Silva Fennica 1986, vol 20 n:o 1: 29–33

Further tests for termite resistance of Finnish pine heartwood

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SELOSTE: JATKOKOKEITA MÄNNYN SYDÄNPUUN TERMIITINKESTÄVYYDESTÄ

Löyttyniemi, K. & Uusvaara, O. 1986. Further tests for termite resistance of Finnish pine heartwood. Seloste: Jatkokokeita männyn sydänpuun termiitinkestävyydestä. Silva Fennica 20 (1): 29–33.

The natural resistance of Finnish-grown *Pinus sylvestris* heartwood to Macrotermitinae termites was tested in Zambia in graveyard conditions. The heartwood exhibited some natural resistance but the durability was, however, far from practical immunity. There was significant tree-to-tree variation in the resistance of heartwood of *P. sylvestris*.

Suomessa kasvatetun männyn sydänpuun termiitinkestävyyttä tutkittiin Sambiassa kaivamalla näytteitä osittain maan sisään. Todettiin, että suomalainen mänty on jonkin verran kestävää myös välittömässä maakosketuksessa. Eri mänty-yksilöistä otettujen näytteiden kestävyydessä oli kuitenkin suuria eroja.

Key words: Macrotermitinae, insect attack, heartwood, *Pinus sylvestris*
ODC 845.3+145.7 Macrotermitinae + 814.1+811.52+174.7 *Pinus sylvestris*
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Approved on 26. 2. 1986

Introduction

Recent screening tests for termite resistance of Finnish coniferous timbers suggest that pine (*Pinus sylvestris* L.) heartwood is to some extent resistant to attack by Macrotermitinae termites in conditions corresponding to those prevailing in woodwork shielded from damp. In addition, there seemed to be some variation in the resistance of the wood among the tested pine individuals (Löyttyniemi 1983).

This gave an impetus to further testing of the natural durability of pine heartwood. The results of these graveyard tests are presented in this paper.

The authors are grateful to Dr. Jukka Selander for identifying the termite specimens.

Material and methods

The wood samples originated from 31 pines (age 70–240 years) cut in October, 1983 in different parts of Finland (range N 61°–67°). A bolt was cut from the middle part of each stem, and five stakes were split from the heartwood of each bolt. The dimensions of the finished stakes were 250 × 25 × 25 mm. Similar samples were prepared from the sapwood of five Zambian grown *Pinus kesiya* (Royle ex Gordon) trees (age 18 years). The annual ring width of the samples was measured, and the basic density of the wood determined. The samples were dried and aged in an oven at 105° C for 48 hrs (cf. Williams 1973) and stored in a dry place until used in field-testing.

The field experiments were carried out in the Copperbelt Province of Zambia (about S 13°; E 28°) in miombo woodland. The lay-out of the test was a square in which the 31 Scots pine stakes and one kesiya pine control sample were placed randomly spaced at intervals of 20 cm. The stakes were buried vertically into the soil leaving 5 cm above ground level. There were five test replicates in different locations. The field-tests were begun in January 1984, in the middle of the rains, and the progress of termite attack was checked in May and October by withdrawing the samples from the soil. The experiment was terminated after 12 months in February, 1985 when many of the samples were found totally destroyed. The degree of damage was assessed by eye as a percent of wood gnawed off (cf. Williams 1973, Fougerousse 1969). Actual termite specimens were also collected.

Results and discussion

Tests and practical experience have shown that pine sapwood does not possess any natural resistance to termite attack (e.g. Fuller 1924, Fougerousse 1969, Löyttyniemi 1983). On the other hand, heartwood timber of pines from the temperate zone, as well as that of the southern pines, is generally repellent or resistant to the lower termites to a varying extent (e.g. Snyder 1924a, 1924b, Wolcott 1947, Williams 1965, Becker et al. 1971, Carter and Smythe 1974). The resistance of such timber to the higher termites (mainly subfamily Macrotermitinae) is, however, largely unknown (cf. Löyttyniemi 1983). The natural durability of the heartwood of true tropical pines has not been tested because of the nonexistence of heartwood in commercial plantation timber of these pine species.

In the present experiment, the buried Scots pine heartwood samples were attacked by only a few Macrotermitinae species (*Ancistrotermes latinosus* (Holmgren) in one test; *Microtermes* sp. in four tests) notwithstanding the rich termite fauna existing in miombo woodland (cf. Nkunika 1982, Selander 1986). This may indicate either that Scots pine heartwood is resistant to or possesses a repellent effect against some termite species or termite groups, or that one bait is in general infested by one invader species only, or both (cf. Williams 1973, Ferrar 1982, Löyttyniemi 1983).

