

RARE AND THREATENED WOOD-DECAYING FUNGI IN THE NATURE PROTECTED AREA AROUND TROJMEZNÁ, PLECHÝ, AND SMRČINA, BOHEMIAN FOREST, CZECH REPUBLIC

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ABSTRACT

The mountain forest in the south of the Bohemian Forest (Šumava National Park) is a refuge for fungi sensitive to forest management. Field research on fungi based on plots in old-growth mountain spruce forest and mixed mountain forests during the years 2003–2013 in this area revealed four critically endangered species (red-listed in the Czech Republic): *Globulicium hiemale*, *Panellus violaceofulvus*, *Psathyrella cotonea* and *Skeletocutis stellae*; and two other critically endangered species on the Bavarian Red List: *Climacodon septentrionalis* and *Phlebia centrifuga*. The ecology of red-listed wood-decomposing fungi occurring in this area is presented. We describe the forest management that is harmful to populations of wood-decomposing fungi in the study area, which was implemented to suppress bark beetle outbreaks in the most protected areas of the Šumava National Park.

Keywords: bark beetle outbreak, coarse woody debris, *Fagus sylvatica*, forest management, macrofungi, nature protected area, *Picea abies*, red list

Introduction

The Bohemian Forest (Šumava) is a mountain range lying along the border of the Czech Republic, Germany and Austria. The Šumava National Park in the Czech Republic is geographically connected to the Bavarian Forest National Park in Germany. These protected areas represent one of the largest centres of wilderness in Central Europe (Křenová and Kiener 2012). The southern part that ranges from Třístoličnick (Dreisessel, 1302 m a.s.l.), Trojmezna (Bayerischer Plöckenstein, 1361 m a.s.l.), Plechý (Plöckenstein, 1378 m a.s.l.), Hraničník (Reischlberg, 1281 m a.s.l.) to Smrčina (Hochficht, 1333 m a.s.l.) is highly valuable due to the near-natural character of the structure and species composition of the trees in this forest, which is still arranged in natural altitudinal vegetation zones (e.g. Vrška et al. 2014). Forests at the highest altitudes, consisting of stands of Norway spruce (*Picea abies*), have been affected by many kinds of interconnected stress factors (e.g. acidification, windstorms and bark beetle outbreaks, Kopáček and Hruška 2010; Svoboda et al. 2012). Since about 1995, salvage logging in spruce stands in the study area aimed at suppressing bark-beetle outbreaks has gradually resulted in the appearance of forest clearings and made neighbouring stands more vulnerable to wind damage followed by attack from bark-beetles (Svoboda and Zenáhlíková 2009).

Šumava NP is currently divided in three zones of protection. Forest zone I corresponds to “strict reserve”, i.e. without any management. However, in some cases, even these zones are subject to forestry activities. In our study area, there is an international agreement to carry out actions against bark beetles in a 500 m wide strip along

the border with Austria as there are commercial forests on the Austrian side, regardless of the fact that parts of this strip are in the zone I (Agreement 2009; Amendment 2011). In addition, there are plans to develop sporting facilities, which will involve the construction of an aerial cableway (chair-lift) to the top of Hraničník Mt. and an adjacent so called “evacuation ski-run”, which will disturb the integrity of the forest in zones I and II. This would have a considerable adverse effect on nature conservation in this area.

This is a Special protected area in Natura 2000 and the habitat, e.g., of Western capercaillie (*Tetrao urogallus*, Bufka 2004) and Eurasian lynx (*Lynx lynx*, e.g. Anděl et al. 2010). The long and continuous existence of this forest means that rare species of fungi occur there (e.g. Lepšová and Matějka 2009b; Bässler et al. 2012). Some species of wood-inhabiting fungi, such as boreo-montane species and those confined to old-growth forests, are highly sensitive to logging and opening up of forest (e.g. Bader et al. 1995; Lonsdale et al. 2008; Olsson et al. 2011; Lehnert et al. 2013). For instance, fragmentation increases the length of edges of remnants of old-growth forest, which has a negative effect on the occurrence of some fungi (Sitonen et al. 2005).

The diversity and ecology of macrofungi has been studied in this mountain area for several years. The main emphasis here has been on introducing endangered wood-decaying fungi. In order to complete the descriptions of the assemblages of wood-decaying fungi in mountain forests in the Bohemian Forest we have included both published data (Luschka 1993; Bässler et al. 2010) and internal reports (Holec 1999; Lepšová and Matějka 2009a). Luschka (1993) reports about

500 wood-decaying fungi in the Bavarian Forest NP, 27 species of which are red-listed in the Czech Republic (Holec and Beran 2006). Bässler et al. (2010) reports 263 fungi in the Bavarian Forest NP, 23 species of which are red-listed in the Czech Republic. Holec (1999) reports about 300 wood-decaying fungi in the Czech part of the Bohemian Forest and adjacent submontaneous area (Šumavské podhůří), 48 species of which are red-listed. Comparison of the data for various forest localities in the area of the Bavarian Forest NP and Šumava NP shows that there are at least 67 species of wood decaying macrofungi red-listed in the Czech Republic.

