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THE RESISTANCE OF BEECH WOOD (*Fagus sylvatica* L.) TO FUNGI CAUSING DECAY FROM TREES WITH VARIOUS DEGREE OF DAMAGE

by Andrzej Szczepkowski

Division of Mycology and Forest Phytopathology
Warsaw Agricultural University

Studies were conducted on natural resistance of about 60 years old beech trees' wood against two fungi: *Fomes fomentarius* and *Laetiporus sulphureus*. The wood was sampled from stands of different health status, from northwestern and southeastern Poland. The trees sampled represented three degrees of damage. The wood resistance against decay was determined basing on the loss of weight of wood samples after 60 and 90 days of activity of test fungi.

Key words: beech wood, wood decay, tree healthiness, natural resistance, *Fomes fomentarius, Laetiporus sulphureus*

INTRODUCTION

The European beech is one of the most important forest stand forming tree species in Poland. It covers 4.2% of the country's forested area, which makes nearly 20% of the broadleaved trees' stands area. The share of beech wood in the large-dimension roundwood amounts to 5.6%, which means it is the fourth most important species: after pine, spruce and oak (Anonym 1999).

The forecasts of beech wood harvest quantity and its utilization till the year 2015 (Paschalis and Jednoralski 1988) assume that the importance of the species will grow. Accordingly to Tarasiuk (1992), the potential for beech as dominant, codominant, or auxiliary species has not been fully used yet in the Polish forests. The role and importance of beech may become even greater if the commonly expressed opinions of future climate warming and eutrophication hold true. On the other hand however an in-

creased susceptibility of forest trees to diseases, pests and weather anomalies is to be expected (Sadowski 1994, Ryszkowski, Kędziora and Bałazy 1995).

Since the early 80-es, the progressing process of health status worsening of conifers and broadleaves has been observed in Europe, including Poland. Considering the last few years, the area of beech stands showing symptoms of decline has been maintained at the level of 10 thousand ha (Szczepkowski 2001). At present the opinion prevails that the health deterioration of those stands where the overabundant decline of trees was observed during the last two decades in Central Europe has been caused by a whole complex of factors: abiotic, biotic and anthropogenous factors, the role and importance of which may change according to local conditions. An important biotic component of the disease, defined in terms of and based on the symptoms as the beech decline are fungi, including also those species – agents of wood decay, that are most often referred to as the secondary factor, involved in the process of dying off (Prihoda 1982, 1985, Surovec and Novotny 1987, Nageleisen 1993, Butin 1995, Oszako 1997, Szczepkowski 1998).

The wood of beech is considered rather low-to-moderate degree resistant against biodeterioration and the action of abiotic factors (Cartwright and Findlay 1951, Scheffer and Cowling 1966, Prosiński 1984). Despite its rather poor natural resistance, the wood of beech is commonly used in different branches of industry. The wood of the species is widely utilized in the production of furniture, plywood, veneer, building carpentry, parquet blocks, wooden panels, housekeeping tools and facilities, wooden haberdashery. It is used in the production of charcoal, railroad sleepers, mining constructions, as well as the raw material in the pulpwood industry (Surmiński 1990).

The results of studies on the quality of wood originated from the areas of forest damages, and particularly so – from the terrain under the impact of air pollution are not univocal and even more – sometimes they are contradictory to one another. No significant influence has been proved so far of the harmful gases and dusts on the resistance of wood against the action of fungi (Liese 1986, Schmidt et al. 1986, Aleksandrowicz-Trzcińska 1994, Fojutowski 1999, Bartkowiak et al. 2000).

The susceptibility of wood to the biotic factors is one of the most important usability attributes, influential for the potential of its practical use. The natural resistance of wood against the fungi caused rot is conditioned by a number of attributes of the wood itself. It is therefore considered a measure of wood quality. The knowledge of susceptibility of beech wood collected from the damaged stands characterized with the overabundant decline of trees as a consequence of the activity of different damaging factors, including the action of fungi may be useful for the construction of the recommendations for the silvicultural - protectional intervention in such damaged stands as well as for the purposes of practical utilization.

The aim of the present paper was to determine the resistance of beech wood collected from trees revealing different degree of damage, against the decay caused by *Basidiomycota*, as compared with the wood of healthy trees, from two regions of beech stands natural distribution.

