Root decays as a potential predisposition factor of a bark beetle disaster in the Šumava Mts.

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ABSTRACT: Root decay infection and potential relations to *Ips typographus* L. outbreaks in the Šumava Mts. (Bohemian Forest) were monitored in 3 permanent sample plots. As an originator of root decays honey fungus predominated, in particular cases *Heterobasidion annosum* (FR.) BREF. was also recorded. As for honey fungus species, *Armillaria ostoyae* (ROMAGN.) HERINK predominated, however, *A. cepistipes* VELENOVSKÝ and *A. borealis* MARXMÜLLER et KORHONEN were also determined. Other wood-destroying fungi were also recorded, e.g. *Stereum sanguinolentum* (ALB. & SCHW.: FR.) FR. and *Climacocystis borealis* (FR.) KOTL. Although *Armillaria* foci were localized directly in a forest edge after bark beetle disaster, it is not possible to state definite relationships between *Ips typographus* L. invasion and root system infection by *Armillaria*. The found out rate of infection is, with respect to an altitude over 1,100 m, extremely high not corresponding to existing knowledge on the behaviour of *Armillaria* in the region of Central Europe. The extent of Norway spruce infection by *Armillaria ostoyae* (ROMAGN.) HERINK can give evidence of the chronic stress load of spruce trees in the area.

Keywords: *Armillaria*; bark beetle; *Ips typographus*; root decay; the Šumava Mts.

In connection with a bark beetle disaster in forests of the Czech Republic, it is necessary to mention the potential effect of fungal diseases as one of important factors influencing the health condition of spruce stands. Root decays are primarily important as an initiation or mortality stressor. Their occurrence is generally the result of the effect of droughts as a starting stressor. Through destabilization of spruce stands, *Armillaria* species can significantly participate in their predisposition to the origin of bark beetle disasters. It has been found that from the viewpoint of the production of volatile substances trees infected by *Armillaria* species are attractive for the invasion of *Ips typographus* L. (MADZIARA-BRUSIEWICZ, STRZELECKA 1977).

The aim of the study was to find if there is a correlation between *Ips typographus* L. infestation to spruce trees in forest edges forming due bark beetle infestation in some areas of the Šumava Mts. and infection of the trees by root rots, particularly *Armillaria* species as predisposition factors of the invasion.

MATERIAL AND METHODS

The study was carried out in plots laid out by the Institute of Landscape Ecology Academy of Sciences of the Czech Republic České Budějovice in the region of the Modrava river, the Šumava Mts. The plots are marked as Pod Studenou horou I–III (hereafter PSH I–III). The investigations were carried out in 2000–2002.

Root decays

From the viewpoint of the study of root decays, a primal investigation was carried out on stand walls in plots PSH I and II in 2000. In trees invaded by *Ips typographus* L., occurrence and extent of infection by fungi, particularly by *Armillaria* species were investigated. Infection symptoms were evaluated in fresh felled trees based on:
– the occurrence of decay on a cutting area;
– the occurrence of decay in notches cut by a power saw to buttresses;

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Table 1. Main characteristics of study sites in the Šumava National Park, PSH I–III – Pod Studenou horou I–III (MORAVEC et al. in press)

Plot	PSH I	PSH II	PSH III
Latitude	48°58′47″N	48°59′02″N	48°58′44″N
Longitude	13°28′54″E	13°27′15″E	13°28′42″E
Altitude (m)	1,235	1,230	1,220
Slope (%)	10	10	5
Aspect	SE	SE	NW
Age (years)	132	175	131
Stand density	8	8	9
Mean d.b.h. (cm)	30	37	35
Mean tree height (m)	23	23	25
Forest type	8K acidic spruce stand	8S mesic spruce stand	8P gleyic acidic spruce stand
Soil type	Stony podzol on nutrient-poor silicic rocks	Stony podzol on nutrient-mesic silicic rocks	Peaty gley soil

– other symptoms, e.g. resin exudation, rhizomorphs formation, creation of mycelial fans (syrrocia) etc.; these, however, cannot be considered to be a definite evidence of the infection of living trees irrespective of other features.