The aim of this paper is to evaluate the occurrence of endangered wood-decaying fungi in the area and describe the possible negative effects of management practices on the abundance of these fungi in the Bohemian Forest.

Material and Methods

Study Site

Research on wood-decaying macrofungi was carried out in three regions (Fig. 1).

Trojmezská Mt.

Surveys of fungal sporocarps were carried out at 12 plots (2.4 ha in total, 1220–1340 m a.s.l., northern ex-

posure, mean temperature gradient 3.19–2.77 °C, Svoboda and Pouska 2008; Pouska et al. 2010; Kindlmann et al. 2012). The bedrock in this area is muskovite-biotite granite (Pertoldová et al. 2010). They are in the 8th Forest altitudinal zone (Kindlmann et al. 2012) of mountain spruce forest with rowan (*Sorbus aucuparia*) and with *Athyrium distentifolium* at lower altitudes.

Parts of the old-growth and adjacent spruce stands on Trojmezská Mt. were disturbed by a windstorm in 2007 which resulted in strong bark-beetle outbreak and virtually all canopy trees were dead by 2009. Norway spruce (*Picea abies*) was the dominant species of tree in this forest and is now present mainly as variably tall and dense regeneration. In an attempt to control bark beetles, some trees were felled, their bark peeled off and the logs left at the site between 1999 and 2006 (this was done mainly in a 200 m wide strip along the border with Germany).

Plechý Mt.

Research plots are situated along an altitudinal transect on the NE slope. This area is in the zone of bark-beetle management; i.e. all spruce trees attacked by bark beetles are felled, their bark peeled off and the logs left on the ground. Study area consists of: (1) three study plots, P18–P20, in mountain spruce forest (0.75 ha in total, 1245–1360 m a.s.l., mean temperature gradient 3.3–2.6 °C); (2) six study plots P12–P17, in mixed beech forest (1.5 ha in total, 1024–1158 m a.s.l., mean temper-