MATERIALS AND METHODS

Two trees were selected from each of the three degrees of damage: 0 – no damage (healthy trees), 2 - moderately damaged trees, 4 – declining trees, of an age of about 60 years. The trees selected for the present study have represented two distinct areas of beech origin: the lowland beech from the Baltic Coast (Pomerania) region (Miastko Forest District) and the highland-mountainous beech from the Carpathians (Brzozów Forest District). The stands – representatives of the coastal beech forests were situated in the zone of low intensity contamination, while those from the Carpathians have grown in the region of moderately high air pollution with SO_2 and NO_x (Liwińska and Wawrzoniak 1994, Chwojka, Liwińska and Wawrzoniak 1994, Wawrzoniak et al. 1996). The classification system of tree damage as applied in the present paper has been based on the work by Szczepkowski (2001). Sample trees were selected exclusively from class I and II of the Kraft biosociological classification system; besides, sample trees had straight stems without fungi fruit bodies visible or canker symptoms. Logs were manipulated from trees cut in the second half of September; those had been subjected to seasoning for about 3 months in room temperature. Wood samples of dimension 30 (along the grain) x 20 x 20 mm have been cut from the outer parts of wood slats (covering 20-25 last annual rings). After marking, the samples were dried at 103 ± 2 °C and weighed within 0.01g. Then the samples were put in distilled water for 24 hrs and packed in 20 piece lots (bunches) into polyethylene bags that were subsequently closed using a hot iron. The samples prepared and packed as outlined above were subjected to sterilization – were exposed to radiation flux at the Department of Chemistry and Radiation Technique at the Institute of Chemistry and Nuclear Technique in Warsaw. The radiation (electron) dosage applied was equal 32 kGy, and exposition time – 15 min. The study of natural resistance of beech wood against fungi caused decay was carried out using mycelia of *Fomes fomentarius* (L.:Fr) Kickx and *Laetiporus sulphureus* (Bull.:Fr) Murr., taken from the collection of pure cultures of the Division of Mycology and Forest Phytopathology Warsaw Agricultural University. The test fungi species were selected so that they represented different types of wood decay and they occurred in the sampled forest stands. *Fomes fomentarius* is responsible for the white type of wood decay, while *Laetiporus sulphureus* causes the brown wood decay. The mycelia of both species were passaged by beech wood prior to the experiment onset. Two wood samples were put in each case into 500 cm^3 Weck jars, directly onto the agar-malt medium (the medium composition: 15 g Difco agar, 250 cm^3 beer malt, 750 cm^3 tap water per liter) containing a mycelium that had been produced earlier on it. Two different periods of wood sample exposition to fungi were applied: the 60-day period and the 90-day period. Ten wood samples represented each experimental variant: one fungus species, one exposition duration, one tree damage degree and one geographical origin. The jars with wood samples were placed under constant ambient temperature 21 ± 2 °C and relative air humidity 60-70%, in the dark room. After the prescribed periods of wood decay, the samples were extracted from the jars, the superficial mycelia were removed. The samples were tentatively dried under room temperature and then dried till the stable weight was obtained under 103 ± 2 °C. After drying, the samples were weighed and the loss of weight due to the activity of test fungi was determined.

Wood density was determined with use of the stereometric technique (Krzysik 1978).

RESULTS

The densities of studied beech wood samples are presented, depending on the actual degree of tree damage, in Table 1. Regardless the beech tree damage, it was found that trees from the Baltic Coast had higher wood density. The wood density of the Coastal beech varied from 600 to 777 kg/m^3, while that of the Carpathian beech forest varied from 565 to 755 kg/m^3. Considering the Carpathian beeches, the wood density increases with growing damage degree. The pattern was different in the Coastal beech: the lightest wood originated from the moderately damaged trees, while the heaviest one form the healthy trees, somewhat lighter wood was found in the declining trees.

