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REPORT

SUSCEPTIBILITY OF AIR DRIED AND HIGH TEMPERATURE DRIED REGROWTH KARRI (*Eucalyptus diversicolor*) TO ATTACK BY THE POWDER POST BORER (*Lyctus brunneus*)

Progress Report No. 1

by

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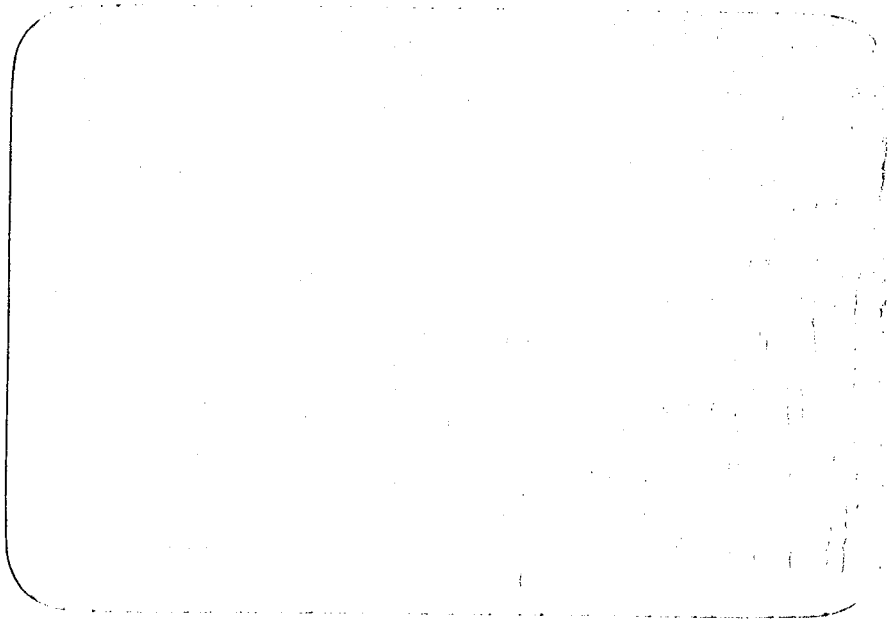
This report has been prepared primarily for internal laboratory use, and the results given and conclusions drawn are of interim nature and may be subject to revision.



SUSCEPTIBILITY OF AIR DRIED AND HIGH TEMPERATURE DRIED REGROWTH KARRI (*Eucalyptus diversicolor*) TO ATTACK BY THE POWDER POST BORER (*Lyctus brunneus*)

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Summary

This report gives results of laboratory bioassays of matched air dried and high temperature dried specimens of sapwood from five regrowth karri (*Eucalyptus diversicolor* F. Muell.) trees against the powder post borer *Lyctus brunneus* (Stephens). The karri trees were randomly selected from a 50 year old regrowth stand in Big Brook Block, Pemberton District of Western Australia. Results clearly show that both air dried and high temperature dried specimens were attacked by *L. brunneus*. Those specimens with the highest starch content recorded the greatest amount of attack.

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Introduction

The sapwood of many seasoned hardwood timbers in Australia is susceptible to attack by powder post borers belonging to the family Lyctidae. Several species of lyctids occur in Australia, however, the most common found attacking timber in service in Western Australia is *Lyctus brunneus* (Stephens). Three of the most important criteria affecting timber susceptibility are sapwood moisture content, starch content and pore (vessel) diameter (Bootle, 1983). To be susceptible, the sapwood must have a moisture content in the range of approximately eight to 25 per cent, pores of sufficient diameter for the adult female to insert her egg laying apparatus (ovipositor) and contain enough starch in order to sustain growth of the developing larvae.

In Australia, the States of New South Wales (Timber Marketing Act, 1977) and Queensland (Timber Utilization and Marketing Act, 1987) require the sapwood of many timbers (quite often species containing wide sapwood bands) to be immunised with an approved lycticide or alternatively be limited to a defined maximum in unexposed building timbers. No legislation exists in the southern states as hardwood building timbers, mostly of the genus *Eucalyptus*, contain only narrow sapwood bands. Hence sapwood loss due to lyctid attack is unlikely to cause significant structural weakening of timber in service.