Species spectrum of *Armillaria*

Armillaria species were cultivated from samples taken from investigated stumps. Cultures originating from under bark mycelial fans and decay on a cutting area. Split billets were surface-treated by ethanol and cultivated on 3% Malt extract agar (MEA). Determination was carried out based on the comparative morphology of growth (JANKOVSKÝ, SCHÁNĚL 1999). In some problematic samples, species determination of *Armillaria* was verified using molecular biological methods.

Distribution of *Armillaria* root rot infection observed on forest edge after bark beetle infestation

In the place of a bark beetle disaster in the area felled in 2000, positions of stumps were surveyed in year 2002. Based on the evaluation of external symptoms such as the occurrence of mycelial fans (syrrocium) under bark, rhizomorphs in the vicinity of stumps and decay on the cutting area, the occurrence of infection was determined. The location of stumps was surveyed digitally in a Field Map application. Totally were examined 178 stumps on this plot. According to infection, stumps were classified into 4 classes:

0 – no symptoms of infection;

1 – development of the under-bark syrrocium of *Armillaria* species; potential occurrence of rhizomorphs in the vicinity of roots; no symptoms of infection on the cutting area;

2 – symptoms of infection on the cutting area; otherwise the same symptoms as in class 1;

3 – evident mineralized cavity on the cutting area and/or extensive infection, ample formation of mycelial fans under bark.

RESULTS

Stump infection observed on freshly felled trees with bark beetle infestation in 2000

Results in particular stand edges were markedly different. While in the stand margin of the PSH III plot root decay was found in one tree of ten only, in investigated trees of the PSH I plot five trees of 17 trees, and on the PSH II plot even eight trees of nine were infected by root decay (Tables 3–5). A reason of the fact can consist in foci of *Armillaria* species in stands where the foci affected just the investigated forest edge in research plots. During an subsequent examination carried out in all plots extensive foci of trees infected by *Armillaria* species were found. Thus, it is possible to suppose that in case of an open stand wall root infection does not play an important role as a predisposition factor in bark beetle invasions. The occurrence of *Armillaria* focus in clear-felled areas after bark beetle sanitation does not exclude, however, the share of *Armillaria* as a predisposition factor in starting

Table 2. Determination of *Armillaria* species from samples taken in plot PSH III in 2002

	A. ostoyae	*A. borealis*	Unsuccessful isolation
Numbers of examined stumps	47, 79,121,169, 119*	119*	65, 134, 70, 117, 107
Number of sampled stumps	5	1	5

*in sample 119, two samples were taken from the stump cavity and buttress. *A. borealis* was determined from the cavity sample

Table 3. Assessing the proportion of *Armillaria* infection in spruce trees invaded by *Ips typographus* L. in plot PSH I

Tree No.	Cutting area	Number of infected buttresses	Number of examined buttresses	Originator	Note
1	0	0	5		
2	0	0	5		
3	0	0	4		
4	0	0	5		
5	0	0	4		
6	0	0	3		
7	0	1	4	*A. ostoyae*	
8	0	0	2		
9	–	1	2	*A. ostoyae*	
10	–	1	3	*A. ostoyae*	
11	0	0	2		
12	0	0	2		
13	0	0	2		
17	0	0	3		
25	–	2	4	*A. cepistipes*	standing
28	–	1	3	*A. cepistipes*	standing
102	0	0	2		
Plot total	0	6	55		
Number of examined trees	0	5	17		
Percentage	0	29.4 Infected trees	100 Totally trees		

Table 4. Assessing the proportion of *Armillaria* infection in spruce trees invaded by *Ips typographus* L. in plot PSH II

Tree No.	Cutting area	Number of infected buttresses	Number of examined buttresses	Originator (Number of infected buttresses/Number of examined buttresses)	Note
7	+	1	5	*Armillaria ostoyae*	*Armillaria* on a cutting area
8	+	2	3	*Armillaria* sp. (undetermined)	*Postia stiptica* on a cutting area
17	+	4	4	*Armillaria* sp. (undetermined)	*Armillaria* on a cutting area (CA)
18	+	3	3	*A. ostoyae* 2/3 + *Heterobasidion* 1/3	*Heterobasidion* and *Armillaria* on a CA
48	+	1	3	*A. ostoyae*	*Heterobasidion* and *Armillaria* on a CA
53	0	3	5	*Armillaria* sp. (undetermined)	
55	0	4	4	*A. ostoyae* 1/4 + *Heterobasidion* 3/4	
56	+	3	3	*Armillaria* sp. 2/3 + *Climacocystis borealis* 1/3	*Climacocystis borealis* on a cutting area
61	0	0	2		
Plot total		21	32		
Number of examined trees		8	9		
Percentage		88.8 Infected trees	100 Totally trees		