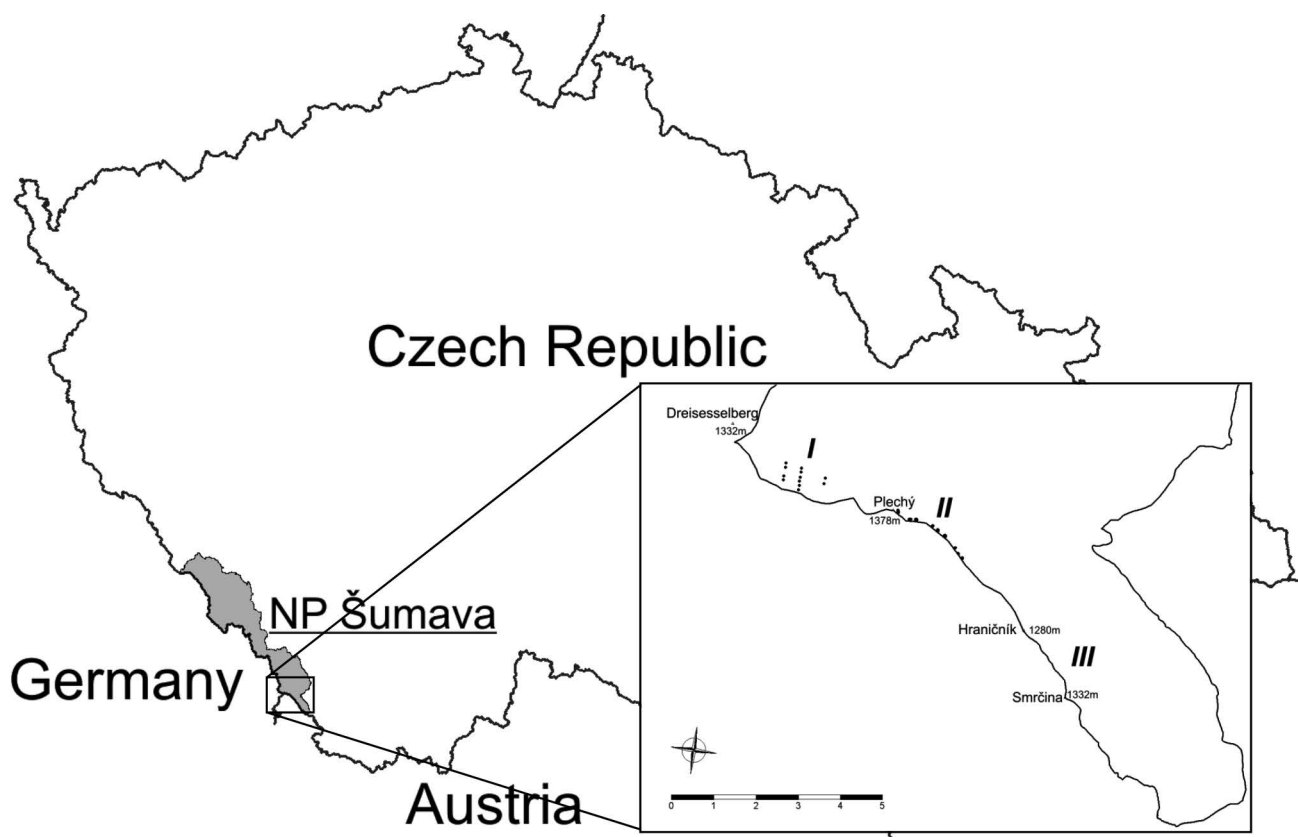


Fig. 1 Map of the Czech Republic showing the location of the study area. The survey of fungi was carried out in three regions. I – Trojmezská region; II – Plechý region; and region III – Hraničník and Smrčina Mts.

ature gradient 4.7–4.0 °C). More detailed description of plots: Lepšová and Matějka (2009b). The bedrock in P12–13 is metamorphic paragneiss, and in P14–20 is muskovite-biotite granite (Pertoldová et al. 2010; Státní geologická služba 2014). Forest altitudinal zones: P12–16 6th zone, mixed forest with beech (*Fagus sylvatica*) dominant; P17 7th zone, spruce (*P. abies*) forest with beech (*F. sylvatica*); P18–20 8th zone, mountain spruce forest (*P. abies*) with rowan (*S. aucuparia*).

The plots differ in the intensity of bark-beetle management: in P18 the trees on approximately 2/3 of the plot were subject to felling and peeling and on 1/3 the bark was peeled off standing spruce trees; P19 and 20: felling and peeling plus felling of standing dead trees that died due to competition. Dead trees at the very margin along the tourist path were felled to protect tourists and then left untouched.

Hraničník and Smrčina Mts.

Study area is situated on northern and eastern slopes of Hraničník and Smrčina Mts. (1120–1300 m a.s.l., Fig. 1). The bedrock is metamorphic paragneiss (Státní geologická služba 2014). The area is in the 7th and 8th Forest altitudinal zones of mixed beech forest and mountain spruce forests at high altitudes. A large part of this area was in a 200 m wide zone of bark-beetle management until 2011; i.e. all spruce trees attacked by bark beetles were felled, peeled of their bark and left on the ground or left standing but peeled. The management strip was enlarged after 2011 and now extends 500 m from the border with Austria (Agreement 2009; Amendment 2011) and includes the whole area of mountain spruce forests.

Data Collecting

Dead wood with a diameter ≥ 10 cm was inspected for the occurrence of sporocarps of macrofungi. **Trojmezna Mt.:** Surveys of fungi were carried out from 2003 to 2013 (excluding 2008, June to November). **Plechý Mt.:** Surveys were carried out from July to October in 2004, 2007 and 2008 (Lepšová and Matějka 2009b). **Hraničník and Smrčina Mts.:** Surveys were carried out during occasional visits in April and May 2011 and October 29th 2013. Different types of dead wood of different species of trees were inspected: trunks lying on the ground, cut logs, stumps and snags. Decomposition of wood was classified using the five stage scale of Sippola and Renvall (1999), slightly modified in the case of deciduous tree species; see Lepšová and Matějka (2009a).

Identification of fungi

We identified the fungi using literature for European countries (e.g. Ryvarden and Gilbertson 1993, 1994; Hansen and Knudsen 1997; Knudsen and Vesterholt 2008) on the basis of macro- and microscopic features of sporocarps. The specimens are deposited in the private herbaria of both authors and in the Museum of South Bohemia (CB).

Results and Discussion

We found 139 species of wood-decaying fungi on spruce at Trojmezna. Among these species 17 are red-listed in the Czech Republic (CZ, Holec and Beran 2006).

We found 152 species of wood-decaying fungi on four tree species along the altitudinal transect (P9–20, i.e. beech and spruce stands), which made up 64% of all macrofungi recorded at Plechý (Lepšová and Matějka 2009b). Among them 15 species are red-listed in CZ, only six of them growing on decaying wood of spruce in the mountain spruce forest (P18–20).

We found six species red-listed in CZ on Hraničník and Smrčina Mts. Holec (1999) reports the occurrence of four other red-listed species on these mountains.

Occurrences and substrate specificity of red-listed species are summarized in Table 1, based on the Red Lists of both the Czech Republic (Holec and Beran 2006) and Bavaria (Karasch and Hahn 2010).

Altogether 28 species red-listed in CZ were recorded in the study area. Four species are critically endangered (CR): *Globulicium hiemale*, *Panellus violaceofulvus*, *Psathyrella cotonea* and *Skeletocutis stellae*, and 10 species are endangered (EN). The Bavarian Red List indicated 31 species in this area, 3 of which are in the CR category: *Climacodon septentrionalis*, *Phlebia centrifuga* and *S. stellae*, and 10 EN species. The IUCN categories for individual species mostly differ in both countries, which indicates the need for an international agreement in order to improve the positive perception of citizens of species protection.

