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Pine wood decomposition ability of different *Phlebiopsis gigantea* isolates

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The ability of *Phlebiopsis gigantea* isolates, derived from different parts of Europe, to decompose pine wood was investigated. This ability was expressed by the loss of dry weight of pine wood blocks. Pine wood decay caused by the isolates of *Ph. gigantea* was similar. In addition there were no significant differences in the decomposition ability at all the isolates, which were displayed as the loss of dry weight of wood. When the wood decay ability of two isolates were compared there were significant differences only between the less and the most effecive isolates. This might be attributed to the low genetic variation among European population of this fungus. The isolates used in Finland and Poland as biopreparation were the most effective.

Key words: *Phlebiopsis gigantea*, *Pinus sylvestris*, decay.

INTRODUCTION

Phlebiopsis gigantea (Fr.: Fr.) Jülich is a corticiaceous basidiomycete, which commonly colonizes fresh conifer wood in boreal and temperate zones throughout the world (Holdenrieder and Greig 1998; Mańka 1998). The fungus causes white rot of coniferous wood and is a primary colonizer of logs and wood debris. It was found that *Ph. gigantea* colonized thinning stumps and had some ability to replace *Heterobasidion annosum* (Fr.) Bref. This pathogen causes one of the most dangerous diseases of forest trees all over the world (Gremmen 1970; Hubbes 1980; Mańka 1998). *Heterobasidion annosum* due to butt and root rot of living trees. Rishbeth (1950, 1951) found that *Ph. gigantea* might be used for biological control. He developed a method of preparing inoculum for biological control as a commercial biopreparation (Rishbeth 1961, 1963, 1967). Using of *Ph. gigantea* against *H. annosum* is the only example of successful biological control of a fungal disease in forestry (Holdenrieder and Greig 1998). Biological stump treatment with *Ph. gigantea* were carried out in Britain, Bulgaria, Canada, Finland, France, Italy, Germany, Norway, Poland, USA and Russia (Holdenrieder and Greig 1998). There are manual (Rykowski and Sierota 1982) and mechanical (Korhonen et al. 1994) methods of *Ph. gigantea* application. In each country, where the biopreparation is produced, different isolate of *Ph. gigantea* has been used.

In Poland the manual application with water solution of biopreparation is used on the stump surface, which must be cover by soil or litter after that treatment (Rykowski and Sierota 1982; Sierota 1995).

The aim of this work was to investigate the ability of 10 strains of *Ph. gigantea* isolated from different places in Europe to decompose pine wood.

MATERIALS AND METHODS

In this study ten isolates of *Phlebiopsis gigantea* were used: PG1[9602], PG2 [96026] Poland, Zielonka Forest; PG3 – biopreparation PG [96013, Poland], PG4 [95042] Italy, Abruzo; PG5 [95212] Hungary, Kerceszmor; PG6 [94135] Germany, Bayern; PG7 [91002b] biopreparation Rotstop, Finland; PG8 [94408] Finland, Kirkkonummi; PG9 [94138] United Kingdom; PG10 [93358] Finland, Joutseno.

Wood decomposition capacity of saprotrophs was tested using the method described by Orłoś (1957).

Dry Scots pine wood blocks, $1.5 \times 2.5 \times 5$ cm in size, were put on well-grown mycelium of each *Ph. gigantea* isolate in the centre of Kolle flasks. All the flasks were incubated at 23°C. Dry weight of wood blocks was estimated twice – before the experiment and after three months of incubation on the mycelium. Subsequently the percentages of wood loss were determined, which expressed the ability of wood decay. All the data were subjected to ANOVA analysis of variance.

RESULTS

The average dry weight loss of wood caused by *Phlebiopsis gigantea* varied from 11.5% to 16.4% (Table 1). The most effective decay was due to the isolate PG2 (Zielonka Forest), which caused 16.4% dry weight loss. The least was the loss of 11.5% due to PG4 (Italy). The loss of dry weidht of wood caused by the isolates of *Ph. gigantea* used in biopreparations equaled to 15.6% and 16.2% for the Polish forula "PG" and Finnish one "Rostop", respectively. The isolate PG2 (Zielonka Forest) also cased strong decay – 15.4%. The best dry weight loss of wood was caused by PG7 (Rotstop formula) – 25%, and the worst – by two isolate PG5 (Hungary) and PG10 (Finland).

