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ROT CAUSED BY *STEREUM SANGUINOLENTUM* AND ITS SPREAD THROUGH THE NORWAY SPRUCE STEM IN THE LHC OBROVA NOHA MANAGEMENT-PLAN AREA

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Abstract

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In the LHC Obrova noha management-plan area (Municipal Forests Prostějov), peeling and browsing damage to spruce (*Picea abies*) caused by red deer was monitored. In total, 20 plots of an area of 25 × 25 m were monitored in stands aged 26–65 years. On the whole, 56% of 1561 trees were damaged by peeling and browsing, 82% of the damaged trees were attacked by *Stereum sanguinolentum* (Alb. et Schw.: Fr.) Fr. Trees in the 3rd age class affected by rot show the highest proportion, viz 92% trees damaged by peeling. In the plots, in total 90 sample trees with the presence of rot were cut down. Peeling damage happened 6 to 41 years ago. The rot affected 10 to 94% of the sample tree stem volume (on average 39%). The volume of devalued wood is in positive correlation with a time elapsed after peeling damage (r = 0.683). The rot spread vertically through the tree stem by an average speed of 10.5 cm.year^{-1} (from 1.3 to 28.1 cm.year^{-1}). The progress rate negatively correlated with a period elapsed after the stem damage (r = –0.723).

peeling and browsing, *Stereum sanguinolentum*, LHC Obrova noha management-plan area, spread of rot

Spruce stands in the Czech Republic are stressed by a number of stressors for a long time. Their ecological stability decreases and the proportion of salvage felling increases. Damage to trees by peeling and browsing appears to be one of the basic factors participating in the present condition of spruce stands. During the nation-wide inventory in 1999, in total 220 thousand ha of the reduced area of damaged stands were found (BALEK, 2001). Stands attacked by rot demonstrate lower mechanical stability (VICENA, 2001) and can be also more frequently attacked by other biotic pests (PFEFFER et al., 1961; KULA, ZABECKI, 1999; ČERNÝ, 2000, 2001).

Under standard conditions, *Stereum sanguinolentum* (Alb. et Schw.: Fr.) Fr. is rather a saprophyte occurring on decaying wood. However, in case of any bark injury it penetrates into the tree stem where the rot develops rather rapidly. Final results of the rot are particularly related to the speed of its spread and the extent of its occurrence in the stem. Thus, more detailed knowledge on regularities of its spread can contribute to the more accurate economic assessment of damage and total impacts.

In the Department of Forest Protection and Game Management, Faculty of Forestry and Wood Technology in Brno, problems of rot caused by *Stereum san-*

guinolentum are dealt with for a long time. In recent years, extensive surveys were carried out in several regions, viz the Beskids (ČERMÁK et al., 2004a), Training Forest Enterprise "Masaryk Forest" Křtiny (ČERMÁK et al., 2004a), the Žďárské vrchy Hills (ČERMÁK, STREJČEK, unpublished.). Monitoring the damage implemented in 2004–2005 in the LHC Obrova noha management-plan area is a follow-up of the surveys.

MATERIAL AND METHODS

The area belongs to the Drahanská vrchovina Upland natural forest region, subregion the Konická vrchovina Upland. The 3rd oak/beech vegetation zone predominates, the 2nd beech/oak vegetation zone is less represented. In the species composition, Norway spruce predominates. As for broadleaved species, beech and oak show the highest proportion. The studied region is characterized by some facts which have to be described in more detail. Thanks to the extent of the forest estate (788 ha) standard stocks of red deer causing peeling damages are not set. Moreover, the game occurs in the area mainly only in winter or from December to the end of May to June. Present average annual shooting is 8–10 red deer.

On the basis of preliminary monitoring, representative plots were placed in the region for detailed monitoring. These plots of an area of 25 × 25 m were situated in spruce stands aged 26–65 years. In total, 20 representative plots were selected (7 in stands of the 2nd age class, 7 in the 3rd and 6 in the 4th age class). In each of the plots, spruce trees were classified into the following categories: healthy tree, damaged tree and damaged tree with rot (distinguished: open wounds, oozy occluded wounds, wounds of a large extent). In total, 1561 trees were examined.