S. stellae is in CR category in both Red Lists and is probably the most endangered species in the study area. *P. centrifuga* is the next of the most endangered species, scored as EN in CZ and CR in Bavaria. Both species are characteristic of mixed mountain beech forests with silver fir (Holec and Beran 2006), but we recorded them only in the spruce forest at Trojmezna.

We recorded 3 critically endangered (in CZ) species of fungi on dead wood of spruce on Trojmezna Mt. The forest in this area is currently not managed and is a refuge for many red-listed species. In contrast, the spruce stands on Plechý, Hraničník and Smrčina Mts., which were subjected recently to felling and/or peeling seem to host a smaller number of red-listed species on spruce. In these stands the management policy is to suppress bark beetle infestations. This has already disturbed the most valuable stands of near-natural mountain spruce forest near the tops of Plechý, Hraničník and Smrčina Mts.

Near-natural mountain spruce forests host several rare species of wood-decaying fungi, some of which are of boreo-montane distribution. Among them, circumpolar species *Phellinus nigrolimitatus* which is unable to fruit in commercialized forests without old fallen trunks (Ryvarden and Gilbertson 1994) occurs regularly and widely in the whole study area of near-natural spruce forests. We consider this species as an important flagship species for

Table 1 Czech and Bavarian red-listed species of wood-decaying fungi found in the area of Trojmezrná, Plechý, Hraničník and Smrčina, number of records and substrate. Explanations: Red-list categories in the Czech Republic and in Bavaria (adapted to correspond with IUCN categories): CR critically endangered, EN endangered, VU vulnerable, R rare, NT near threatened, DD data deficient. () records outside of plots at Plechý.

Abbreviations: Ac – *Acer* sp. div., Fs – *Fagus sylvatica*, Pa – *Picea abies*, CZ – Czech Republic

	Red List		Trojmezrná		Plechý		Hraničník ^a		Smrčina	
	IUCN category	Bavaria	2003–2013	H ^b	2004, 2007–2008	H ^b	2013	H ^b	2011	H ^b
Species / dead tree part	CZ		Number of records		Number of records		Number of records		Number of records	
			Snag	Trunk/Log	Snag	Trunk/Log	Snag	Trunk/Log	Trunk/Log	
<i>Antrodia heteromorpha</i>		EN			2 Pa				1 Pa	
<i>Antrodia sinuosa</i>		VU		1 Pa						
<i>Antrodiaella citrinella</i>	EN	EN		13 Pa						
<i>Camarpella pugillus</i>	new			1 Pa						
<i>Camarops polysperma</i>		VU			1 Fs					
<i>Camarops tubulina</i>	NT	EN		6 Pa			1 Pa			x
<i>Chrysomphalina chrysophylla</i>	EN			2 Pa		x	1 Pa			
<i>Climacodon septentrionalis</i>		CR			1 Fs					
<i>Cystostereum murrayi</i>	NT	EN		3 Pa		x	1 Pa			
<i>Dentipellis fragilis</i>		VU								
<i>Entoloma tjallingiorum</i>	EN	EN		1 Pa						
<i>Flammulaster limulatus</i>	EN	R								x
<i>Globulicium hiemale</i>	CR			1 Pa						
<i>Gymnopilus picreus</i>		R		42 Pa						
<i>Hericium coralloides</i>		VU								
<i>Hericium flagellum</i>	NT	VU		1 Pa						
<i>Hymenochaete cruenta</i>	NT	NT								
<i>Hymenochaete fuliginosa</i>	EN	VU		2 Pa		x	2 Pa			x
<i>Lentinellus castoreus</i>	VU	VU		6 Pa			1 Pa			
<i>Leptoporus mollis</i>	NT	EN								
<i>Mitrella paludosa</i>		NT								x
<i>Mycena aciculata</i> / <i>Mycena longisetata</i> confusion ^c	DD	NT		1 Pa						
<i>Mycena laevigata</i>	VU									
<i>Omphalina epichysium</i>	EN									

	Red List		Trojmezrná		Plechý		Hraničník ^a		Smrčina	
	IUCN category		2003-2013		2004, 2007-2008		2013		2011	
	CZ	Bavaria	Number of records	H ^b	Number of records	H ^b	Number of records	H ^b	Number of records	H ^b
<i>Panellus violaceofulvus</i>	CR		1 Pa							
<i>Phellinus chrysoloma</i>		VU	3 Pa		3 Pa		2 Pa			
<i>Phellinus nigrolimitatus</i>	NT	EN	2 Pa	x	12 Pa	x	1 Pa	x	2 Pa	x
<i>Phellinus viticola</i>		VU	9 Pa	121 Pa	12 Pa		1 Pa	x	2 Pa	
<i>Phlebia centrifuga</i>	EN	CR	7 Pa							
<i>Phleogena faginea</i>	EN	EN			1 Fs		1 Fs			
<i>Pholiota scamba</i>		VU	4 Pa	x	2 Pa	x				
<i>Pholiota squarrosoides</i>	EN	VU			3 Fs					
<i>Phyllotopsis nidulans</i>	NT		1 Pa							
<i>Pluteus podospileus</i>	EN				2 Fs					
<i>Pluteus umbrinus</i>	VU	EN			2 Fs					
<i>Postia fragilis</i>		NT								
<i>Postia undosa</i>	VU	EN		x	(1 Pa)	x				
<i>Psathyrella cotonea</i>	CR				2 Fs					
<i>Pseudographis pinicola</i>	new		2 Pa							
<i>Skeletocutis stellae</i>	CR	CR	1 Pa							
<i>Trechispora mollusca</i>	DD		5 Pa							
<i>Vibrissa truncorum</i>	NT	VU						x		x