In the most cases the parts of the stakes in the soil were badly damaged by termites after an exposure period of 12 months. On the average, about two-thirds of the wood ($\bar{x}$ = 63±2.3 %) was destroyed during the study period (Fig. 1). The destruction rate had slowed during the dry season when the activity of subterranean termites is generally low. On the other hand, the parts of the stakes above ground remained more or less intact; and the wood was still sound and even unstained inside. The destruction rate of the kesiya pine sapwood samples was significantly higher: all samples had been totally destroyed within six-seven months, including

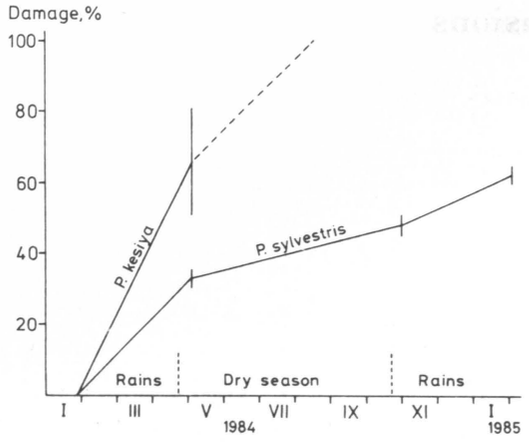

Figure 1. Damage (volume loss) percentage ($\bar{x}$±S.E.) of *Pinus sylvestris* heartwood and *Pinus kesiya* sapwood stakes in graveyard tests.

the parts above ground.

There was significant tree-to-tree variation in the resistance of the heartwood of the pine individuals (F = 2.52***). A few samples exhibited signs of superficial attack only, while some others were totally destroyed (Fig. 2). The degree of damage did not correlate with the width of annual rings ($\bar{x}$ = 9.3±0.37 mm for five yrs; r = 0.03), nor with the basic density ($\bar{x}$ = 385±4.2 kg/m^3; r = −0.17) of the wood samples. In some conditions, wide-ringed coniferous wood has been found to be less durable than more slowly grown wood (e.g. Rudman 1963, Löyttyniemi 1983).

There was also no correlation between the degree of damage and the geographical origin (latitude) of the samples (r = 0.05). Generally speaking, the natural termite resistance of woods tends to increase as one moves from the temperate zone to the tropics (e.g. Snyder 1924a, 1924b, Wolcott 1957; see also Löyttyniemi 1983). Nor was there any correlation between the degree of damage and the age of the pines from which the wood samples originated (r = 0.08).

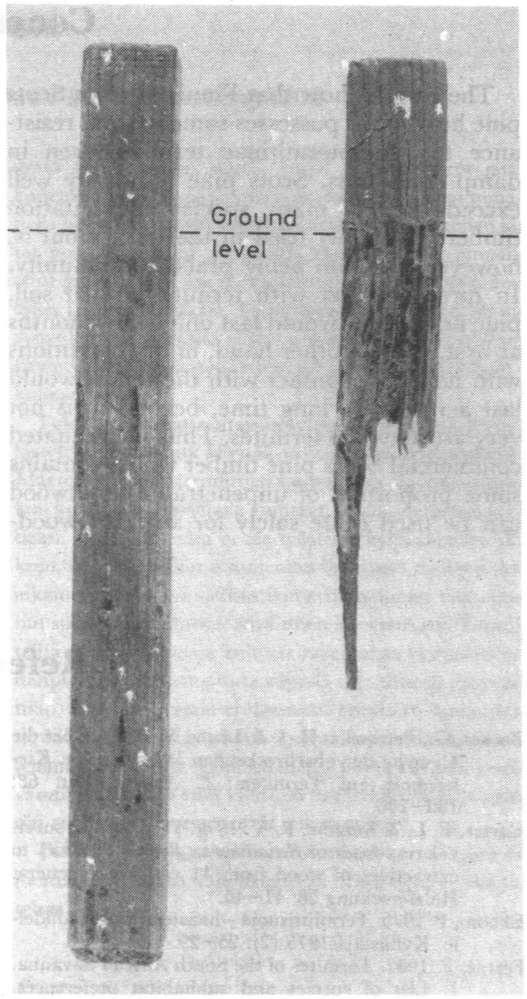

Figure 2. The range of termite attack on *Pinus sylvestris* heartwood stakes in graveyard tests after exposure of 12 months.