Table 5. Assessing the proportion of *Armillaria* infection in spruce trees invaded by *Ips typographus* L. in plot PSH III

Tree No.	Cutting area	Number of infected buttresses	Number of expected buttresses	Originator	Note
4	0	0	4		
5	0	2	5	*Armillaria ostoyae*	
6	0	0	3		
7	0	0	3		
8	0	0	1		
9	0	0	3		
12	0	0	2	*Stereum sanguinolentum* on a cutting area	
13	0	0	2		
93	0	0	3		Trap tree
98	0	0	1		Trap tree
Plot total	0	2	27		
Number of examined trees	0	1	10		
Percentage of infected trees	0	10 Infected trees	100 Totally trees		

the bark beetle gradation in trees predisposed by *Armillaria.*

Species spectrum of *Armillaria*

Armillaria clearly predominated as the causal agent of root decays, in some cases *Heterobasidion annosum* (FR.) BREF. was also recorded. As for *Armillaria* species, *A. ostoyae* (ROMAGN.) HERINK predominated, *A. cepistipes* VELENOVSKÝ and *A. borealis* MARXMÜLLER et KORHONEN were also found (Table 2). In addition to *Armillaria* sp. and *Heterobasidion annosum* (FR.) BREF., other wood-destroying fungi were also recorded, e.g. *Stereum sanguinolentum* (ALB. & SCHW.: FR.) FR. and *Climacocystis borealis* (FR.) KOTL. (Tables 3–5).

From the viewpoint of the species spectrum of *Armillaria*, the situation was somewhat different in particular plots. Generally, *A. ostoyae* (ROMAGN.) HERINK dominated. In plot PSH I, *A. cepistipes* VELENOVSKÝ was found. From stumps with an extensive cavity (No. 119, other 2 outside) in plot PSH III, also *A. borealis* MARXMÜLLER et KORHONEN was determined in 2002. In the stump, *A. ostoyae* (ROMAGN.) HERINK was also isolated from the second sample. However, also in this plot *A. ostoyae* (ROMAGN.) HERINK predominated. *A. cepistipes* VELENOVSKÝ*,* known from plot PSH I in 2000, was not identified. From 14 samples taken in plots PSH I and PSH II in 2000, *A. ostoyae* (ROMAGN.) HERINK was determined in 8 cases. In 4 cases from samples taken in plot PSH II, isolation did not succeeded. It is possible to suppose, however, that also in these cases *A. ostoyae* (ROMAGN.) HERINK was an causal agent. In two trees in plot PSH I only, honey fungus was determined as *A. cepistipes* VELENOVSKÝ.

Distribution of *Armillaria* root rot infection in the PSH III stand edge

In total, some 178 spruce stumps in a stand wall were examined in 2002. The trees were felled in 2000. A cavity was found in case of two examined stumps only. Symptoms of permeating infection on a cutting area were evident in 18 trees (Table 6). The existing 2nd and 3rd degree of infection when the decay permeates to a cutting area can be considered to be the evidence of the occurrence of infection in the period of tree life. It is possible to suppose that already during the tree life its function was affected due the infection of roots by *Armillaria*. Thus, at least 11% of trees were markedly infected by *Armillaria* already during the tree life. In existing stumps of the infection degree 1 when mycelial fans (syrrocium) develop under bark, the relationship is not conclusive. Colonization could occur until felling and/or *Armillaria* activity actuated due to

Table 6. Numbers of infected stumps and classes of stump infection by *Armillaria* in the PSH III stand wall

	Total	Infection class			
		0	1	2	3
Total number	178	108	50	18	2
Percentage	100	61	28	10	1