a – including upper parts of the Rasovka stream

b – Holec (1999)

c – Emmett et al. (2008)

mountain spruce forests in Central Europe. Although its red list status differs in the Czech Republic and Bavaria, its value was recognised in the Czech Republic and it was suggested in 2005 and 2011 this species to be protected by law as endangered. *P. nigrolimitatus* is a reliable indicator of the naturalness of spruce and mixed mountain forests in Central Europe (Blaschke et al. 2009), and was commonly found in forest stands unmanaged for several tree generations, e.g. in near-natural old-growth boreal forests where this fungus occurs much more frequently than in young managed stands (Stokland and Kauserud 2004). Quantitative data on the occurrence of *P. nigrolimitatus* in Šumava NP are documented for study plots at Trojmezná (Pouska et al. 2010; Pouska et al. 2011) and Plechý (Lepšová and Matějka 2009a). However, our plots are not included in the National park monitoring system. Since *P. nigrolimitatus* has perennial sporocarps and is sensitive to forest management, namely logging, it is a suitable species for indicating the naturalness of forests. We suppose that the sensitivity of *P. nigrolimitatus* to logging is due to the long life span of its mycelia in trunks (Pouska et al. 2011).

Other species with boreo-montane distribution growing on spruce are *Chrysomphalina chrysophylla*, *Cystostereum murrayi*, *Hymenochaete fuliginosa*, *Phellinus viticola* and *Postia undosa*, which were recorded not only on Mt. Trojmezná, but also Plechý and Hraničnick Mts. (Table 1). Their distribution and ecology are described in Table 2.

Antrodiella citrinella occurs along with the common polypore *Fomitopsis pinicola*, which thrives in dead trees after bark-beetle attack. *A. citrinella* is classified as an endangered species, but the conditions for this species in the Bohemian Forest are currently good (Bässler et al. 2012).

Although there is a high diversity of fungi in Europe and many are threatened, none are included in the appendices of the Bern Convention or in the EU Habitats Directive. The conservation of fungi is often neglected due to insufficient knowledge of their ecology, distribution and status (Dahlberg and Croneborg 2006). The only species on the list of candidates currently known to occur in the Bohemian Forest is *Skeletocutis odora*, which is known from two localities, the Boubín near primeval forest (Kubany Urwald) and a nearby nature reserve, Milešický prales (e.g. Lepšová 2004).

The law governing protected species “in particular” (plants, animals and fungi) no. 395/92 Coll. and the Law on nature and landscape protection No. 114/92 Coll. protect only one species that occurs in the area studied, *Camarops tubulina*. The legislation protecting fungi in the Czech Republic do not reflect new findings on ecology and occurrence of the endangered macrofungi, which need protection. This need is regularly stressed by expert mycologists as additional proposals of amendments to regulation of the Law on nature and landscape protection (No. 114/92 Coll.). The recent regulation no. 395/92 Coll.

protects 42 species of macrofungi. Amendments suggested in 2005 and 2011 contain 96 and 82 species of macrofungi, respectively and would represent valuable instruments for protecting these fungi. Both amendments suggested in 2005 and 2011 include at least 15 species that occur in the Bohemian Forest, four of which occur in the area studied: *C. chrysophylla*, *Flammulaster limulatus*, *P. nigrolimitatus* and *Vibrissea truncorum*, i.e. these species will be protected by law, if the legislation is effective. None of the recorded species is protected by law in Germany (“Bundesartenschutzverordnung”, Art. 10 G v. 21.1.2013 I 95), as there are no wood-decaying fungi in this law.

The fragmentation of natural forests resulted in a reduction in the diversity of aphylloroid fungi in Finland and red-listed species were strongly affected by the loss of connectivity at the scale of hundreds of kilometres and at the scale of a forest stand (Nordén et al. 2013). Large scale deforestation and fragmentation of natural forests started approximately two thousand years earlier in Central Europe (e.g. Kaplan et al. 2009), where patches of relatively natural forest have been isolated for much longer. As a consequence, some species are endangered in Central Europe. For example, *S. stellae* (Table 1, Table 2) has not been found in Bavaria since 1986 (Karasch and Hahn 2010). Therefore, any further reduction in the size of natural forests may have a detrimental effect on the survival of some rare species. In terms of management so that forests remain favourable for dead-wood dependent species, Jonsson et al. (2005) recommend, e.g.: ensuring there is a sufficient amount of dead wood available; planning at the landscape level to minimize isolation and reduce edge effects.

