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Some problems in the results assessment in laboratory evaluation of wood for resistance to termites based on visual ratings of attack on test blocks

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Abstract: *Some problems in the results assessment in laboratory evaluation of wood for resistance to termites based on visual ratings of attack on test blocks.* The aim of the work is to check the visual assessment of the degree of damage to *Pinus sylvestris* L. wood blocks by *Reticulitermes lucifugus* Rossi in an experiment made according to ASTM D 3345-08 [2009]. The three evaluator made the assessment individually. The differing results obtained by the three evaluator give food for thought. The varied results of the three evaluator assessments it gave rise to thoughts. The visual assessment of the degree of wood damage done by different people can vary significantly.

Keywords: Termites, Research procedure, visual assessment

INTRODUCTION

Two groups of termites are dangerous for wood constructions*: dry wood boring termites and subterranean termites.* The subterranean termites are more dangerous for building constructions, because they destroy not only wood and wood-based materials but also electrical installations and air-conditioning devices.

There are two types of methods for testing the resistance of wood to attack of subterranean termites: field tests [Ncube et al. 2012, Shanbhag and Sundararaj 2013] and laboratory tests [Schultze - Dewitz 1958, Becker and Petrowitz 1971, Becker et al. 1972, Unger 1978, Krajewski et al. 2015]. Laboratory tests are carried out in relation to soil termites according to two basic procedures: ASTM D 3345-08 [2009] and PN-EN 117 [2005]. The use of *Reticulitermes lucifugus* Rossi is included in both procedures. The procedure contained in ASTM D 3345-08 [2009] is designed basically for laboratory evaluation of wood and other cellulosic materials for resistance to subterranean termites. The procedure contained in PN-EN is used in principle in study of determination of toxic values of wood preservatives against *Reticulitermes lucifugus*.

In both these laboratory procedures the basic problem is the visual way of assessing the degree of wood damage. The method is subjective. The authors found this problem during the evaluation of various wood species [Krajewski et al. 2015, Krajewski et al. 2016] and waterlogged wood in different condition [Krajewski et al. 2015] for resistance to termites. The results of the experiment carried out according to ASTM D 3345-08 [2009] are presented in this publication in order to fully reveal the problem.

MATERIALS AND METHODS

The examinations were conducted in accordance with the ASTM standard [2009]. Scots pine (*Pinus sylvestris* L.) sapwood was used to prepare seasoned samples of 7%±1% moisture content and sized 25,4x25,4x6,4mm. Seven blocks of Scots pine sapwood (*Pinus sylvestris* L.) from various trees were used for experiment.

Each block, in accordance with the ASTM standard recommendations, was placed separately on the bottom of a testing container (a glass vessel of 450 ml) and covered with 200 g of screened, washed and heat-sterilized white sand. The saturation point of the sand was established empirically. The amount of water, used to moisten the sand in the testing container, was then reduced by 7% of the saturation point of the sand. The only deviation

from the ASTM D 3345-08 [2009] standard was the fact that benzalkonium chloride solution was not used as antiseptic.

The biological experiments were conducted in a coercion test, in accordance with the above mentioned standard, on the *Reticulitermes lucifugus* Rossi termite. In each prepared testing container, 1±0,05 g of *Reticulitermes lucifugus* termites were placed. Pseudergates provided 90% of all the individuals in each container. The containers with termites and wood samples were stored in an incubator in the temperature of 27°C for 4 weeks. The moisture content of the sand was supplemented weekly.

The ASTM D 3345-08 [2009] standard provides the following classification of mortality rate of the termite based on visual evaluation: grade low (0-33%), average (34-66%), high (67-99%), complete (100%).

The degree of damage to the samples, decisive to estimating the resistance (or susceptibility) of the wood to destruction by the termite, was classified visually, based on the visual rating system and photos in the ASTM D 3345-08 [2009] standard, i.e. 10 – sound, surface nibbles permitted, 9 – light attack, 7 – moderate attack, penetration, 4 – heavy, 0 – failure. In ambiguous cases, an intermediate index was accepted.

