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Influence of butt rot on beetle diversity in artificially created high-stumps of Norway spruce

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Abstract

The making of high-stumps to benefit wood living organisms is a common practice in Scandinavian forestry. To minimise the cost of this action trees of low quality, e.g. rotten trees, are chosen if possible. In this study we investigated if the wood decay fungi *Heterobasidion* spp. affects saproxylic beetles assemblages in Norway spruce (*Picea abies*) high-stumps. In total we caught 43 species of saproxylic beetles (Coleoptera) of which one was red-listed. Associations with the fungi were tested on 13 beetle species and three of them showed negative associations with the occurrence of *Heterobasidion*, while none of the tested species showed a positive association with *Heterobasidion*. Species richness did not differ between infected (30) and non-infected (33) stumps, but the beetle assemblages differed to some extent. Two additional bracket fungi species were found on some of the high-stumps, *Fomitopsis pinicola* and *Trichaptum* spp. Both these fungi had beetle species significantly associated with them. Interestingly, we found that *F. pinicola* and *Trichaptum* spp. never occurred together in the same stumps. None of them, however, seemed to be affected by presence of *Heterobasidion* spp. In conclusion, *Heterobasidion* spp. infections influence the beetle fauna by disfavouring some beetle species but we did not find any species positively associated with *Heterobasidion* spp. This suggests that increasing the proportion of pre-rotten high-stumps could have a negative effect on beetle diversity on clear-cuts.

Keywords: High-stump; Coleoptera; Saproxylic; Heterobasidion; Fungi; Snags

1. Introduction

Intensive forestry since the beginning of the 20th century has resulted in low volumes of dead wood in the Fennoscandian forests (Fridman and Walheim, 2000). As a consequence the populations of many saproxylic organisms, e.g. among fungi and beetles, have decreased (Nilsson et al., 1995; Jonsell et al., 1998; Fridman, 2000; Martikainen et al., 2000; Siitonen and Saaristo, 2000; Kouki et al., 2001; Nilsson et al., 2002; Similä et al., 2002; de Jong et al., 2004). Actions to mitigate further decrease and raise the amount of dead wood are now being applied during most silvicultural actions. In accordance with the forest certification schemes, Programme for the Endorsement of Forest Certification schemes (PEFC) and the Forest Stewardship Council (FSC), one action is creation of high-stumps (snags; (Anon, 2000a,b). As Norway spruce, *Picea abies* L. (Karst.), is the dominating tree species, a majority of the high-stumps are created from this species.

Spruce is often infected by *Heterobasidion* spp., a primary wood decayer that infects living trees causing white-rot (Bendz-Hellgren et al., 1998; Vasiliauskas et al., 2002). The rot is mainly confined to the roots of the tree but can spread several meters up in the stem (Stenlid and Redfern, 1998). As it is economically beneficial to make high-stumps of low quality trees, a large proportion of the high-stumps would be made from *Heterobasidion* infected spruce trees. Studies on fungal succession in general, however, have shown that the primary decay fungus that first colonises the wood will determine the future fungal and beetle succession to a large extent (Kaila et al., 1994; Jonsell and Nordlander, 1995; Okland et al., 1996; Holmer et al., 1997; de Jong et al., 2004; Lindhe et al., 2004; Jonsell et al., 2005). The latter because many saproxylic beetle species are associated to a specific fungus rather than to specific wood properties (Kaila et al., 1994; Jonsell and Nordlander, 1995; Okland et al., 1996; de Jong et al., 2004; Lindhe et al., 2004; Jonsell et al., 2005).

Whether the presence of *Heterobasidion* affects beetle or fungi colonisation in high-stumps has not been investigated, but

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it has been proposed as important for future research (Ehnström, 2001). If *Heterobasidion* infected high-stumps are less suitable for many beetle species, the making of large number of infected high-stumps could be negative from a species conservation point of view. Even if *Heterobasidion* is beneficial for some species, it does not mean that the proportion of such high-stumps have to increase, only that they should not be excluded. Anyhow, to know if and how *Heterobasidion* infection is influencing the beetle species colonisation in high-stumps could contribute to find cost effective strategies in forestry (Weitzman, 1998; Carlen et al., 1999).

The aim of the study was to compare high-stumps of spruce that were infected respectively non-infected with *Heterobasidion* at the time of clear felling. We sampled beetles in both infected and non-infected high-stumps from 10 clear-cuts in southern Sweden. Further we also investigated if a *Heterobasidion* spp. infection affects the colonisation of other fungal species in the stumps.