Conclusions

The occurrence of wood-decaying fungi was recorded in the area between the Třístoličnick and Smrčina Mts., in the Šumava National Park (Bohemian Forest), Czech Republic. The forest at Trojmezná, where has been almost no management, hosts very rare and critically endangered species of fungi, namely *S. stellae*, *G. hiemale*, *P. violaceofulvus* and *P. centrifuga*. Mountain spruce forests have been affected by bark-beetle outbreaks over the last nearly 20 years and the spruce forests adjacent to reserves subjected to intensive salvage logging, which has threatened the survival of these very rare species. The presence of *P. nigrolimitatus* can be used as an indicator of the “basic” naturalness of spruce forests in this area.

Comparison of red-list categories revealed discrepancies in evaluation of endangered fungal species in the Czech Republic and Bavaria. As the two National parks in this area are adjacent to one another a common scheme for evaluating rare and endangered organisms is needed.

The legislative politics does not reflect scientific results and experience of experts, whose recommendations

Table 2 Red-listed and some rare species of wood-decaying fungi that were recorded in the area Trojmezná – Smrčina, Šumava National Park, with descriptions of their occurrences and Red List status in the Czech Republic based on Holec and Beran (2006).

Abbreviations: Aa – *Abies alba*, Ac – *Acer* sp. div., Cb – *Carpinus betulus*, Pa – *Picea abies*, Ps – *Pinus sylvestris*, Q – *Quercus* sp.; CZ Czech Republic, BF Bohemian Forest, DS decay stage; Red List categories: CR critically endangered, EN endangered, VU vulnerable, NT near threatened, DD data deficient.

Taxon, general ecology and its occurrence in the study area. Causes of threat.	IUCN
<i>Globulicium hiemale</i> (Laurila) Hjorstam A North European species, growing on Pa trunks lying on the ground; occurs also on dead branches of standing trees (H. Ostrow pers. comm.). Known in BF (Holec and Beran 2006). Luschka (1993) records it on Pa, Holec (1999) on <i>Pinus rotundata</i> , also Bässler et al. (2010). Trojmezná Mt., Pa, a small lying trunk of a tree that died due to competition, DS 2	CR
<i>Panellus violaceofulvus</i> (Batsch: Fr.) Singer On wood of conifers, namely Aa, scattered in CZ, known in BF (Luschka 1993; Holec 1999; Holec and Beran 2006). Trojmezná Mt., Pa, a branch of a lying trunk of a tree that died due to bark-beetle attack, DS 2	CR
<i>Psathyrella cotonea</i> (Quél.) Konrad et Maubl. On wood of broadleaved trees and conifers, known in BF (Holec and Beran 2006). Plechý Mt., transect: P15, Fs, large branches on the ground in advanced DS 4–5	CR
<i>Skeletocutis stellae</i> (Pilát) Jean Keller On trunks of conifers, Pa and Aa, Several localities in BF (Holec and Beran 2006), including Milešický prales (Lepšová 2004). Circumpolar in the boreal conifer zone (Ryvarden and Gilbertson 1994). Trojmezná Mt., Pa, a large log of a felled tree, DS 3	CR
<i>Antrodiella citrinella</i> Niemelä et Ryvarden Grows on trunks of conifers with the rot of <i>Fomitopsis pinicola</i> in near-natural and old-growth forests. Known in BF (became locally abundant, Bässler et al. 2012), also Holec and Beran (2006). Restricted to primeval coniferous forests (Ryvarden and Gilbertson 1993). Trojmezná Mt., Pa, lying trunks from trees that died due to various causes including windthrow and bark-beetle attack, DS 2–4	EN
<i>Chrysomphalina chrysophylla</i> (Fr.) Clemenson On wood of conifers, Pa and Aa, known in BF (Holec and Beran 2006 as <i>Gerronema chysophyllum</i>), including Milešický prales (Lepšová 2004). Trojmezná Mt., Pa, lying trunks (unascertained cause of death), DS 3–4; Hraničník Mt., Pa, a lying trunk	EN
<i>Entoloma tjallingiorum</i> Noordel. On trunks of broadleaved trees, known in BF (Holec and Beran 2006). Trojmezná Mt., Pa, on the base of snag of a tree that died due to bark-beetle attack, DS 2	EN
<i>Flammulaster limulatus</i> (Fr.) Watling On wood of broadleaved trees, near-natural beech and slide rock forests, known in BF (Holec and Beran 2006). Plechý Mt., on Ac, Fs and Aa, DS 2–4	EN
<i>Hymenochaete fuliginosa</i> (Pers.) Bres. On branches and trunks of Pa and Aa in mountain areas, known in BF, also Bässler et al. (2010). Endangered by the lack of suitable substrate, namely of Aa (Holec and Beran 2006). Trojmezná Mt., Pa, snags, lying trunks and stumps, DS 2–4; Hraničník Mt., Pa, lying trunks	EN
<i>Omphalina epichysium</i> (Pers.: Fr.) Quél On wood of conifers, Pa, Aa, and broadleaved trees, Fs, Ac. In near-natural forests with sufficient quantities of decaying wood (Holec and Beran 2006). Holec (1999) and Luschka (1993) do not report this species from BF. Endangered by intensive logging and by the lack of decaying wood in forests. Plechý Mt., Fs, a lying trunk, DS 2	EN
<i>Phlebia centrifuga</i> Karsten On trunks of Aa, Pa and Fs, in near-natural and old-growth mountain forests. Known in BF, also Bässler et al. (2010). Endangered by degradation of forests by clear cutting, logging, wood removal and disruption of natural death of trees (Holec and Beran 2006). Trojmezná Mt., Pa, lying trunks (unascertained cause of death and butt rot), DS 3–4	EN
<i>Phleogena faginea</i> (Fr.: Fr.) Link On bark or wood of dead standing or lying trees, namely Fs, Ac, Cb. Endangered by removal of dead wood and logs from forests (Holec and Beran 2006). Known in BF (Luschka 1993; Bässler et al. 2010). Plechý Mt., Fs, DS 4; Hraničník Mt., Fs, snag, DS 2	EN
<i>Pholiota squarrosoides</i> (Peck) Sacc. On dead wood of broadleaved trees lying on the ground and snags, almost exclusively on Fs in CZ. Near-natural and old-growth forests with Fs namely in the mountains. Known in BF. Endangered by cutting and removing large trees from forests and general landscape (Holec and Beran 2006). Plechý Mt., strongly decayed large branches of Fs, DS 2–5	EN
<i>Pluteus podospileus</i> Sacc. et Cub. On wood of broadleaved trees, namely of Fs, Q, Cb in near-natural and old-growth forests. Known in BF (Holec and Beran 2006). Endangered by logging and wood removal from forests. Plechý Mt., large branches of Fs, lower elevation, DS 2–4	EN