In selected plots, sample trees were marked with mensurational quantities approaching the values of a mean stem. In each of the plots, it was 3–6 sample trees (according to the stand age and the number of suitable trees) which were felled and subsequently examined in detail. In total, it referred to 90 sample trees. The sample trees were measured (total length in cm, diameter in mid-length in cm, the distance of a wound caused by peeling from the stem foot in cm) and then shortened to one-metre sections until the *Stereum sanguinolentum* rot was evident at the end of a section. If the rot was not evident at the end of the section at all, the section was shortened any farther the height of the rot rise in the stem to be determined as precisely as possible (from the upper edge of a wound). Volumes of sections, volumes of healthy wood and rot in the sections were calculated from determined parameters (by Smalian's or Huber's formula).

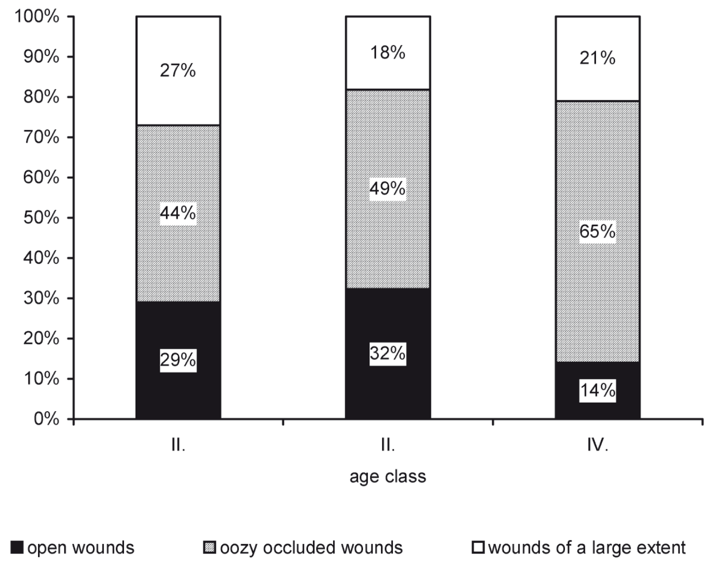
The percentage loss of wood was determined (the proportion of the stem part with the presence of rot of the total sample tree volume). In the place of a wound, the time was determined which elapsed from the time of the origin of peeling injury (the number of undamaged annual rings). The rate of the rot progress in $cm.year^{-1}$ was determined as the height of the rot rise divided by the number of years elapsed from the year of the damage origin. In determining the rate of progress of *S. sanguinolentum* it was not taken into account that the infection did not have to occur in the year of the stem damage by peeling or browsing but only in following years. Actually, it is not possible to determine the year of infection retrospectively.

RESULTS

Of all trees in representative plots, 56% were affected by bark peeling and as for damaged trees about 82% showed symptoms of rot caused by *S. sanguinolentum* (Tab. I). From the viewpoint of the proportion of particular categories of wounds oozy occluded wounds dominated. Their proportion increases with age at the expense of open wounds (Fig. 1).

I: *The proportion of trees damaged by peeling and browsing and the proportion of trees with rot*

Age class	Total number of trees	Number of trees damaged by peeling	% of the total number of trees	Number of trees with wound rot	% of the number of damaged trees
II (21–40 years)	753	432	57.4	318	73.6
III (41–60 years)	432	255	59.0	234	91.8
IV (61–80 years)	376	187	49.7	168	89.8
TOTAL	**1561**	**874**	**56.0**	**720**	**82.4**