2. Material and method

The study was conducted on 10 clear-cuts in the county of Småland in southern Sweden (Fig. 1). The clear-cuts were done during autumn and winter 2000–2001 and the high-stumps were sampled three years later. Several stumps, up to 10 per clear-cut, were sampled to determine which were infected or not. From these we randomly chose 4 high-stumps, 2 infected by *Heterobasidion* and 2 non-infected, from each of the 10 clear-cuts, i.e. 40 high-stumps in total.

To distinguish non-infected from infected high-stumps bore cores were taken from the butt of the high-stumps and at breast height. At each height two perpendicular bore cores were taken directed towards the pith of the high-stump. The bore cores were immediately transferred to plastic bags, transported to laboratory and incubated at 20 °C for 10 days. *Heterobasidion* spp. was regarded as the cause of the decay if conidial colonies of these species were detected. Classification of other butt rot causing agents was not made. *Heterobasidion* is a primary pathogen (Käärik and Rennerfelt, 1957) and any high-stump with both discoloration and presence of conidia was regarded as being infected at the time of clear-cut. To be regarded as non-infected the high-stumps had to be free of any discoloration at the centre of the tree at both heights, and without infection of *Heterobasidion* spp. If the high-stump was infected by *Heterobasidion* spp. at the butt of the high-stump and/or at breast height but without discoloration, it was excluded from further studies. The diameter of each stump was also recorded.

2.1. Sampling of beetles

The high-stumps were cut at 70 cm above ground and a 1 m section (from ∼70 to ∼170 cm above ground) was collected. The 1 m sections were transported to the lab and in order to rear the beetles from the wood each stump was put into a fine meshed polyester sack (originally designed to protect game meat when hanging). In the bottom of the sack we placed a funnel connected to a container filled with glycol and water. In order to prevent the beetles from gnawing their way out through the sack, special attention was taken to have the sack as stretched as possible to avoid it from touching the stump. The stumps were checked regularly as long as beetles were still emerging. After 10 months no more beetles were emerging and the collecting was terminated.

The fungal flora on each stump was recorded both in the field and in the laboratory, but only fruiting bodies were recorded (Table 1), not mycelia. All saproxylic beetles were identified to species level. The nomenclature follows Lundberg and Gustafsson (1995). Beetles were classified as saproxylic according to Dahlberg and Stokland (2004). The red-list categories follow Gärdenfors (2005).

2.2. Statistics

Differences between the number of species in infected and non-infected stumps and differences in stump diameter between the clear-cuts were analysed using paired *t*-tests. The stumps from each category (rotten or not) were pooled within the same clear-cuts. To evaluate if any beetle species were associated with *Heterobasidion* infected stumps, diameter or a certain fungal occurrence, a multiple regression model was used and the variables tested for were, *Heterobasidion*, *Trichaptum*, *Fomitopsis* and diameter, respectively. All species occurring in more than five stumps were tested and each species was analysed separately. The species count data were square-root transformed. All analyses were performed in SAS 9:1 in the GENMOD procedure. Poisson distribution was used since it is recommended for count data where many of the samples contain zero-recordings (Quinn and Keough, 2002). For three species this model did not converge due to the occurrence pattern of the species. These species were either absent or present in large numbers and therefore we found it more appropriate to treat the data from these species as present/absent and they were analysed with logistic regression since it deals with binary data (Hosmer and Lemeshow, 1989).

3. Results

3.1. Species numbers

The 40 stumps did not differ in diameter between the infected and non-infected stumps (paired *t*-test, *t*-value 0.95, *p*-value 0.18, Table 1). In total 3211 saproxylic beetle individuals belonging to 43 different species were caught. There were 30 species in the infected stumps and 33 in the non-infected. The mean number of species per clear-cut was 8.8 in the infected stumps and 9.3 in the non-infected and this difference is not significant (paired *t*-test, *t*-value 0.3, *p*-value 0.38). We found one red-listed species, *Zilora ferruginea* (NT), and it was caught in four non-infected high-stumps in two different clear-cuts.