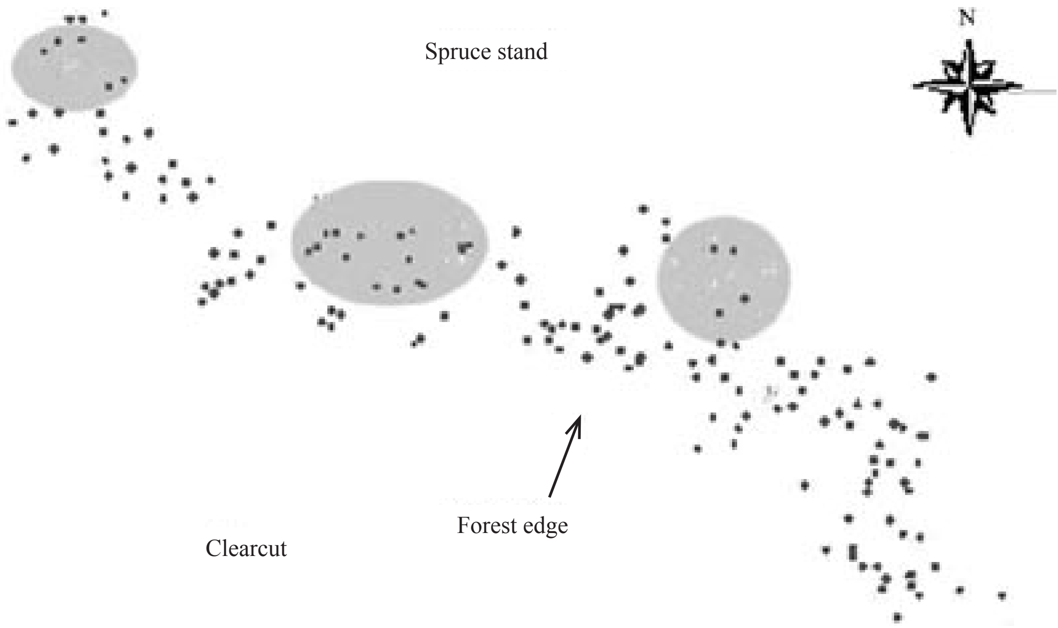

Fig. 1. Situation and foci of *Armillaria* infection in PSH III plot (included stumps with infection stage 2 and 3). Circle – stumps free of infection symptoms, square – stumps in the 1st infection stage, small cross – stumps in the 2nd infection stage, triangle– stumps in the 3rd infection stage. Positions obtained from the Field Map laser telemeter

felling. The proportion amounted to 28% in the area under examination.

The position of stumps in particular classes of infection is evident from Fig. 1. Infection foci are evident where stumps were localized in infection classes 2 and 3. Stumps with the mere occurrence of mycelial fans (syrrocium) under bark were distributed evenly throughout the area.

DISCUSSION

The impact of different stress factors into predisposition of spruce to bark beetle infestation was already evaluated at monitored plots in Šumava Mts. At the same time the retrospective evaluation of the response of mountain forest ecosystems in Šumava Mts. to multiple stress were studied (CUDLÍN et al. 2001a,b).

Results obtained by the study do not show a coherent relationship between the invasion of *Ips typographus* L. and the root system infection by *Armillaria* although *Armillaria* foci were found directly in the forest edge after bark beetle disaster. Thus, its effects can be rather supposed only. It could show, however, the important role of an initiation stressor in relation to starting the *Ips typographus* L. outbreak.

It is possible to note that the determined rate of infection is, with respect to an altitude over 1,100 m, particularly high not corresponding to existing knowledge on the behaviour of *Armillaria* species in forests in Central Europe. Honey fungus in these areas plays a role of the important pathogen of a root system. Particularly the distribution and extent of infection of Norway spruce by *Armillaria ostoyae* (ROMAGN.) HERINK is surprising under these conditions. *Armillaria ostoyae* (ROMAGN.) HERINK is typical pathogen of secondary spruce stands in fertile stands in oak-beech and beech zone (JANČAŘÍK, JANKOVSKÝ 1999). However precedent studies of ecology and pathology of *Armillaria* species affected in Šumava Mts. (MAREK, LEPŠOVÁ 1999) correspond with our results. Thus, it can give an other evidence of the chronic stress load of spruce trees in these areas (CUDLÍN et al. 2001a). It is necessary to note that the rate of infection determined by the used methods corresponds to outer symptoms of infections in the vicinity of stumps and cutting faces which are first indirect symptoms of root damage. The health condition of roots is, however, with respect to methodical difficulties in desired scale and conditions, virtually unidentifiable.