Karri (*Eucalyptus diversicolor* F. Muell.), which occurs in a limited area of the south-west of Western Australia, has been rated by the Preservation Section of the Division of Forest Products (1950) as immune to lyctid attack i.e. in a few instances attack has been recorded but its intensity has been so light that the infestation may be regarded as exceptional.

Fairey (1975) rated karri as rarely susceptible i.e. seldom attacked in service. These two sources of information on lyctid susceptibility include both laboratory testing and information supplied by officers concerned with the utilization of wood. In general, the ratings refer to the susceptibility of sapwood to attack by *L. brunneus* under Australian conditions.

The rating for karri was probably based upon material originating from mature trees. Nowadays, there is an influx of young regrowth karri thinnings appearing in the market-place. This regrowth material has a much wider sapwood band than mature growth karri representing approximately 30 per cent of the regrowth log (Brennan, unpubl. data). Therefore more sapwood is being included in finished timber products.

Since regrowth karri appeared on the market, the Department of Conservation and Land Management of Western Australia has received a number of reports that lyctid borers have caused considerable damage to the sapwood. Current consumer preference for exposed beams is believed to have contributed to an increased number of reported incidences of attack. In some instances suppliers of karri have been obligated to replace timber products attacked by lyctids.

The regrowth karri resource represents at least one million cubic metres over the next 20 years (Anon, 1987) and from this it is intended to produce high grade furniture in addition to the presently produced structural materials and tile battens. Therefore, the reputation and credibility of the growers, suppliers, manufacturers and the timber are at stake when consumers have cause for complaint over the degrade of karri sapwood by lyctids.

In October 1985, a collaborative research project was initiated between CSIRO and the Western Australian Department of Conservation and Land Management (CALM) to investigate the following facets of regrowth karri sapwood:

(i) The susceptibility of regrowth karri sapwood to attack by *L. brunneus*.

(ii) To determine whether high temperature drying of regrowth karri affects its susceptibility to *L. brunneus*.

(iii) To investigate the susceptibility of regrowth karri from various provenances.

The second investigation is an attempt to render the sapwood immune by destruction or depletion of some of its nutritional content (particularly starch); a practice that has had some success with messmate stringybark (*Eucalyptus obliqua* L'Herit.) (Creffield, unpubl. data). Harris (1961) also showed that greater starch depletion occurred in one-inch (25 mm) boards of European Oak (*Quercus robur* L.) when kiln dried compared to matched air dried material. Due to handling, health and economics, a non-chemical means by which susceptible sapwood could be rendered immune would be more advantageous than chemical immunisation.

This report presents some progress results using five regrowth karri trees from the Pemberton District of Western Australia. Stands in this area are currently being thinned to increase wood production. Commercial size thinnings are sold and converted into tile battens.

Materials and Methods

(i) Timber Samples: Five, randomly selected 50 year old regrowth karri trees were harvested from a stand in Big Brook Block, Pemberton District (W.A.) during a thinning operation. Matched pairs of samples were obtained from each tree at each of three positions; the butt, midway along the bole and the crown of the log. One sample of each matched pair was seasoned by air drying whereas the other was high temperature kiln dried from green to between 10 and 12 per cent moisture content. All samples were dried at the Wood Utilization Research Centre of the Department of CALM.

(ii) High Temperature Drying Schedule: The following schedule was used for those karri samples assigned to high temperature drying:-

	Time	Dry Bulb Temp. ^{o}C	Wood Temp. ^{o}C
Pre-steaming	4 h	100	94-97
Drying	8 h	115	108-112
Re-conditioning	4 h	100	94-97

Fan direction was reversed every four hours during the drying procedure.