Nine of the caught species was represented by only one individual and an additional eight species were represented by

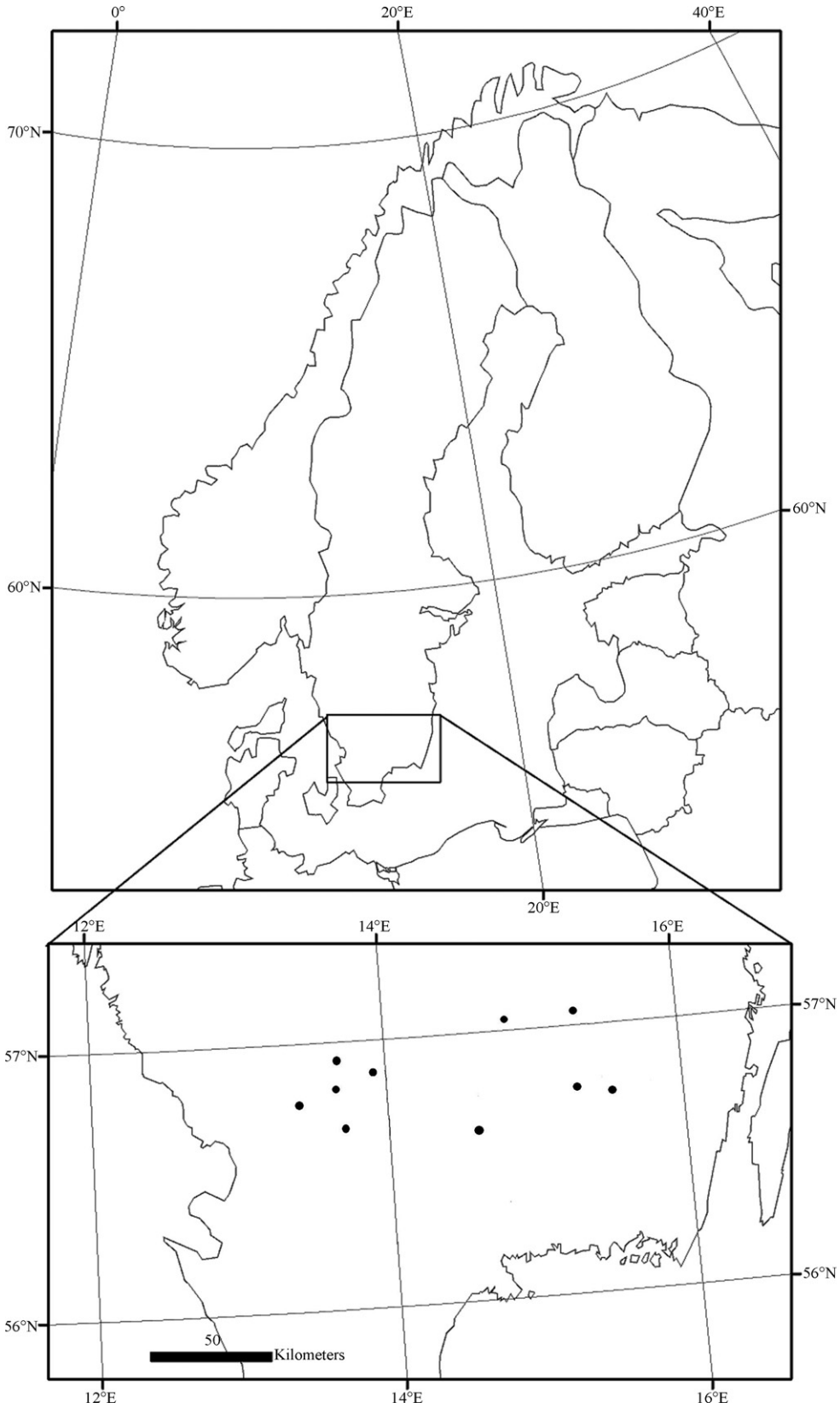

Fig. 1. A map of southern Sweden showing the location of the sampled clear-cuts.

two individuals. Thirteen species were found exclusively in non-infected stumps, whereas 10 species were exclusively found in the infected stumps. However, these 23 unique species occurred most as single individuals. Only five species occurred with five individuals or more and just one of these five were found in more than two different high-stumps. This species was *Euplectus karsteni* and it was found in 4 infected high-stumps with in total 15 individuals.

Table 1
Showing data on the 1-m stumps and how the fungi were distributed

Heterobasidion infection	Average diameter (cm)	*Fomitopsis* occurrence	*Trichaptum* occurrence	F and T occurrence	Nor F or T
Present (20)	29 (20–38)	7	3	0	10
Absent (20)	30 (22–44)	5	4	0	11

Total number of stumps were 40 and 20 of those were infected by *Heterobasidion*.