PFEFFER (1950) mentioned that after a dry year of 1947, more than 90% trees attacked by bark beetles were also infested by *Armillaria.* He notes that bark beetles (*Ips typographus* L., *Pityogenes chalcographus* L., *Polygraphus poligraphus* L.) look for weakened trees and accelerate their dieback. Also FRANCKE-GROSSMAN (1950) mentioned a narrow linkage between red rot caused by *Heterobasidion annosum* (FR.) BREF. and bark beetles in *Picea sitchensis* (BONGARD) CARR. Similar relationships between root decays and bark insect in *Abies grandis* (DOUGLAS) LINDL give HERTERT et al. (1975).

Root decays caused by *Armillaria* species and some other primary parasitic wood-destroying fungi increase the host water deficit and predispose it to the invasion of bark beetles (FRANCKE-GROSSMANN 1950; MADZIARA-BORUSIEWICZ, STRZELECKA 1977; JANKOVSKÝ 1994). On the other hand, CHRISTIANSEN and HUSE (1980) did not corroborate that *Ips typographus* L. preferred trees attacked by rot.

Relationships between the origin of dead standing trees, fungi and bark beetles studied KŘÍSTEK and URBAN (1994) in the Křtiny Training Forest Enterprise in 1985. Even though they found the high frequency of attack by wood-destroying fungi and bark beetles they stated that the proportion of trees invaded by the most important bark beetle *Ips typographus* L. was relatively low. As for examined dead standing trees, windfalls and fractures, 90% of them showed symptoms of attack by fungi and were colonized particularly by secondary bark beetles (*Pityogenes chalcographus* L.*, Polygraphus poligraphus* L.*)*, *Ips typographus* L. was observed rather in co-dominant trees.

KULA and ZABECKI (1999a) mention the niche analysis of cambioxylophagous insect in relation to root rots occurred in standing dead trees killed by bark beetle attack. They state that a prolonged trophic niche was characteristic in the spruce stem for *Pityogenes chalcographus* L., *Obrium bruneum* FABR. and *Molorchus minor* L. The same authors mention that the occurrence of fungal pathogens affected the structure of the cambioxylophagous insect synusia, spruce attractiveness for attack by some bark and wood-destroying species as well as the niche width. In co-dominant trees attacked by *Ips typographus* L., increased frequency was observed of the root system infection by *Armillaria* and *Heterobasidion annosum* (FR.) BREF. and/or combination of both originators of root decays (KULA, ZABECKI 1999b). The authors assessed the occurrence of infection on the basis of development of the under-bark mycelial fan of *Armillaria* at the stem base.

During preliminary studies at landings of felled standing dead trees killed by bark beetle attack, rot symptoms by *Armillaria* at the stem base were observed in the cutting area of 15% of stems coming from salvage felling in the Masarykův les Training Forest Enterprise Křtiny at Drahany Highland by Brno in 1992. Mycelial fans of *Armillaria* under bark were, however, found in 90% of stems. According to the inspection of stumps, the frequency of rots in a cutting area corresponded to results obtained in the landing (18%), during more detailed observations in buttresses, *Armillaria* infected 94% from 50 examined trees. Evaluation of the proportion of *Armillaria* in the origin of standing dead trees killed by bark beetle attack according to the presence of rot on a cutting area is thus considerably undervalued. The formation of under-bark white mycelial fans (syrrocium) on these trees is a response to the sudden dieback of a host (JANKOVSKÝ 1994).

It is necessary to emphasize once again that from the viewpoint of tree attractiveness for *Ips typographus* L. invasion it is necessary to differentiate strictly both courses of infection by *Armillaria* – i.e. (1) chronic damage when roots are damaged and (2) acute damage when *Armillaria* spreads rapidly through phloem in a virtually dead tree. While acute infection is quite evident, in case of chronic infection it is necessary to assess a number of often oblique symptoms of the root system infection by *Armillaria*. This methodical problem of assessing the root system condition is obviously a reason for different opinions on the correlation between the bark beetle invasion and tree infection by *Armillaria*.

The importance of root rots from the viewpoint of host tree predisposition results particularly from the further increase in water stress in consequence of root damage. The focus-like character of infection spreading, among others, by root grafts is also important in *Armillaria*. In disturbed stands, higher incident felling occurs and the process of gradual opening up of stands proceeds. The rot out root system does not ensure stability and attacked trees uproot or break out in the stump part. Individual windfalls and windbreaks are a suitable substrate for breeding bark insect including bark beetles.