Taxon, general ecology and its occurrence in the study area. Causes of threat.	IUCN
<p><i>Lentinellus castoreus</i> (Fr.) Konr. et Maubl Saproparasite, later wood-decomposer, in wounds of living trees, later on stumps and logs of Aa, less on Pa and Fs. Rarely on other trees. In near-natural forests with a good range of different stages of decaying wood. Endangered by lack of old host trees, logging and wood removal. Known in BF (Holec and Beran 2006; Bässler et al. 2010). Trojmezná Mt., Pa, lying trunks (unascertained cause of death or butt rot), DS 3; Plechý Mt., Fs, on a large lying trunk, DS 2; Hraničník Mt., Pa, a lying trunk snapped off a living tree</p>	VU
<p><i>Mycena laevigata</i> (Lasch) Gillet On wood of conifers, namely on Pa and Ps, very rare on broadleaved trees. In near-natural forests. Known in BF. Endangered by disturbance from intensive logging (Holec and Beran 2006). Plechý Mt., out of plots, mountain saddle position, rather wet with Pa trunks on the ground, DS 2</p>	VU
<p><i>Pluteus umbrosus</i> (Pers.: Fr.) P. Kumm. On wood of broadleaved trees, namely of Fs and Q. In forests with good supply of decaying wood. Known in BF (Holec and Beran 2006). Endangered by clear cutting and wood removal. Plechý Mt., large remnants of Fs, DS 3–4</p>	VU
<p><i>Postia undosa</i> (Peck) Julich On wood of conifers, namely on Pa, in near-natural mountain forests. Known in BF (Holec and Beran 2006; Bässler et al. 2010). Inside the natural distribution of Pa in Europe, circumpolar in coniferous regions of the North temperate zone (Ryvarden and Gilbertson 1994). Trojmezná Mt., Pa, lying trunks (cause of death unascertained) or logs of felled trees, DS 3–4; Plechý Mt., out of plots, decaying log of Pa in mixed forest</p>	VU
<p><i>Camarops tubulina</i> (Alb. et Schwein.: Fr.) On trunks of conifers – Pa, Aa, and broadleaved trees – Fs, in mixed mountain forests (also Bässler et al. 2010) and cold inverse positions at low altitudes. Endangered by removal of dead trees from forests (Holec and Beran 2006). Included in regulation 395/92 as protected and critically endangered species (Law 114/92 on nature and Landscape protection, CZ). Trojmezná Mt., Pa, lying trunks from trees that died due to bark beetles, butt rot or wind, DS 3; Hraničník Mt., Pa, a windfall</p>	NT
<p><i>Cystostereum murrayi</i> (Berk. et M. A. Curtis) Pouzar Namely on Aa trunks on the ground, rarely on Pa. Characteristic species of mountain mixed beech and silver fir forests and mountain spruce forests. It was found also in cold inverse positions at low altitudes. Endangered by forestry practices such as logging (Holec and Beran 2006). Known in BF (Luschka 1993; Holec 1999). Trojmezná Mt., Pa, lying trunks, DS 3; Plechý Mt., Pa, lying trunks, DS 3–4; Hraničník Mt., Pa, a lying trunk, DS 3</p>	NT
<p><i>Hericium flagellum</i> (Scop.) Pers. Grows on old standing trees and on lying trunks and snags of Aa and rarely of Pa, in mountain spruce and mixed forests. Endangered by the lack of old host trees, namely of Aa, and removal of wood from forests (Holec and Beran 2006). Well known in BF (Luschka 1993; Holec 1999; Bässler et al. 2010). Trojmezná Mt., Pa, a snag and lying trunk, DS 3; Plechý Mt., Aa, DS 2–4</p>	NT
<p><i>Hymenochaete cruenta</i> (Pers.: Fr.) Donk On dead standing or fallen trunks of Aa, rarely on Pa, namely in mountain areas. Endangered by Aa decline (Holec and Beran 2006). Known in BF (Luschka 1993; Holec 1999; Bässler et al. 2010). Plechý Mt., out of plots, on lying trunk of Aa, DS 4</p>	NT
<p><i>Leptoporus mollis</i> (Pers. ex Fr.) Pilát Saproparasite, later wood-decomposer, rarely in near-natural forests on wounds of living and dead standing conifers, namely on Pa in CZ. Known in BF (Holec and Beran 2006; Bässler et al. 2010). Circum-boreal in coniferous forests (Ryvarden and Gilbertson 1993). Endangered by cutting of dying subgrade trees preferentially hosting this species, salvage logging and peeling the bark off trees. Plechý Mt., on logs of Pa, after salvage logging, in an old wound</p>	NT
<p><i>Phellinus nigrolimitatus</i> (Romell) Bourdot et Galzin Saproparasite, later wood-decomposer, growing on conifers, namely on Pa rarely Aa, trunks lying on the ground of near-natural and old-growth mountain spruce forests and in cold inverse situations. Known in BF (Holec and Beran 2006; Bässler et al. 2010). Circumpolar in boreal coniferous forests (Ryvarden and Gilbertson 1994). This species is an indicator of mountain spruce and boreal forest continuity (Stokland and Kauserud 2004; Blaschke et al. 2009). Endangered by forest management, logging and removal of dead wood from forests. Cutting may negatively affect its survival due to the disruption of mycelial spreading into the dead trunk. The effect of peeling the bark off trunks is not clear, but further studies are needed. Cause of natural death of infected trees is mostly age, windthrow, competition, butt rot and bark-beetle attack. Trojmezná Mt., Pa, snags and lying trunks (cause of death mostly unascertained, then competition, butt rot, bark-beetle attack and cutting in some cases), DS 2–5; Plechý Mt., Pa, mountain spruce forest exclusively, lying trunks, DS 3–5; Hraničník Mt., Pa, a lying trunk</p>	NT
<p><i>Phyllotopsis nidulans</i> (Pers.: Fr.) Singer On conifers and broadleaved trees, mostly at high altitudes (Holec and Beran 2006). Known in BF (Holec 1999). Trojmezná Mt., Pa, a snag, a lying trunk, DS 2</p>	NT