3.2. Species associations

Thirteen species were found in more than five high-stumps and their occurrence and abundance were analysed according to stump diameter, and fungal presence in the stump. Three of these species were significantly associated with non-infected stumps: *Abdera triguttata*, *Euglenes pygmaeaus* and *Hapalarea gracilicornis*. *Cis punctulatus* was nearly significant ($p = 0.08$) and as the former also associated with non-infected stumps. No species was significantly associated with *Heterobasidion* infected stumps. None of the other beetles did show any tendency in any direction (Table 2).

Whether *F. pinicola* was present in stumps or not made a significant difference for two species, *Hadreule elongatula* and

Table 2
Results from the regression analyses on species associations

Art	Variable	Df	Estimate	χ^2	Pr > χ^2
Hapalaraea gracilicornis	***Heterobasidion* spp.**	1	−2.1	15.81	<0.0001
	Trichaptum spp.	1	−0.94	0.98	0.32
	Fomitopsis	1	+1.5	8.09	<0.005
	Diameter	1	−0.06	1.81	0.18
	Deviance/Df 0.77				
Leptusa fumida	*Heterobasidion* spp.	1	−0.74	1.55	0.21[a]
	Trichaptum spp.	1	+0.19	0.08	0.78
	Fomitopsis	1	−0.3	0.18	0.67
	Diameter	1	+0.02	0.18	0.66
	Deviance/Df 0.84				
Corticaria longicollis	*Heterobasidion* spp.	1	+0.13	0.08	0.77
	***Trichaptum* spp.**	1	−1.6	3.83	0.05
	Fomitopsis	1	−1.03	2.85	0.09
	Diameter	1	−0.01	0.04	0.83
	Deviance/Df 1.84				
Cis punctulatus	*Heterobasidion* spp.	1	−0.77	2.96	0.08
	***Trichaptum* spp.**	1	+1.38	7.87	0.005
	Fomitopsis	1	+0.5	0.82	0.36
	Diameter	1	+0.03	0.73	0.39
	Deviance/Df 2.34				
Hadreule elongatula[b]	*Heterobasidion*	1	+0.72	0.83	0.36
	Trichaptum spp.	1	+1.05	1.27	0.26
	Fomitopsis	1	+27.2	10.51	0.001
	Diameter	1	+0.04	0.33	0.57
	Deviance/Df 0.79				
Euglenes pygmaeus	***Heterobasidion* spp.**	1	−1.6	8.18	0.004
	Trichaptum spp.	1	−0.08	0.01	0.90
	Fomitopsis	1	+0.07	0.01	0.91
	Diameter	1	−0.05	1.30	0.25
	Deviance/Df 2.11				
Anaspis thoracica	*Heterobasidion* spp.	1	+0.52	0.41	0.52
	Trichaptum spp.	1	−24.7	1.76	0.18
	Fomitopsis	1	+0.41	0.28	0.60
	Diameter	1	+1.35	3.04	0.08[a]
	Deviance/Df 0.68				
Anaspis flava	*Heterobasidion* spp.	1	−0.37	0.24	0.62
	Trichaptum spp.	1	−0.36	0.12	0.73
	Fomitopsis	1	+0.05	0.00	0.95
	Diameter	1	+0.07	1.34	0.24[a]
	Deviance/Df 0.75				

Table 2 (*Continued*)

Art	Variable	Df	Estimate	χ^2	Pr > χ^2
Abdera triguttata	***Heterobasidion* spp.**	1	−2.65	41.0	<0.0001
	***Trichaptum* spp.**	1	+2.74	71.7	<0.0001
	Fomitopsis	1	+0.89	2.24	0.07
	Diameter	1	+0.05	4.44	0.035
	Deviance/Df 2.38				
Rhagium inquisitor	*Heterobasidion* spp.	1	−1.27	1.48	0.22[a]
	Trichaptum spp.	1	+0.28	0.05	0.82
	Fomitopsis	1	+0.42	0.17	0.67
	Diameter	1	+0.07	0.68	0.41
	Deviance/Df 0.81				
Rhyncolus sculpturatus	*Heterobasidion* spp.	1	−0.56	0.65	0.41
	Trichaptum spp.	1	+0.55	0.53	0.47
	Fomitopsis	1	−1.03	1.0	0.32[a]
	Diameter	1	+0.14	0.03	0.86
	Deviance/Df 1.07				
Crypturgus pusillus[b]	*Heterobasidion* spp.	1	+0.15	0.05	0.81
	Trichaptum spp.	1	−0.65	0.53	0.46
	Fomitopsis	1	−0.94	1.42	0.23[a]
	Diameter	1	+0.07	1.23	0.27
	Deviance/Df 1.16				
Crypturgus hispidulus[b]	*Heterobasidion* spp.	1	+0.14	0.04	0.84
	Trichaptum spp.	1	+1.75	0.38	0.53
	Fomitopsis	1	+0.53	2.63	0.10
	Diameter	1	+0.12	3.04	0.08[a]
	Deviance/Df 1.05				