Table 1
Average dry weight loss of stump wood caused by *Phebiopsis gigantea* isolates

Isolates	Avarage dry weight loss %	Min. dry weight loss %	Max. dry weight loss %
PG1	**15.4**	14.0	17.0
PG2	**16.4**	14.0	21.0
PG3	**15.6**	13.0	20.0
PG4	**11.5**	11.0	13.0
PG5	**12.4**	10.0	16.0
PG6	**12.1**	11.0	13.0
PG7	**16.2**	11.0	25.0
PG8	**13.7**	11.0	19.0
PG9	**12.7**	11.0	18.0
PG10	**13.0**	10.0	22.0

The analysis of variance revealed no significant differences in ability of wood decay among all compared *Ph. gigantea* isolates.

However, the analysis of variance showed (Table 2) significant differences among isolates in wood decomposition capacity in eight cases. The two isolates, which caused the smallest weight loss of wood (PG4 from Italy and PG6) differ significantly in comparision to four isolates (PG1, PG2, PG3 and PG7), that are due to the biggest weight loss of wood.

Table 2
Value of F counted in ANOVA analysis of variance

	PG2	PG3	PG4	PG5	PG6	PG7	PG8	PG9	PG10
PG1	0.51^{ns}	0.023^{ns}	28.854**	4.292^{ns}	8.727*	0.107^{ns}	0.706^{ns}	5.158^{ns}	0.931^{ns}
PG2		0.219^{ns}	11.599*	4.469^{ns}	8.914*	0.006^{ns}	1.301^{ns}	5.309^{ns}	1.600^{ns}
PG3			8.494*	2.912^{ns}	6.904*	0.050^{ns}	0.634^{ns}	3.309^{ns}	0.100^{ns}
PG4				0.200^{ns}	1.000^{ns}	6.988*	1.052^{ns}	0.667^{ns}	0.442^{ns}
PG5					0.024^{ns}	1.667^{ns}	0.316^{ns}	0.034^{ns}	0.108^{ns}
PG6						7.052*	0.671^{ns}	0.222^{ns}	0.227^{ns}
PG7							0.551^{ns}	1.851^{ns}	0.834^{ns}
PG8								0.257^{ns}	0.031^{ns}
PG9									0.058^{ns}

Explanations: ns — no significant differences in dry weight loss of wood; * — significant differences in dry weight loss of wood, ($\alpha = 0.05$); ** — significant differences in dry weight loss of wood, ($\alpha = 0.01$); F from tables for $\alpha = 0.05 - 5.59$.

DISCUSSION

There are some data available on the ability of *Ph. gigantea* to decompose timber. In the USA, Minnesota, the fungus caused decay in 62% of *Pinus panderosa* cross-sections stored for 13 weeks in summer (Lingren and Erickson 1957). In Britain considerable degradation has occurred in stocks of *Pinus nigra* var. *maritima* utility poles stored for 12 months and in peeled logs of *P. sylvestris* (Greig, unpubl. data see, Holdenrieder and Greig 1998).

Ważny and Grzywacz (1975) indicated that *Ph. gigantea* caused white decay of pine wood in 8% and 20% after 3,5 months and 9 months respectively. Sierota (1995) found that 6 months after inoculation, *Ph. gigantea* causes 22% loss in dry weight of samples from stumps and 52.2% from lateral roots. The decay was determined by wood moisture. The least favourable wood for *Ph. gigantea* was that from stumps of cut standing dead trees.

In the experiment described in the present work samples from fresh stump wood were used. The average dry weight loss of wood was about 5% smaller after 3 months than in the example cited above after 6 months. But the most effective isolates (from Finland, Rotstop formula) caused 25% of the loss of dry weight of wood samples.

Molecular markers (molecular amplified microsatelites and ITS region) showed considerable genetic variation among the European *Ph. gigantea* isolates. Equal distribution of these markers in strains from different locations indicates low genetic differentiatin among European populations of *Ph. gigantea*. In addition no essential regional differences in the efficiency of *Ph. gigantea* strains against *H. annosum* were found. On spruce the mean efficiency varied between 60–96% but the difference was significant only between the most and the least effective isolates. On pine all tested *Ph. gigantea* isolates were 100% effective (Korhonen et al. 1997).

In the present study the weight loss of pine wood caused by *Phlebiopsis gigantea* isolates from different European localities was similar. In addition there were no significant differences in decomposition ability of all isolates, displayed as the loss of dry weight of wood. Significant differences were found only between the least and most effective isolates. This might be attributed to the low genetic variation among European populations of this fungus.