Taxon, general ecology and its occurrence in the study area. Causes of threat.	IUCN
<i>Vibrissea truncorum</i> (Alb. et Schwein.) Fr. On branches and twigs of broadleaved trees submerged in mountain streams. Known in BF (Holec and Beran 2006). Hraničník Mt., Holec (1999)	NT
<i>Mycena aciculata</i> (A.H. Sm.) Desjardin & E. Horak Litter saprotroph in wet places, coniferous forests, namely Pa litter. Reported from BF as <i>Mycena longiseta</i> Höhn. s. auct. Eur. on Czech Red list (Holec and Beran 2006). Trojmezná Mt., Pa, a snag, a lying trunk (unascertained cause of death, possibly bark beetle and butt rot), DS 3–5	DD
<i>Trechispora mollusca</i> (Pers.: Fr.) Liberta On well decayed wood of conifers and broadleaved trees. Known in BF (Holec and Beran 2006; Bässler et al. 2010). Trojmezná Mt., Pa, lying trunks (unascertained cause of death), DS 3–5	DD
<i>Camaropella pugillus</i> (Schwein.) Lar. N. Vassiljeva To our knowledge the only published record of this species on <i>Pinaceae</i> worldwide. Previously published record in CZ is on a lying branch of Fs (Johnová 2009). Trojmezná Mt., Pa, a lying trunk of a tree that probably died due to bark-beetle attack, DS 2	
<i>Pseudographis pinicola</i> (Nyl.) Rehm Perhaps the first record in CZ, but well known in Scandinavia (e.g. Dahlberg et al. 2010). Trojmezná Mt., Pa, snags, DS 2	

should be implemented. This has resulted in weaknesses in the current legislation aimed at protecting nature, which is evident in the Šumava National Park.

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