(iii) Preparation of Specimens: Test specimens, containing full sapwood width, were cut (using a tungsten-tipped saw) from each air dried (AD) and high temperature dried (HTD) sample. In most cases two test specimens were obtained from each sample i.e. two AD specimens and two HTD specimens for each of the three positions per tree. Test specimens were irregular in shape, but had approximately the same sapwood volume.

(iv) The Bioassay: Clear glass jars (1.2 L vol., 100 mm square by 150 mm

high) were used as bioassay chambers. A thin layer of a forest loam was then placed into each jar to act as a beetle foothold. The jars containing soil were then thoroughly heat sterilised. After sterilisation, one test specimen was placed into each jar and allowed to condition to a moisture content of between 14 and 15 per cent in an insectary (27^{o}C, 75 per cent RH) for at least seven days before inoculation of test insects.

A screw top metal lid was fitted with a paraffin wax impregnated cardboard wad to ensure a mite-proof seal. At the centre of the lid a circular hole 30 mm in diameter was punched through the metal and the cardboard wad. The hole was then sealed with rice paper (cigarette paper) and glued down at the edges with a liquid adhesive. This allowed aeration and permitted the timber specimens to be maintained at the desired equilibrium moisture content.

Since the sexing of *L. brunneus* adults is time-consuming, it was decided (after checking that a suitable number of females were present) to place 20 adults taken at random from a daily collection, on to each specimen.

Four months after the beetle inoculation, all specimens were examined for evidence of larval activity by splitting each specimen longitudinally and noting larval channelling present. The extent of larval channelling in a timber specimen is a subjective qualitative assessment. Therefore, any larval channelling present, regardless of the amount, was considered an indication of the timber's susceptibility to attack and subsequent degrade by *L. brunneus*.

A rating of susceptible (S) is given to a test specimen where larval channelling was present. However, to give an indication of the amount or

intensity of larval channelling present a rating system was used as follows:

S111 - Extensive attack, complete destruction of the sapwood.

S11 - Moderate attack, larval channelling not as extensive as S111. Frass packed galleries not as broad as S111.

S1 - Slight attack. Attack confined to a small amount of larval channelling, sometimes only 10 mm in length along the vessel.

Figure 1 indicates the difference between the three susceptibility ratings. A non-susceptible rating (NS) was given when a test specimen revealed no larval channelling.

(v) Starch Assessment: After examination for larval channelling, each test specimen was assessed for starch content in the sapwood using a semi-quantitative iodine test (see Appendix 1). The concentration of starch present in the sapwood was recorded using a visual grading system of LOW (L), MEDIUM (M), HIGH (H) or NOT DETECTED (-).

Results and Discussion

Table 1 gives details on the susceptibility rating assigned to each sapwood test specimen bioassayed with *L. brunneus*. Also listed in Table 1 are the results of the semi-quantitative starch assessments performed on each test specimen after splitting.

The qualitative results given in Table 1 show that all five regrowth karri

trees were susceptible to attack by *L. brunneus*. As the susceptibility rating system adopted is based on a qualitative assessment, no statistical analyses of the results have been undertaken. However, a number of conclusions can be drawn from the results:

(i) In general, the butt position of the trees appeared to be more heavily attacked by *L. brunneus* than either the mid or crown positions; the best example being Tree 1 (AD). Worthy of note is that a rating of S111 (extensive attack) was only recorded for the butt position of Trees 1, 3 and 5 (see Table 1).

(ii) The HTD schedule employed in this study had little or no effect on the subsequent susceptibility of matched regrowth karri specimens to *L. brunneus*.

(iii) One of the regrowth karri trees (Tree 4) had a much thinner sapwood band compared to the other four trees. Despite this, *L. brunneus* was still able to attack the sapwood as test specimens rated either an S1 or S11 for all three positions within the tree.