All the isolates tested could be used in the stump treatment experiments to confirm decay ability in the forest.

Some attempts were made to use other saprotrophs against pathogens. Orłoś (1957) found that *Fomitopsis pinicola* (Sw.: Fr.) P. Karst. reduced dry weight of spruce wood by about 28% but in forest experiments which were undertaken by Poleshchuk and Yakimov (1986) this fungus was not effective. *Resinicium bicolor* or *Hypholoma fasciculare* are other fungi (Holdenrieder and Greig 1998; Rykowski and S i e r o t a 1983a, b; Ł a k o m y 1998) which show strong competitive ability and potential for biological control of *Heterobasidion annosum* and deserve study. In wood blocks *R. bicolor* displaces *H. annosum* (H o l-m e r and S t e n l i d 1993) under laboratory conditions. It spreads up to 45 cm per annum in spruce roots (H o l m e r and S t e n l i d 1997). Ł a k o m y (1998) showed that *Hypholoma fasciculare* caused decay of pine wood in 15% after 4 months. On the other hand the fungus might be inoculated into soil using colonized wood blocks as it forms and spreads by mycelial cords (D o w s o n et al. 1988a, b). *Hypholoma fasciculare* was tested in forest against *H. annosum* or *Armillaria* spp. and it was more or less effecitve in stump protection (T w a r o w s k a 1972; R y k o w-s k i and S i e r o t a 1983a, b; P e a r c e and M a l a j c z u k 1990; Ł a k o m y and D u x 1998).

In spite of other study *Ph. gigantea* is the only one bioprep. in Forestry. All isolates showed similar wood decomposition capacity. It means that each of them could be used as bioprep. to protect pine stumps against *H. annosum*, in particular Polish isolates of *Ph. gigantea* which belonged to the most effective ones. Obviously laboratory results should be confirmed by the experiments in forests. In the commercial producton of bioprep. one isolate can used and improoved for years. Because of low genetic variation and similarity in capacity of wood decomposition between isolates, it should not make an ecological problem in the forest.

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Zdolność rozkładu drewna sosnowego przez różne izolaty *Phlebiopsis gigantea*

Streszczenie

Badano zdolność rozkładu drewna sosny zwyczajnej dziesięciu izolatów *Phlebiopsis gigantea* pochodzących z różnych miejsc w Europie (PG1, PG2 i PG3 z Polski, PG4 – Włoch, PG5 – Węgier, PG6 – Niemiec, PG7, PG8 i PG10 Finlandii, PG9 – Wielkiej Brytanii). Dwa izolaty

PG3 i PG7 pochodziły z handlowych biopreparatów stosowanych w Polsce (biopreparat PG – PG3) i Finlandii (biopreparat Rotstop – PG7) do zabiezpieczania pniaków sosnowych przed *Heterobasidion annosum*. Zdolność rozkładu drewna wyrażano jako różnicę suchej masy próbek drewna pniakowego sosny zwyczajnej przed i po inokulacji testowanym izolatem i inkubacji w termostacie, w temp. 24°C, przez trzy miesiące.

Uzyskane wyniki (tabela 1 i 2) świadczą o niewielkim zróżnicowaniu izolatów co do zdolności rozkładu drewna. Najsilniej działały 4 izolaty: dwa wyizolowane z pniaków sosnowych z Polski (PG1 – 15,4% i PG2 – 16,4%; tab. 1), oraz oba izolaty z biopreparatów (PG3 – 15,6% i PG7 – 16,2%), natomiast najsłabszą zdolnością rozkładu drewna charakteryzowały się izolaty z Włoch (PG4 – 11,5%) i Niemiec (PG6 – 12,1%).

Na podstawie analizy wariancji istotne różnice uzyskano przy porównaniu izolatów najsłabiej i najsilniej rozkładających drewno (tabela 2). Zbliżona zdolność rozkładu drewna przez różne izolaty może być także związana z niewielkim zróżnicowaniem genetycznym europejskich populacji *Ph. gigantea*, co dowiedli Korhonen i inni (1997). Wydaje się, że do produkcji biopreparatu można wykorzystywać wiele izolatów *Ph. gigantea*, szczególnie że polskie izolaty należały do najsilniej działających. Wykorzystywanie w produkcji i wprowadzanie do środowiska leśnego jednego izolatu przez wiele lat nie powinno stanowić problemu ekologicznego.