the tree and its detailed examination. However, in some cases it is necessary to cut the wood into smaller fragments, like it was in this case. The occurrence of "blind" fruit body on 13,0 m height was visible after additional cuttings and barking.

Conditions which have influence on infection

The possibility of infection increases with the age of the tree. It is connected with increasing amount of the uncovered heartwood. There are some agents which have influence on the frequency of these situations. These are: natural breaking of bigger amount of thick branches, occurrence of wounds which are the effects of conditioning cuttings and wood hauling, occurrence of wounds in the effect of accidental damages. From observation, it can be concluded that amount of infected trunks and spreading of decay also increase with the age of the tree.

Liese (1936), Burkot-Klonowa (1974) and Mańka (2005) present agents which potentially may have influence on the infections' occurrence. The first author claim that resistance of fungi which live in knags is higher in young stands. Moreover, knags which occur in autumn are safer than those which occur in spring. In the second work it was noticed that trees which have more sapwood than heartwood are more resistant for *Phellinus pini* infection.

Protection of stands

Losses caused by the red ring rot pathogen can be minimalize. Such activities are needed because the white pocket rot spreads through the trunk which is the most valuable part of the tree from the forest management point of view. It is important to take up activities which can minimalize losses not when the occurrence of fruit bodies is visible, but during planning of forest's planting.

During growth of the stand it is important to pay attention on taking out of thick branches. They can cause injuries on neighboring trees and occurrence of big wounds susceptible for infection after breaking of branches. Then, it is essential to care about correct removing of branches during early and late cleaning. This kind of treatment should be done in autumn, perpendicularly to surface of trunk. Pruning of branches should be done multistage and should concern on dead branches (rarely living branches). Thereby, places where the *Phellinus pini* infection might occur are limited (Mańka 2005; Łakomy and Kwaśna 2008; Sierota and Szczepkowski 2014).

During forest thinning of the older stands, trees with the fruit bodies should be removed. Thereby, possibility of neighboring trees' infection is limited. If the occurrence of fruit bodies was not observed, trees which indicate less certain symptoms of disease such as: the hollow heart phenomenon, trunk damages or its incorrect cleaning. It is important to care about minimalizing of trees' damages during all forestry work (Mańka 2005; Łakomy and Kwaśna 2008; Sierota and Szczepkowski 2014).

Influence of too fertile habitat on the Phellinus pini occurrence

It seems that correct selection of habitat for *Pinus sylvestris* may have influence on its condition in future. It was observed that the Scots pine which was planted on too fertile soil was more infected by fruit bodies than those trees which were growing on futile soil.

On the control area no signs of *Phellinus pini* fruit bodies and hollows occurrence were visible. On the research area on too fertile habitat trees infected by fungi from *Phellinus pini* species were noticed (6/50 trees were infected). On the six infected trees 11 fruit bodies occurred on the average height 338.50 cm with SD = 137.96 cm. In the infected trees 4 hollows were noticed on the average height 420.00 cm with SD = 133.67 cm. Signs of decay were observed only on the research area (Tab. 3). Parameters such as: losses on the trunk, old injuries or dead branches occurred twice (or more than twice) often on the research area than on the control area. Total amount of parameters which indicate on infection was over sixfold bigger on the research area than on the control area.

Research area's data:
GPS coordinates
50 º50'48,32"N; 17 º55'00,70"E
50 º50'48,30"N; 17 º55'03,22"E
50 º50'50,24"N; 17 º55'02,93"E
50 º50'50,28"N; 17 º55'00,63"E
Average circuit on the breast height: 129.6 cm, SD = 30.07 cm.
Approximate height on the tree: 19.5 m, SD = 0.91 m.
Approximate age of the tree: 62 age, SD =14 age
The treetop cover: relaxed 60 %, full 40 %.

Control area's data:
GPS coordinates
50 º50'20,48"N; 17 º52'07,27"E
50 º50'21,22"N; 17 º52'07,10"E
50 º50'21,24"N; 17 º52'03,96"E
50 º50'20,30"N; 17 º52'03,94"E
Average circuit on the breast height: 159.4 cm, SD = 36.64 cm.
Approximate height of the tree: 20.0 m, SD = 1.23 m.
Approximate age of the tree: 74 age, SD =17 age
The treetop cover: relaxed 100 %.

Conclusions

- It was confirmed that the red ring rot pathogen (*Phellinus pini)* causes the white pocket rot in the Scots pine (*Pinus sylvestris*) wood. It spreads only through the heartwood of the infected tree.
- In the researched Scots pine the white pocket rot spread through 91% of the trunk. From the forest management point of view, the most valuable part of the wood raw material was destroyed.
- The only reliable external symptom of infection is the occurrence of fruit bodies. Less reliable signs of infection are: occurrence of hollows, wounds on tree e.g. after incorrect cuts or hollow heart phenomenon.
- Too fertile habitat for *Pinus sylvestris* may by one of the agents which promote spreading of the *Phellinus pini* infection.

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Table 1. Detailed data which presents changes and diseases symptoms on the researched Sots pine.

Changes or disease symptoms on the trunk's surface	Direction of the world	Description	Height of lower border symptoms' occurrence [cm]	Length [cm]	Width [cm]	Depth [cm]
Fruit body 1	SW	Console shape fruit body, sharp ending of edge which is fully viable, fruit body situated in lenticular hollow	280	6	10	7
Fruit body 2	SW	Console shape fruit body, sharp ending of edge which is fully viable, fruit body situated in lenticular hollow	330	5	12	5
Fruit body 3	SW	Console shape fruit body, sharp ending of edge which is fully viable	580	6	9	6
"Blind" fruit body	SW	Accumulation of brown mycelium under the bark's surface	1300	6	3	4
Hollow 1	SW	Lenticular, shallow hollow along the trunk	255	293	13	4
Hollow 2	SW	Lenticular, shallow hollow along the trunk	322	353	9	3
Hollow of tree	S	Hollow which occurred in effect of activity of e.g. woodpecker	588	3	3	17
Dead branches	NE	A few dead branches under the treetop cover	1750	-	-	-

Table 2. Microstructural data of the researched *Phellinus pini* fruit bodies.

Feature	Fruit body 1	Fruit body 2	Fruit body 3
Type of hyphae system		Dimitic	
Dimension of spores	5.5 × 4.5µm	6.5 × 5.0µm	5.5 × 6.5µm
Shape of spores		Ovoid – ellipsoidal	
Color of spores	Colourless	Light ocher	Colourless
Skeletal hyphaes		5µm, thick-walled	
Generative hyphaes		3µm, thin-walled	
Amount of setae	Numerous	Numerous	Very numerous
Size of setae	50 × 8µm	45 × 9µm	50 × 10µm
Color of setae	Dark Brown	Cinnamon	Red-brown
Color of spore print		White	

Table 3. Comparison of data for each parameters which indicate on *Phellinus pini* infection on the research and control area.

Parameter	Research area	Control area
Number of fruit bodies on the area	11	0
Number of trees with fruit bodies	6	0
Number of hollows on the area	4	0
Number of trees with hollows on the area	3	0
Number of signs of decay on the area	2	0
Number of losses on the trunk on the area	5	2
Number of old injuries on the area	2	1
Number of dead branches on the area	6	3
Sum of the parameter for each area	**39**	**6**