All tested species are included. Significant variables are in bold.

[a] Denotes the variable explaining most, when none of the variables were significant.

[b] Denotes that the species were analysed with logistic regression.

Hapalaraea gracilicornis. The first showed a positive association to the presence of *F. pinicola* whereas the latter a negative response (Table 2). The presence of *Trichaptum* spp. in the stumps had significant effects on three of the species. *A. triguttata* and *C. punctulatus* responded positively to the presence of *Trichaptum* spp. whereas *Corticaria longicollis* showed a negative association. Regarding the diameter of the stump, one species *A. triguttata*, was associated with coarser stumps (Table 2).

The occurrence of fruiting bodies of *F. pinicola* and *Trichaptum* did not show any relation to whether to stumps were infected with *Heterobasidion* or not. However, *F. pinicola* and *Trichaptum* spp. never occurred with fruiting bodies on the same high-stumps (Table 1).

4. Discussion

The overall number of species did not differ between the infected and non-infected high-stumps, indicating that none of the two categories are more important regarding species richness. However, this study shows that *Heterobasidion* spp. could have an effect on beetle assemblages as 3 (nearly 4) of the 13 tested beetle species showed statistical significant negative associations to the presence of these fungi. The three species that were negatively associated were *A. triguttata*, *E. pygmaeus* and *H. gracilicornis*. Whether their response was direct or indirect we do not know. *A. triguttata* is known to live from the mycelia of *Trichaptum* spp. (Ehnström and Axelsson, 2002) and in our study it avoided stumps infected with *Heterobasidion*. There was, however, no indication that *Trichaptum* was affected by the presence of *Heterobasidion* as both fungi occurred on the same stumps. This suggests that *Heterobasidion* spp. alters the wood, e.g. by some metabolites, making it unfavourable for *A. triguttata* even though *Trichaptum* is present. *E. pygmaeus*, regarded as a fungivorous species on mycelia-infected wood, was also negatively associated with *Heterobasidion* spp. It did not show any tendencies regarding the other tested fungal species either and therefore we can only speculate about the reasons behind this as the ecology of this species is poorly known. The same is true for the third species, *H. gracilicornis*, a rove-beetle usually found under spruce bark, probably feeding on various detritus. In addition to these three beetle species several other species were found exclusively in either infected or non-infected stumps, but with few individuals and in too few samples to analyse statistically, e.g. the red-listed *Z. ferruginea* (in four non-infected stumps) and *E. karsteni* (in four infected stumps). It is possible that these two species are affected by *Heterobasidion* spp., but a larger survey is needed to answer this as the trend we see here might be an artefact due to the rather small sample.

It is well known that many beetles are associated with different bracket fungi (Palm, 1959; Okland et al., 1996; Jonsell, 1999; Jonsell and Nordlander, 2004; Jonsell et al.,

2005). In our study, *H. elongatula* was strongly positively correlated with the fungi *F. pinicola*, in accordance with other studies (Jonsell and Weslien, 2003; Jonsell et al., 2005). *H. elongatula* has been proven to benefit from created high-stumps (Schroeder et al., 2006). This is probably a consequence of *F. pinicola* being favoured by the high-stumps and that the beetle prefers *F. pinicola* in sun exposed conditions. We also found another beetle, *H. gracilicornis*, was positively associated with *F. pinicola*. As mentioned earlier the ecology is largely unknown for this beetle but this study suggests that *H. gracilicornis* feeds from the mycelia of *F. pinicola*. *A. triguttata* and *C. punctulatus* both showed positive associations with *Trichaptum* spp. These beetle species are fungivores and they are known to live from *Trichaptum abietinum* but probably from other species of this genus as well (Fossli and Andersen, 1998; Ehnström and Axelsson, 2002; Orledge and Reynolds, 2005). Also the earlier mentioned red-listed species *Z. ferruginea* is associated with these fungi (Ehnström and Axelsson, 2002; Jonsell et al., 2005). *C. longicollis* responded negatively to the presence of *Trichaptum* spp. and the cause for this can not be determined in this study.