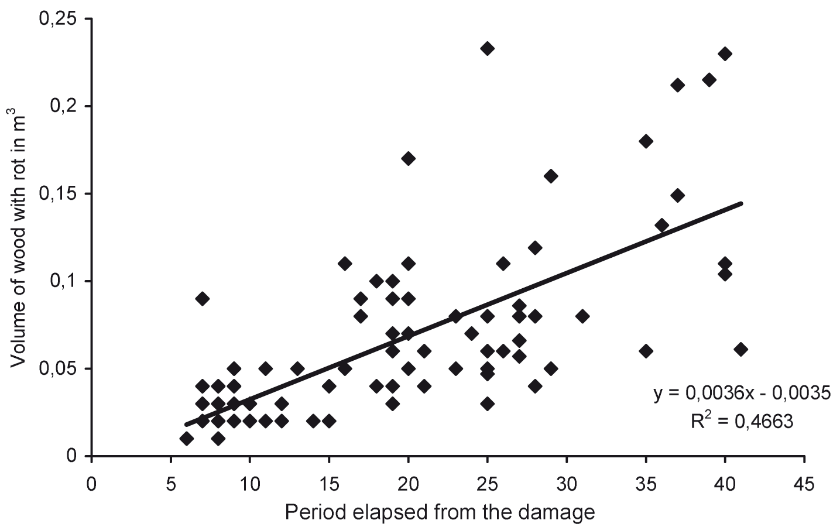


1: *The proportion of particular categories of damaged trees with rot*

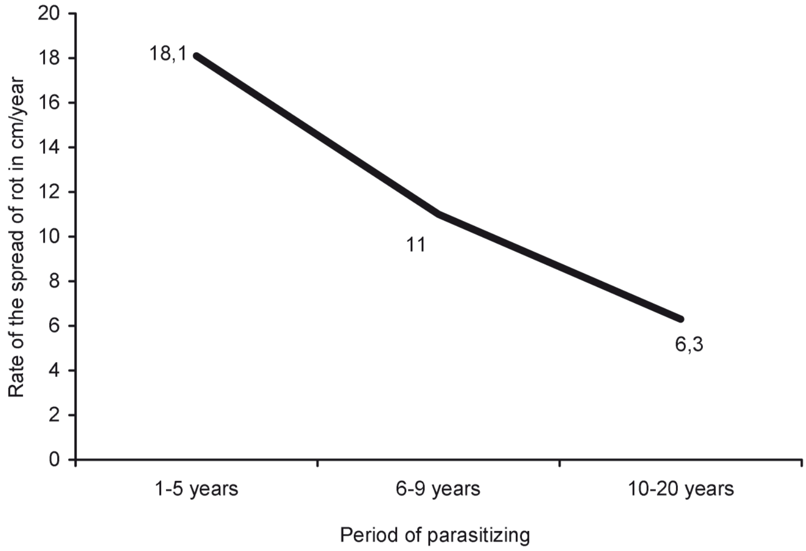
In the sample trees, 6 to 41 years elapsed from the stem damage by bark peeling or browsing, on average 19 years, the majority of wounds occurred at an age of 20–40 years. The rot ascended to a height of 0.46–3.65 m (on average 1.59 m) from the upper edge of a wound affecting 1.5–4.75 m of the stem base (on average 2.73 m) which amounts to 0.01–0.23 m^3 (on average 0.07 m^3).

In relative terms, the rot affected 10–94% of the sample tree stem volume (on average 39%). The volume of wood debased by rot correlates positively with a period elapsed from the peeling damage ($r = 0.683$, $p < 0.05$) the relationship being the logical result of the rot spread through a stem (Fig. 2).

The rot spread through the stem by a rate of 10.5 $cm.year^{-1}$ (ranging from 1.3 to 28.1 $cm.year^{-1}$). The average rate of the rot vertical progress through a stem decreases with a period elapsed from the origin of damage (Fig. 3). The relationship shows negative correlation ($r = -0.723$, $p < 0.05$), see Fig. 4.

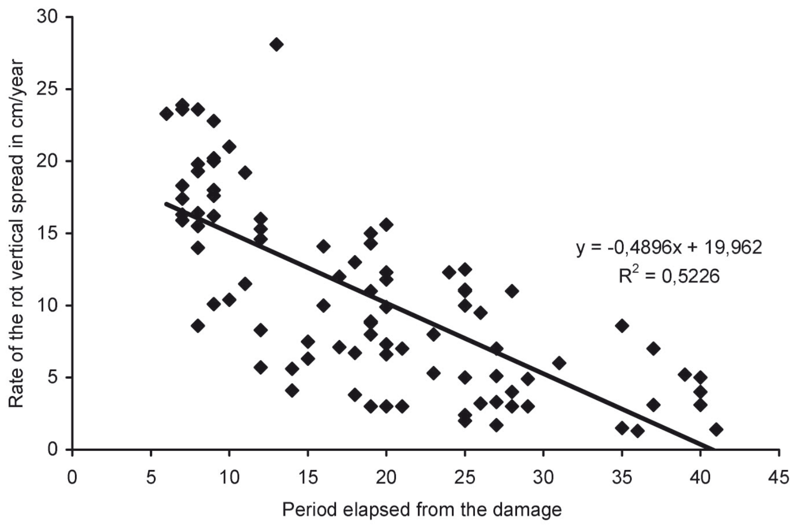


2: *Correlation between a period elapsed from the stem damage and the volume of wood affected by rot*



3: *The average rate of the rot progress in relation to the period elapsed from the damage origin*

Based on determined sample tree volumes damaged by rot and on the basis of the stand growing stock both absolute and relative expected losses of wood per ha were calculated (Tab. II).