Infection by *Stereum sanguinolentum* (ALB. & SCHW.: FR.) FR. due to bark stripping and browsing is considered to be an important factor for starting the bark beetle disaster. Owing to infection, broken trees represent a suitable niche for starting the gradation of *Ips typographus* L. (ČERNÝ 2000, pers. commun.).

With respect to the mechanism of spruce stand disintegration it is necessary to mention the role of potential causes of vascular mycoses, particularly from the genus *Ophiostoma, Ceratocystis* and *Leptographium,* the vector of which is just bark insect (SOLHEIM 1993). Pathogens of vascular tissues then disturb water relations and increase tree predisposition to bark beetle invasion. The subsequent mass invasion of *Ips typographus* L. results in the sudden dieback of trees being often accompanied by the rapid development of mycelial fans of *Armillaria* in the phloem part up to the height of 5–8 m.

CONCLUSION

In studied forest edges the coherent correlation between *Ips typographus* L. invasion and the root system infection by root rots has not been proved. In the period of gradation of *Ips typographus* L., trees are overpowered by the pest high density and tree predisposition does not play there a fundamental role (LORIO, HODGES 1985). In the area of clear cuts after sanitation felling of trees invaded by bark beetle, foci of *Armillaria* were found. Just these foci together with fractures due to *Stereum sanguinolentum* (ALB. & SCHW.: FR.) FR. rot could play a principal role in the initial stages of the gradation of *Ips typographus* L. The bark beetle looks for preferentially just these weakened and increasingly for invasion predisposed trees.

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Kořenové hniloby jako potenciální predispoziční faktor kůrovcové kalamity na Šumavě

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ABSTRAKT: Infekce kořenových hnilob a možné souvislosti s gradací lýkožrouta smrkového na Šumavě byly sledovány na třech trvalých zkusných plochách. Jako původce kořenových hnilob jednoznačně převažovala václavka, v jednotlivých případech byl zaznamenán rovněž kořenovník vrstevnatý (*Heterobasidion annosum* (FR.) BREF.). Z václavek na ploše dominovala václavka smrková *A. ostoyae* (ROMAGN.) HERINK, zjištěny byly i druhy *A. cepistipes* VELENOVSKÝ a *A. borealis* MARXMÜLLER et KORHONEN. Zaznamenány byly i další dřevokazné houby, a to *Stereum sanguinolentum* (ALB. & SCHW.: FR.) FR. a *Climacocystis borealis* (FR.) KOTL. Přestože byla ohniska václavky lokalizována přímo v kůrovcové stěně, není možné konstatovat jednoznačnou souvislost mezi náletem lýkožrouta smrkového a infekcí kořenového systému václavkou. Zjištěná míra infekce je s ohledem na nadmořskou výšku přes 1 100 m nad očekávání vysoká a neodpovídá dosavadním znalostem o chování václavek v prostředí střední Evropy. Rozsah infekce smrků václavkou smrkovou *Armillaria ostoyae* (ROMAGN.) HERINK může svědčit o chronické stresové zátěži smrků na těchto plochách.

Klíčová slova: václavky; kůrovec; lýkožrout smrkový; kořenové hniloby; Šumava

V souvislosti s kůrovcovou kalamitou v lesích České republiky je třeba upozornit na potenciální vliv houbových chorob jako jednoho z významných činitelů, ovlivňujícího zdravotní stav smrkových porostů. Významné jsou především kořenové hniloby jako významný iniciační, resp. mortalitní stresor. Jejich výskyt je obecně výsledkem působení přísušků jako startujícího stresoru. Václavky se destabilizací smrkových porostů mohou významně podílet na jejich predispozici ke vzniku kůrovcové kalamity.

Cílem studie bylo zjistit, zda existuje korelace mezi náletem lýkožrouta smrkového na smrcích v porostních stěnách na některých lokalitách na Šumavě a infekcí těchto stromů kořenovými hnilobami – především václavkami – jako predispozičním faktorem náletu.