Put into a conservational context our result shows that at least three beetle species are negatively affected by *Heterobasidion*, directly or indirectly, and this suggests that leaving only rotten spruce high-stumps could be a problem as it may provide habitat to a less diverse beetle fauna. However, the effect might not be too drastic as a similar number of species were found on both infected and non-infected stumps. Furthermore, there could also be species associated with *Heterobasidion*, species which this study failed to detect. Regarding the two other fungal species, *F. pinicola* and *Trichaptum* spp. and their associated species, the making of high-stumps is probably beneficial. But whether a high-stump is colonised by the former or the latter cannot be controlled by silvicultural actions. None of them, however, seemed to be affected by the presence of *Heterobasidion*. It is known that many wood decomposing fungi species follow a certain successional pattern (Niemelä et al., 1995; Holmer et al., 1997). This probably does not apply to *Heterobasidion* spp. since it grows upwards from ground level and from the centre in the stem and outwards. But these successional patterns could explain why *F. pinicola* and *Trichaptum* spp. was not found on the same stumps as they both are primary decay fungi and probably competitors.

When doing a study like this, it is important to acknowledge that what we see, in this case high-stumps with different fungal composition, is probably not what the beetles see. In this study we controlled the presence/absence of *Heterobasidion* spp. and we also knew which stumps that definitively hosted *F. pinicola* and *Trichaptum* species by recording fruiting bodies. There are, however, many factors we did not control, e.g. the extent of the *Heterobasidion* infections or the complete fungal community in the stumps. A fungal species may be present in a stump but not producing fruiting bodies. These and other factors (which we might not even be aware of) make the variation in studies like this large and one has to bear that in mind when drawing conclusions about species and habitat associations. The high number of species found as singletons (nine) implies that more sampling is needed and an extended sampling of *Heterobasidion* spp. infected high-stumps could give us more information about beetle species and how they respond to *Heterobasidion* spp. Furthermore, our study is only a snap shot in time and whether the effect of *Heterobasidion* spp. will be more or less pronounced as succession progress is also for future studies to reveal.

5. Conclusions

Whether a high-stump is pre-rotted or not has an effect on beetles species composition in the high-stump as 3 (23%) of the 13 analysed species were negatively affected by *Heterobasidion* spp. The stumps hosted a similar number of species and it has to be stressed that this is a rather small study and the species caught here are all common. To evaluate the effect of *Heterobasidion* on more rare species, or the species only found in few numbers, the sampling has to be extended. *Heterobasidion* spp. infections influence the beetle fauna by disfavouring some species, e.g. *A. triguttata*, but we did not find any species positively associated with *Heterobasidion* spp. The occurrence of *F. pinicola* and *Trichaptum* spp. also influence the beetle fauna in the stumps, but these fungi seemed not to be affected by the presence of *Heterobasidion*. As high-stumps constituting an increasing proportion of dead wood in today's production forest it can have a negative effect on some beetle species if forestry promotes the making of *Heterobasidion* spp. infected high-stumps. Therefore, it would be preferable from a conservation point of view if spruce high-stumps were to be made from both infected and non-infected trees but not increasing the proportion of rotten high-stumps.

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Appendix A

The complete species list and the number of individuals caught for each species. Beetles species frequencies are shown for each fungal species (whether the fungi was present or absent). For *Trichaptum* and *Fomitopsis* the number of stumps with occurrence were 7 and 12, respectively. The number of stumps where the species occurred is shown within brackets (see Table 1A).