4: *Relationship between the period elapsed from the stem damage and the rate of the rot vertical spread*

II: *Average growing stock debased by rot according to age classes*

Wood affected by rot					
II		III		IV	
$m^3.ha^{-1}$	% growing stock	$m^3.ha^{-1}$	% growing stock	$m^3.ha^{-1}$	% growing stock
18.9	11.0%	32.6	16.4%	57.6	14.4%

DISCUSSION AND CONCLUSIONS

In various surveys carried out in Europe in the past 40 years, the proportion of Norway spruce trees damaged by peeling and subsequently attacked by *S. sanguinolentum* ranged from about 20 to nearly 100%. Under conditions of the CR, it approached or rather exceeded 50%. The average value of parasitism found in the LHC Obrova noha management-plan area mostly approaches values found in the Křtiny Training Forest Enterprise (TFE) (ČERMÁK et al., 2004b) and in the southern Russian taiga (SMIRNOV, 1981) where on average 82% peeled trees were attacked by the fungus. The rate of attack near the value mentioned above was also found in other studies (BŘEZINA, 1994; JALŮVKA, 2004; DOMANSKI, 1966).

The proportion of oozy occluded wounds increasing with age at the expense of open wounds can be naturally interpreted above all as manifestation of the curative potential of trees. However, it is not able (particularly in large wounds) to ensure absolute healing the wounds. Therefore, also in the 4th age class, where the average time elapsed from the injury amounted to 31 years, 35% wounds were not healed (14% open wounds, 21% large wounds). Moreover, oozy healed wounds are often disturbed by the effect of climatic factors. KESSL et al. (1957) mention that even small wounds effect trees for a rather long time (including the risk of infection). In wounds up to 5 cm in width, the wound heals after 10–20 years, in wounds 5–10 cm in width it takes 20–30 years and in wounds over 10 cm in width it takes 40 and more years provided the wound is occluded at all.

The highest damage to stands aged 20 to 40 years is also noted in other European studies, 21–40 years mentions ECKMŰLLNER (1985), 15–30 years KOLTZENBURG (1985) and ČERMÁK et al. (2004c), 18–38 years GILL et al. (2000). Within the age range mentioned above, stems of spruce trees are at lest partly cleared of drying lower branches preserving, however, smooth bark which suits for peeling.

The average rate of the vertical spread of rot in the LHC Obrova noha management-plan area approaches values found in the Křtiny TFE (ČERMÁK et al., 2004b) where the rate of progress amounted to 16 cm.year^{-1}. Data on the rate of the vertical spread of rot mostly range from 1 to 80 cm.year^{-1}. In the LHC Obrova noha management-plan area, the rate of progress in particular stems was in the lower part of the range. The determined relationship between a period elapsed from the stem damage and the rate of the rot progress was already demonstrated in some previous studies (BŘEZINA, 1994; ČERMÁK et al., 2004a; ČERMÁK et al., 2004b).

In studies implemented by our department in 1986–2005 (ŠTEFEK, 1987; BŘEZINA, 1994; PEKA, 1996; ČERMÁK et al., 2004a; ČERMÁK et al., 2004b) the amount of wood affected by *Stereum sanguinolentum* rot (the 2nd-4th age classes) ranged between 7 and 58 m^3.ha^{-1}, data from the LHC Obrova noha management-plan area approach the upper limit of the range (see Tab. II). Data on the volume of wood devalued by rot in particular trees are also very similar to results obtained in the LHC Obrova noha, viz 0.01–0.34 m^3 (on average 0.08 m^3). The determined increase in the volume of rot with a period elapsed from the injury origin was already proved in previous studies (ČERMÁK et al., 2004c).

In general, it is possible to conclude that in the LHC Obrova noha management-plan area, the relatively high rate of damage to stands caused by deer barking and *Stereum sanguinolentum* rot was found. Thus, the rot progressed in stems by a rate which ranged within values determined already in previous studies according to regularities demonstrated in surveys carried out in other regions.

SOUHRN

Hniloba pevníku krvavějícího (*Stereum sanguinolentum*) a její šíření kmenem smrku na LHC Obrova noha