(iv) In most cases, there was a relationship between starch content of the sapwood and the degree of susceptibility to *L. brunneus*, i.e. the higher the starch content, the greater the degree of attack. For example, comparing data for all five trees (total of 56 test specimens), a high starch content (H) was recorded in the sapwood of 19 test specimens (including both AD and HTD). Each one of these 19 specimens were susceptible (S) to attack; eight being rated as S111, 10 at S11 and only one at S1. At the other end of the scale, starch was not detected in seven test specimens. Of these, six were non-susceptible (NS). Surprisingly, one

specimen (an AD mid specimen from tree 1) was rated as susceptible, having been given a score of S1. The effect of starch concentration on susceptibility rating is summarised in Table 2.

Samples of five regrowth trees, from a younger karri stand (Poole Block, Pemberton District) are currently being bioassayed with *L. brunneus*. A slightly different HTD schedule has been employed to dry the samples in a further attempt to destroy essential nutrients in the sapwood. Similarly, AD samples are being assessed for comparison. Details of the results will be forwarded to CALM in Progress Report No. 2.

Acknowledgements

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This report dated 22 December 1987.

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TABLE 1

Susceptibility of five regrowth karri (*Eucalyptus diversicolor*) trees (matched air dried and high temperature dried test specimens) to attack by *Lyctus brunneus*. Results of the semi-quantitative starch test performed on all specimens are also included

		Air dried		High temperature dried	
Tree No.	Position	Rating	Starch	Rating	Starch
1	Butt 1	S111	H	S111	H
	" 2	S111	H	S111	H
	Mid 1	S1	-	NS	-
	" 2	S1	L	NS	-
	Crown 1	NS	-	NS	L
	" 2	NS	-	S1	M
2	Butt 1	S11	H	S1	M
	" 2	S11	H	S1	L
	Mid 1	S1	L	NS	L
	" 2	NS	L	S1	L
	Crown 1	S1	M	S1	M
	" 2	S1	M	S1	M
3	Butt 1	S111	H	S111	H
	" 2	S111	H	NT	
	Mid 1	S11	H	S1	H
	" 2	NT		NT	
	Crown 1	S11	H	S1	L
	" 2	S11	H	S1	M
4	Butt 1	S1	L	S1	L
	" 2	S1	M	S1	M
	Mid 1	S11	H	S11	M
	" 2	S11	H	S1	M
	Crown 1	S1	M	S1	L
	" 2	S1	M	S1	M
5	Butt 1	S11	H	S11	M
	" 2	S11	H	S111	H
	Mid 1	NS	L	NS	-
	" 2	NS	-	NT	
	Crown 1	S11	H	S1	L
	" 2	S1	M	S1	M

Key: S111 = highly susceptible
S11 = moderately susceptible
S1 = slightly susceptible
NS = non-susceptible
NT = not tested (insufficient material forwarded)
H = high starch content
M = medium starch content
L = low starch content
- = starch not detected.