Table 1

Tabela 1

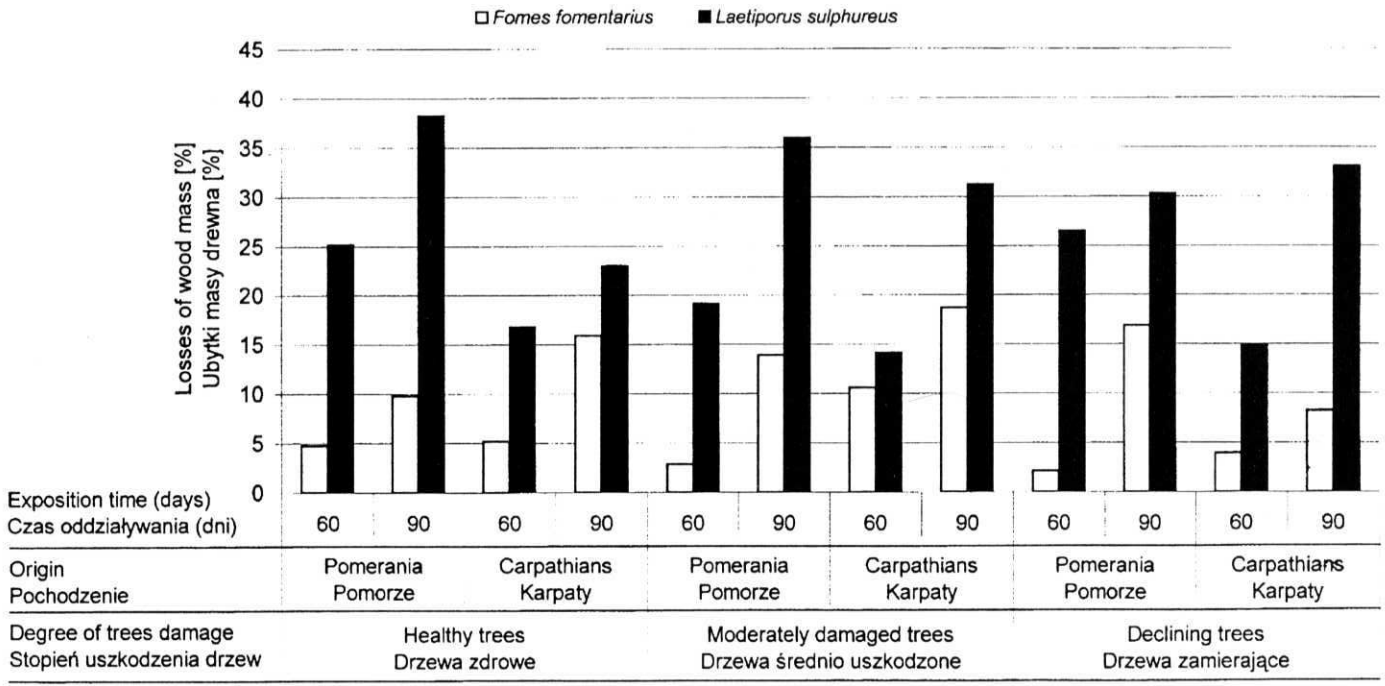
Mean density of wood subjected to the mycological test (kg/m^3)

Średnia gęstość drewna próbek poddanych testowi mikologicznemu (kg/m^3)

Degree of trees demage Stopień uszkodzenia drzew	Origin of wood Pochodzenie drewna	
	Pomerania Pomorze	Carpathians Karpaty
Healthy trees Drzewa bez uszkodzeń	698	628
Moderately damaged trees Drzewa średnio uszkodzone	652	648
Declining trees Drzewa zamierające	695	681
Dispersion of results Dyspersja wyników	600-777	565-755

Out of the two fungi species used in the experiment, *Laetiporus sulphureus* has had higher activity, expressed in terms of beech wood weight loss (Fig.1). The wood samples taken from the Coastal beech forest were less intensively decayed by *Fomes fomentarius* after both 60 and 90 days of exposition (the only exception being the wood of dying off trees), as compared with the samples extracted from the Carpathian Beech forest. Opposite has been the pattern of wood decay rate by *L. sulphureus*. The Coastal beech wood samples were subjected to slightly more intensive decay, regardless the exposition time to the activity of the fungus, comparing with the Carpathian beech. The only departure from the pattern was found in the case of dying trees' wood after 90 days of decay (Fig.1). The lowest resistance against the decay caused by *F. fomentarius* was that found for the moderately damaged Carpathian beeches and for the declining Coastal beeches. After 90 days of exposition, the weight loss was equal 18.72 and 16.88%, respectively. In the case of action of *L. sulphureus*, the largest loss in wood

Fig. 1. Mass losses of wood subjected to test fungi
Rys. 1. Ubytki masy drewna poddanego działaniu grzybów testowych



mass after 90 days of exposition was stated for the samples representing the healthy trees from the Coast (38.24%), while the per cent loss found for the declining trees from the Carpathians equaled 33.05% (Fig.1).

The statistical analyses conducted have not proved statistically significant differences considering the weight loss between the wood samples of damaged and non-damaged beech trees. The significance of the correlation coefficient was tested using the Fisher test (á=0.05). The value of standard deviation of arithmetic mean of weight loss in particular damage classes has been maintained after 90 days of exposition to the activity of the test fungi within the range: 7.15 - 16.17% (*F. fomentarius*) and from 6.57 to 16.05% (*L. sulphureus*).

DISCUSSION

The study on the beech trees resistance to the decay caused by fungi in trees characteristic with different degree of decline was part of a larger research project, conducted at the Division of Mycology and Forest Phytopathology Warsaw Agricultural University and aimed at learning the causes and consequences of decline of beech trees in Poland.

In this paper it was assumed that one of the potential measures of change in properties of wood following the pathological processes in beech stands, is the alteration of the natural resistance of wood against decay caused by fungi. Both the test fungi species (*Fomes fomentarius* and *Laetiporus sulphureus*) are economically important in Polish forestry. They infect live trees, but the decay process may continue even after the tree has been cut off, if only the adequate level of wood humidity is maintained. A particularly dangerous toward the beech has been considered *F. fomentarius*, a fungus species responsible for serious material loss. The fungus attacks usually weakened trees, ill trees, causing further worsening of their sanitary status and health status (Butin 1995).