Na LHC Obrova noha (Městské lesy Prostějov) bylo sledováno poškození smrku (*Picea abies*) loupáním a ohryzem kůry způsobeným jelenem evropským. Celkem bylo monitorováno 20 ploch o velikosti 25 x 25 m v porostech ve stáří 26–65 let. V souhrnu bylo 56 % ze 1 561 stromů poškozeno loupáním a ohryzem, 82 % z poškozených stromů bylo zasaženo hnilobou pevníku krvavějícího (*Stereum sanguinolentum*). Největší podíl mají stromy s hnilobou ve III. věkové třídě – 92 % loupáním poškozených stromů. Na plochách bylo skáceno celkem 90 vzorníkových stromů s presencí hniloby. K poškození loupáním u nich došlo před 6–41 lety. Hnilobou bylo zasaženo 10–94 % hmoty kmene vzorníku (v průměru 39 %). Objem znehodnocené hmoty pozitivně koreluje s dobou uplynulou od poškození loupáním (r = 0,683). Hniloba se v kmeni vertikálně šířila průměrnou rychlostí 10,5 cm.rok^{-1} (v rozsahu od 1,3 do 28,1 cm.rok^{-1}), rychlost postupu negativně koreluje s dobou uplynulou od poškození kmene (r = –0,723).

loupání a ohryz, *Stereum sanguinolentum*, LHC Obrova noha, šíření hniloby

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REFERENCES

BALEK, J.: Hniloby dřeva – dlouho přehlížený problém. Zprávy lesnického výzkumu - Reports of Forestry Research, 2001, 46, 2: 117–118.

BŘEZINA, J.: Škody působené ohryzem a loupáním jelení zvěří a následnými hnilobami na smrku ztepilém na LS Nové Hrady. Diplomová práce VŠZ Brno, 1994. 93 s.

ČERMÁK, P., GLOGAR, J., JANKOVSKÝ, L.: Damage by deer barking and browsing and subsequent rots in Norway spruce stands of Forest Range Mořkov, Forest District Frenštát p. R. (the Beskids Protected Landscape Area). Journal of Forest Science, 2004a, 50, 1: 24–30.

ČERMÁK, P., JANKOVSKÝ, L., LIČKA, D., BERÁNEK, J., GLOGAR, J.: Damage to spruce stands by deer barking and subsequent rots in Forest Range Proklest, the Křtiny Training Forest Enterprise "Masaryk Forest" (the Drahany Upland). Acta univ. agric. et silvic. Mendel. Brun. (Brno), 2004b, 52, 2: 165–174.

ČERMÁK, P., JANKOVSKÝ, L., GLOGAR, J.: Progress of spreading *Stereum sanguinolentum* wound rot and its impact on the stability of spruce stands. Journal of Forest Science, 2004c, 50, 8: 360–365.

ČERNÝ, A.: ústní sdělení (2000) in JANKOVSKÝ, L., CUDLÍN, P., MORAVEC, I.: Root decays as a potential predisposition factor of bark beetle disaster in the Šumava Mts. Journal of Forest Science, 2003, 49, 3: 125–132.

ČERNÝ, A.: Pevník krvavějící *Haematostereum sanguinolentum* Pouz. nov. comb. významná parazitická dřevokazná houba rozšířená v jehličnatých lesích v mírných pásech na celém světě. Zprávy lesnického výzkumu - Reports of Forestry Research, 2001, 46, 2: 122.

DOMANSKI, S.: Próba fytopatologicznej oceny swierkow ospalowanych przez zwierzyne w Karkonoszach. Folia for. pol. Ser. A, 1966, 12: 157–174.

JALŮVKA, J.: Ohryz a loupání jelení zvěří a napadení sekundárními houbovými patogeny ve smrkových porostech (LS Morávka, Beskydy). Diplomová práce LDF MZLU v Brně, 2004. 59 s.

KESSL, J., FANTA, B., HANUŠ, S., MELICHAR, J., ŘIBAL, M.: Ochrana proti škodám zvěří. 1. vyd. Praha: SZN, 1957. 202 s.

KULA, E., ZABECKI, W.: Nika kambixylofágů na smrcích stresovaných kořenovými patogeny. Journal of Forest Science, 1999, 45, 8: 348–357.

PEKA, T.: Škody způsobené ohryzem a loupáním jelení zvěří a následnými hnilobami na smrku ztepilém v revíru Samčanka, LS Ostravice. Diplomová práce FLD MZLU v Brně, 1996. 65 s.

PFEFFER, A. et al.: Ochrana lesů. 1. vyd. Praha: SZN, 1961. 838 s.

SMIRNOV, K. A.: Effect of elk damage to spruce bark on increment and species succession in the southern taiga. Lesovedenie, 1981, 4: 56–65.

ŠTEFEK, J.: Škody působené jelení zvěří na lesních dřevinách v oblasti honitby Radhošť na Lesním závodě Frenštát pod Radhoštěm. Diplomová práce VŠZ Brno, 1987. 88 s.

VICENA, I.: Hniloby stromů a polomy. Zprávy lesnického výzkumu – Reports of Forestry Research, 2001, 46, 2: 125–127.

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