Conclusions

The results show that Finnish-grown Scots pine heartwood possesses some natural resistance to Macrotermitinae termites even in damp conditions. Scots pine durability well exceeds that of many species of plantation timber commonly used in the tropics but is, however, far from being practical immunity. In direct contact with termite-infested soil, pine heartwood would last only a few months at best. On the other hand, in dry conditions with no direct contact with the soil, it would last a relatively long time, because it is not very attractive to termites. Thus impregnated commercial Scots pine timber which contains some proportion of unpenetrable heartwood can be used quite safely for shielded woodwork in the tropics.

The wide variation found among pine individuals as to the resistance of heartwood is probably based on chemical rather than physical properties of the wood. Analyzing of heartwood extractives and testing of their antitermitic properties are needed for further understanding of this phenomenon. Such studies could also lead to the development of natural termite repellents as well as to the discovery of indicators for selecting pine timber according to its durability.

The results also confirm that Finnish-grown pine heartwood is moderately decay-resistant even in tropical conditions (cf. Löyttyniemi 1986).

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Seloste

Jatkokokeita männyn sydänpuun termiitinkestävyydestä

Kuusta ei voi puun huonon permeabiliteetin vuoksi kyllästää tavanomaisin menetelmin tyydyttävästi ja tehdä sitä siten termiitinkestäväksi. Samasta syystä jää männyn sydänpuuosa termiittisuojaa vaille. Näiden puulajien luontainen termiitinkestävyys olisi tiedettävä, jotta voitaisiin arvioida suomalaisen puutavaran ja puurakenteiden käyttökelpoisuus termiittiriskialueilla (ks. esim. Hickin 1971, Ekbom 1975, Mansikkamäki ja Vihavainen 1977, Löyttyniemi 1983).

Suomalaisten puulajien termiitinkestävyyden selvittämiseksi tehty alustava koe (Löyttyniemi 1983) osoitti, että kuusen manto- ja sydänpuuosa sekä männyn mantopuu ovat luontaisesti täysin kestämättömiä trooppisen alueen Macrotermitinae-termiittejä vastaan kosteudelta suojatuissa olosuhteissa. Sitävastoin männyn sydänpuu oli selvästi kestävämpää.

Männyn sydänpuulla tehtiin jatkokokeita Sambiassa 1984–85 käyttäen 31 eri puolella Suomea kasvaneesta männystä otettuja puunäytteitä. 250 × 25 × 25 mm kokoiset sauvat kaivettiin maahan niin, että 50 mm osa jäi maan pinnalle. Termiittivahingon kehittymistä seurattiin 12 kuukauden ajan.

Tulokset osoittivat suomalaisen männyn sydänpuun olevan jonkin verran kestävää myös välittömässä maakosketuksessa. Maan sisässä olleesta puunäytteiden osasta oli kolmen kuukauden kuluessa tuhoutunut keskimäärin noin kolmannes ja 12 kuukaudessa kaksi kolmannesta. Eri mänty-yksilöistä otettujen näytteiden kestävyydessä oli kuitenkin suuria eroja. Kestävyyserot eivät kuitenkaan olleet riippuvuussuhteessa näytteiden puuaineen tiheyden, vuosilustojen leveyden eivätkä puiden iän tai maantieteellisen alkuperän kanssa. Maan pinnalla ollut puunäytteen osa oli useimmissa tapauksissa jäänyt lähes koskemattomaksi. Termiiteiltä säilynyt puu oli pysynyt kovana ja sisältä lähes väriviattomana. Vertailuna käytetyt kesiya-mäntynäytteet tuhoutuivat täysin noin 6 kuukaudessa.

Tulosten mukaan voitaisiin sydänpuuta sisältävää kyllästettyä kestopuuta käyttää välittömässä kosketuksessa Macrotermitinae-termiittien asuttamaan maahan silloin, kun kestävyyttä tarvitaan enintään muutamaksi kuukaudeksi. Jos kestopuuta ei ole työstetty kyllästämisen jälkeen, on suojavaikutus kuitenkin ilmeisesti melko pitkäaikainen, koska pinnallisestikin sydänpuuhun tunkeutunut suoja-aine hidastaa termiittien iskeytymistä. Termiiteiltä perussuojatuissa kuivissa rakenteissa voitaneen sydänpuupitoista kestopuuta käyttää turvallisesti pysyvästikin, koska sydänpuu ei ilmeisesti erityisesti houkuttele termiittejä. Mikäli kestopuuta ei haluta käyttää, on käsittelemätön sydänpuupitoinen mänty kuitenkin aina kestävämpi vaihtoehto kuin kuusi tai esimerkiksi käsittelemätön eteläinen mänty ja eräät eukalyptukset.

Tulokset osoittivat myös, että männyn sydänpuu on luontaisesti melko lahonkestävää trooppisissa olosuhteissa.