Average degrees of damage to the wood were calculated for each variant of the experiment. The significance of the difference of obtained average results was verified statistically. Chebyshev's inequality was used to evaluate the significance of the difference between the average degree of pine wood damage recognized separately by each evaluator. If the absolute value of the difference of arithmetic average values of degree of wood damage made by two evaluators was bigger or equal to triple value of standard error of the difference, i.e.:

$$|\overline{x_1} - \overline{x_2}| \geq 3 \cdot \varepsilon(\overline{x_1} - \overline{x_2})$$

then the difference of average values was recognized as statistically significant. Otherwise, it was recognized as accidental.

RESULTS AND DISCUSSION

The results of the wood damage assessment by termites are presented in Table 1.

Table 1. Assessment of the degree of damage of samples by termites made by 3 evaluators

No of block	evaluator No 1	evaluator No 2	evaluator No 3
1	8	4	4
2	5,5	2	0
3	5,5	0	4
4	5,5	2	4
5	7	2	4
6	4	0	0
7	5,5	2	4
The average	5,9	1,7	2,9

The qualification of statistical verification of differences in the degree of wood damage between evaluators is presented in Table 2.

No dead termites were observed in any of the laboratory glassware. Mortality of termites was therefore rated as low. Individual wood species show different resistance to termites [Schultze – Dewitz 1958, Becker and Petrowitz 1971, Becker et al. 1972, Unger 1978, Grace and Yamamoto 1994, Grace et al. 1996, Kard et al. 2007, Shanbhag and Sundararaj 2013].

The precise assessment of the degree of damage is important because of the accuracy of comparing the natural resistance of wood to termite damage and the effectiveness of wood

preservatives. The varied results of the three evaluators' assessments provided questions for thought. No damage assessment of a single block that was made by the evaluator of No 1 is not consistent with the ratings of evaluator No 2 and No 3. The damage assessment of individual blocks, which were made by evaluators No 2 and No 3, are compatible only in 2 cases (Table 1). The evaluation of the average degree of damage to the samples by the evaluator No 1 is significantly different from the evaluations of the evaluators No 2 and No 3 (Table 2).

Table 2. Statistical verification of the results of the assessment of the difference in mean degree of damage to wood samples by termites according to individual evaluators

Evaluators	$\lvert\overline{x_1} - \overline{x_2}\rvert \geq 3 \cdot \varepsilon(\overline{x_1} - \overline{x_2})$	Statistical verification of results
No 1 and No 2	4,2 > 2,1	Differnce of average mortality is statistically significant
No 1 and No 3	3,4 > 2,7	Differnce of average mortality is statistically significant
No 2 and No 3	1,2< 2,7	Differnce of average mortality is statistically insignificant

However, the average wood damage rates are related to a small number of samples (7 blocks). At ASTM (2009), a minimum of 5 samples in 1 variant was provided. In order to confirm the imperfections of the visual assessment method, it is necessary to continue the research. Performing tests on a larger number of samples seems to be deliberate. Assessment by a larger number of people is also desirable.

CONCLUSIONS

The following conclusions emerge from the research.

Visual assessment of the degree of wood damage done by different people can vary significantly.

It is necessary to develop an assessment method based on the weight loss of the samples to avoid subjective judgment.

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Streszczenie: *Niektóre problemy z określeniem wyników w laboratoryjnej kwalifikacji drewna pod kątem odporności na termity na podstawie wizualnej oceny ataku na klocki testowe.* Celem pracy jest sprawdzenie zgodności oceny wizualnej stopnia uszkodzenia klocków drewna *Pinus sylvestris* L. przez *Reticulitermes lucifugus* Ross w doświadczeniu zrobionym według ASTM D 3345-08 (2009). Ocenę zrobili indywidualnie trzej współautorzy. Różniące się wyniki uzyskane przez trzech współautorów dają wiele do myślenia. Wizualna ocena stopnia uszkodzenia drewna przez termity wykonana przez różne osoby może się istotnie różnić.

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