One of the wood properties influential in the resistance of wood against fungi activity is wood density. The density of studied beech wood samples has been within the range considered typical for the species (Wagenführ and Scheiber 1974). Considering the two geographical provenances covered by the present study, it was stated that the Carpathian beech has had smaller density of wood in each of the three beech tree damage degrees. One possible explanation of the wood density pattern found could be sought in the fact that the Carpathian beech has been growing under higher loads of the environmental pollution as compared with the Coast region. This tentative hypothesis needs however further study, especially because examples can be found in the relevant literature of both decrease (Aleksandrowicz 1994) and insignificant increase (Liese 1987) in wood density of trees from stands damaged by industrial emission. Some authors found no correlation between wood density and the degree of stand damage by the industrial air pollution (Koltzenburg and Knigge 1987).

The investigations carried out in the present study did not show any influence of the damage degree of live beech trees. Similarly, no effect was proved in the studies on the impact of industrial born air pollution on wood quality (wood resistance) (Liese 1986, Schmidt et al. 1986, Aleksandrowicz-Trzcińska 1994, Fojutowski 1999, Bartkowiak et al. 2000). The values of weight loss due to the activity of *F. fomentarius* as found in this paper are significantly larger than those reported by Rosnev and Stiptzov (1986) for the beech (*Fagus sylvatica* L.) wood. The discrepancy may be explained in terms of the actually different methodological attempts employed.

The results obtained in the present paper prove that the degree of damage of beech trees as expressed in morphological deformation of trees' shoots and twigs, the crown branching patterns, the assimilatory apparatus discoloration and defoliation, does not influence significantly the resistance of the beech wood against the activity of the basidiomycota test fungi. It was found however in some experimental treatments that the wood of healthy trees was less susceptible to decay than the damaged trees' wood. To finally learn the problem of the increased culling of trees as a consequence of multisided disease processes as observed in many broadleaved stands, including beech stands, is still important and it would need more investigations, eg. on the wood raw material quality in such trees.

CONCLUSIONS

1. The wood of beech trees aged about 60 years and extracted from stands characteristic of overabundant tree culling in two regions: the Baltic Coast and the Carpathians, representing moderately damaged and declining trees was shown to be equally not resistant to the action of *Fomes fomentarius*, resulting in the white rot of wood as well as the activity of *Laetiporus sulphureus* - the latter causing the brown rot of wood, as compared with the wood of healthy trees.
2. The higher activity expressed in terms of weight loss of beech wood was found for *Laetiporus sulphureus* as compared with *Fomes fomentarius*, both after 60- and 90-day exposition.

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ODPORNOŚĆ NA ROZKŁAD POWODOWANY PRZEZ GRZYBY DREWNA BUKA (*Fagus sylvatica* L.) Z DRZEW O RÓŻNYM STOPNIU USZKODZEŃ

Streszczenie

Naturalną odporność drewna buków trzech stopni uszkodzeń (1 – bez uszkodzeń, 2 - średnio uszkodzone, 4 – obumierające) poddano działaniu grzybów: rozkładu białego – *Fomes fomentarius* i rozkładu brunatnego – *Laetiporus sulphureus*. Drewno reprezentowało dwa obszary naturalnego występowania buka: nizinny (pomorski) i wyżynno-górski (karpacki). Próbki drewna (30 x 20 x 20 mm) pochodziły z ostatnich 20-25 przyrostów rocznych drzew w wieku około 60 lat. Przyjęto dwa okresy oddziaływania grzybów na drewno (60 i 90 dni), po których określano ubytki masy próbek. Stereometrycznie określono gęstość drewna próbek.

Uzyskane wyniki badań dowodzą, że stopień uszkodzeń buków, objawiający się w deformacji morfologicznej pędów, strukturze ugałęzienia koron, przebarwieniach aparatu asymilacyjnego oraz defoliacji, nie wpływa istotnie na odporność drewna tego gatunku na działanie testowych grzybów podstawkowych. Gęstość badanego drewna próbek buka mieściła się w zakresie charakterystycznym dla tego gatunku, z tym że drewno z Karpat miało nieco mniejszą średnią gęstość, we wszystkich trzech stopniach uszkodzeń drzew, niż drewno z Pomorza.

Author's address:
dr inż. Andrzej Szczepkowski
Szkoła Główna Gospodarstwa Wiejskiego w Warszawie
Katedra Ochrony Lasu i Ekologii
Zakład Mikologii i Fitopatologii Leśnej
02-528 Warszawa, ul. Rakowiecka 26/30
POLAND