Šetření bylo provedeno v letech 2000–2002 na plochách vytyčených pracovníky Ústavu ekologie lesa AV ČR České Budějovice v oblasti Modravy na Šumavě (tab. 1 – MORAVEC et al. v tisku). Studoval se výskyt václavek na základě pozorování přítomnosti symptomů infekce na kořenových nábězích a na pařezech v místech kůrovcových stěn z roku 2000.

Výsledky na jednotlivých porostních stěnách se výrazně liší. Zatímco na porostní stěně na ploše Pod Studenou horou III (dále PSH) byla kořenová hniloba zjištěna pouze na jediném stromu z deseti, na šetřených stromech na ploše PSH II bylo kořenovou hnilobou naopak infikováno osm stromů z devíti šetřených (tab. 3–5). Důvodem mohou být ohniska václavek na plochách, která v tomto případě zasáhla sledovanou stěnu. Tento závěr potvrdilo i šetření z roku 2002.

Jako původce kořenových hnilob jednoznačně převažovala václavka, v některých případech byl zaznamenán rovněž kořenovník vrstevnatý *Heterobasidion annosum* (FR.) BREF. Z václavek na ploše dominovala václavka smrková *A. ostoyae* (ROMAGN.) HERINK, zjištěny byly i druhy *A. cepistipes* VELENOVSKÝ (na PSH I) a *A. borealis* MARXMÜLLER et KORHONEN (na PSH II). Kromě václavek a kořenovníku byly zaznamenány i další dřevokazné houby, a to *Stereum sanguinolentum* (ALB. & SCHW.: FR.) FR. a *Climacocystis borealis* (FR.) KOTL. (tab. 3–5).

Na porostní stěně PSH III bylo v roce 2002 vyšetřeno 178 smrkových pařezů v porostní stěně, smýcené v roce 2000. Dutina byla zjištěna pouze v případě dvou šetřených pařezů. Symptomy pronikající infekce na řezné ploše byly zřejmé u 18 stromů (tab. 6). Za důkaz přítomnosti infekce v době života stromu je možné považovat současný 2. a 3. stupeň infekce, kdy hniloba proniká na řeznou plochu. Lze předpokládat, že díky infekci kořenů byla václavkou ovlivněna jejich funkce již za života stromu. Minimálně 11 % stromů bylo tedy již za života stromů výrazněji infikováno václavkou. U současných pařezů ve stupni infekce 1, kdy se tvoří pod kůrou syrrocium, není tato souvislost průkazná. Ke kolonizaci mohlo dojít až po smýcení, resp. aktivita václavek se smýcením aktivizovala. Na sledované ploše činil tento podíl 28 %.

Pozice pařezů v jednotlivých stupních infekce je zřejmá z obr. 1. Zřetelná jsou ohniska infekce, kde byly lokalizovány pařezy ve stupních infekce 2 a 3. Pařezy s pouhým výskytem syrrocia pod kůrou byly distribuovány rovnoměrně po celé ploše.

Lze konstatovat, že zjištěná míra infekce je s ohledem na nadmořskou výšku přes 1 100 m značně vysoká a neodpovídá dosavadním znalostem o chování václavek. Ty jsou významným stanovištním faktorem především na živných stanovištích 2.–4. lesního vegetačního stupně. Václavka na těchto plochách sehrává úlohu významného patogena kořenového systému. Především rozšíření a rozsah infekce smrků václavkou smrkovou *Armillaria ostoyae* (ROMAGN.) HERINK je v těchto podmínkách překvapující a může svědčit o chronické stresové zátěži smrků na těchto plochách.

Na zkoumaných porostních stěnách se nepodařilo jednoznačně prokázat korelaci mezi náletem lýkožrouta smrkového a infekcí kořenového systému kořenovými hnilobami. V období gradace lýkožrouta smrkového jsou stromy pod tlakem velké denzity škůdce a predispozice stromů zde nehraje zásadní úlohu. V oblasti pasek po asanaci kůrovcových souší však byla zjištěna ohniska václavek. Právě ta mohla mít spolu se zlomy v důsledku hniloby pevníku krvavějícího (*Stereum sanguinolentum* (ALB. & SCHW.: FR.) FR.) zásadní úlohu v počátečních fázích gradace lýkožrouta smrkového. Ten přednostně v základním i mírně zvýšeném stavu vyhledává právě tyto oslabené a k náletu predisponované stromy.

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