Table 1A

Species	Total	Heterobasidion present, $n = 20$	Heterobasidion absent, $n = 20$	Trichaptum present, $n = 7$	Trichaptum absent, $n = 33$	Fomitopsis present, $n = 12$	Fomitopsis absent, $n = 28$
Abdera triguttata	594	3 (3)	591 (7)	491 (6)	103 (4)	76 (2)	518 (8)
Anaspis bohemica	1	–	1 (1)	–	1 (1)	–	1 (1)
Anaspis flava	11	5 (3)	6 (4)	1 (1)	10 (6)	4 (2)	7 (4)
Anaspis frontalis	8	3 (2)	5 (2)	–	8 (7)	4 (3)	4 (4)
Anaspis rufilabris	2	2 (2)	–	1 (1)	1 (1)	2 (2)	–
Anaspis schilskyana	4	4 (3)	–	2 (1)	2 (2)	1 (1)	3 (2)
Anaspis thoracica	9	5 (4)	4 (3)	–	9 (7)	5 (3)	4 (4)
Anobium pertinax	5	–	5 (1)	–	5 (1)	–	5 (1)
Anobium thomsoni	196	186 (2)	10 (2)	–	196 (4)	–	196 (4)
Anomognathus cuspidatus	1	1 (1)	–	1 (1)	–	–	1 (1)
Anoplodera reyi	6	–	6 (2)	2 (1)	4 (1)	–	6 (2)
Anthaxia quadripunctata	1	1 (1)	–	–	1 (1)	–	1 (1)
Callidium coriaceum	2	1 (1)	1 (1)	–	2 (2)	–	2 (2)
Cis punctulatus	65	20 (4)	45 (7)	23 (4)	42 (7)	22 (3)	43 (8)
Corticaria lateritia	2	2 (1)	–	–	2 (1)	–	2 (1)
Corticaria longicollis	47	21 (6)	26 (5)	1 (1)	45 (10)	3(3)	43 (8)
Crypturgus hispidulus	729	473 (13)	256 (13)	75 (6)	654 (20)	273 (9)	456 (17)
Crypturgus pusillus	592	232 (10)	360 (10)	251 (3)	341 (17)	43 (5)	549 (15)
Crypturgus subcribrosus	3	1 (1)	2 (2)	2 (1)	1 (1)	–	3
Dasytes plumbeus	1	–	1 (1)	1 (1)	–	–	1 (1)
Dromius quadrimaculatus	1	–	1 (1)	–	1 (1)	1 (1)	–
Ennearthron cornutum	21	4 (1)	17 (2)	–	21 (3)	5 (2)	16 (1)
Euglenes pygmaeus	67	4 (4)	51 (5)	7 (1)	48 (7)	8 (3)	47 (5)
Euplectus karsteni	15	15 (3)	–	–	15 (3)	–	15 (3)
Euplectus nanus	2	2 (1)	–	–	2 (1)	–	2 (1)
Hadreule elongatula	715	545 (15)	170 (12)	29 (5)	686 (22)	195 (12)	520 (15)
Hapalarea gracilicornis	39	3 (3)	36 (11)	1 (1)	38 (13)	23 (7)	16 (7)
Hylurgops palliatus	1	–	1 (1)	–	1 (1)	–	1 (1)
Leptusa fumida	17	6 (4)	11 (8)	5 (2)	12 (10)	4 (3)	13 (9)
Leptusa ruficollis	1	–	1 (1)	–	1 (1)	–	1 (1)
Megatoma undata	3	–	3 (1)	–	3 (1)	–	3 (1)
Phloeocharis subtilissima	3	2 (1)	1 (1)	–	3 (2)	–	3 (2)
Pityogenes chalcographus	2	–	2 (2)	1 (1)	1 (1)	–	2 (2)
Plegaderus vulneratus	2	–	2 (1)	2 (1)	–	–	2 (1)
Ptinus fur	1	–	1 (1)	–	1 (1)	–	1 (1)
Pytho depressus	3	–	3 (2)	1 (1)	2 (1)	2 (1)	1 (1)
Rhagium inquisitor	8	3 (1)	5 (4)	3 (1)	5 (4)	4 (2)	4 (3)
Rhizophagus dispar	2	2 (1)	–	–	2 (1)	–	2 (1)
Rhizophagus ferrugineus	1	1 (1)	–	–	2 (1)	–	1 (1)
Rhyncolus chloropus	14	14 (2)	–	–	14 (2)	–	14 (2)
Rhyncolus sculpturatus	11	4 (3)	7 (5)	4 (2)	7 (6)	1 (1)	10 (7)
Stenichnus bicolor	3	2 (2)	1 (1)	–	3 (3)	1 (1)	2 (2)
Zilora ferruginea	4	–	4 (4)	3 (3)	1 (1)	2 (2)	2 (2)

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