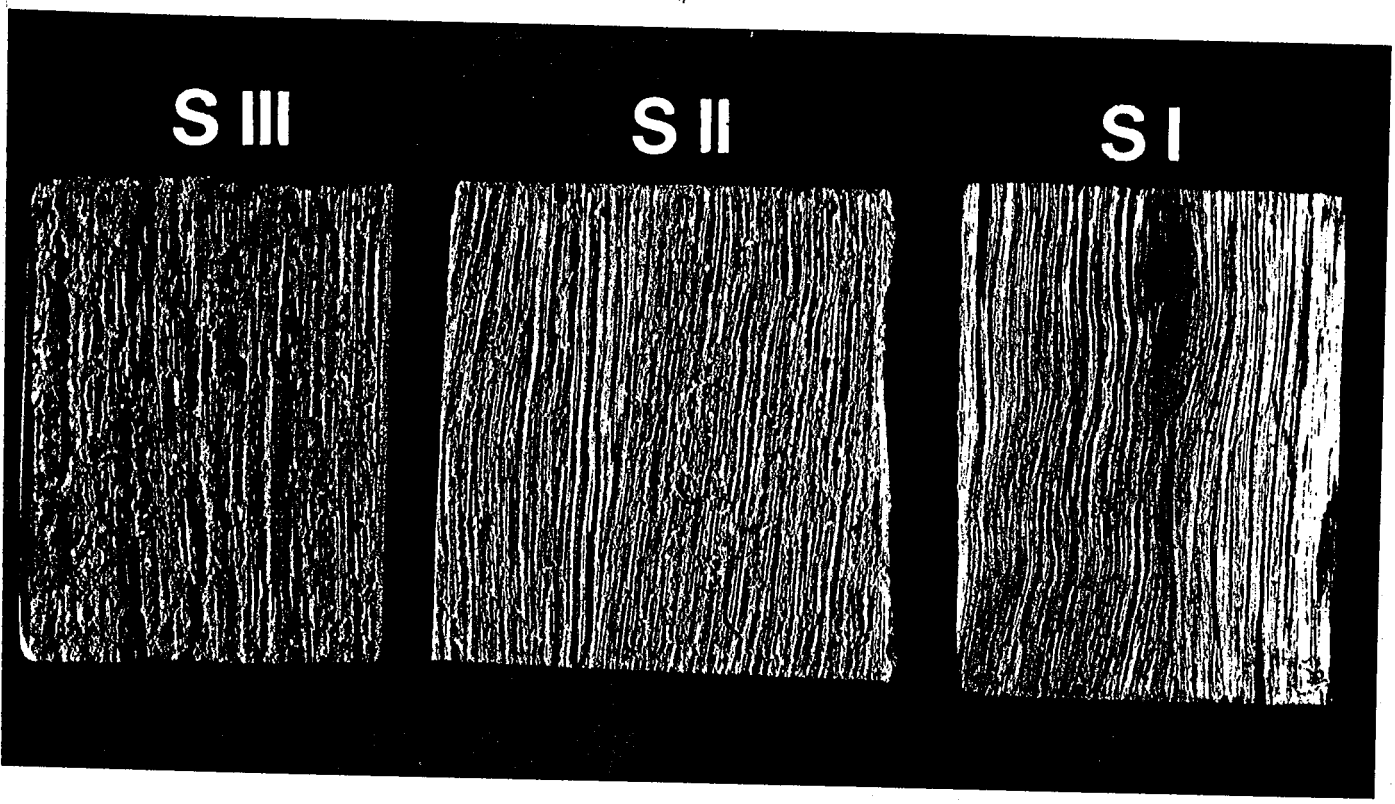

FIGURE 1. Three test specimens attacked by *L. brunneus* showing the rating scale used to depict the intensity of larval channelling present. Left to right S111 (extensive attack), S11 (moderate attack) and S1 (slight attack).

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APPENDIX 1

IODINE TEST FOR STARCH IN WOOD

A. Reagent

Potassium Iodide	14 g
Iodine Crystals	7 g

Dissolve the two chemicals in 20-30 ml of water and then dilute the concentrated solution to 1000 ml with water. When not in use keep reagent in dark place.

B. Preparation of Wood Surface for Test

The ideal specimen is one containing both sapwood and heartwood. The specimen could be green, but for semi-quantitative assessment it should be dry. Since, in the majority of cases, the starch grains are stored mainly in the medullary rays of the sapwood, it is desirable to cut a smooth radial surface for application of the iodine solution. However, the reaction in the presence of starch is detectable on any surface whether it be back, quarter or transversely cut, but the intensity of colour developed is more readily assessed on a true radial surface. A rough sawn surface should be avoided as the increased surface area of exposed fibres gives a false impression of the starch concentration present.

C. Application of the Test Solution

(1) The iodine solution may be applied with a brush or by smearing.

(2) Two or three minutes is usually allowed for colour to develop before the starch content is assessed.

(3) In the presence of starch, blue black particles will develop which are generally visible to the naked eye. However, if only a small quantity of starch is present its detection is more readily and effectively made by means of a hand lens (X10).

(4) In the absence of starch, the wood surface merely takes on the pale yellow colour of the iodine solution.

(5) In this test, the presence of heartwood is recommended as generally it does not contain starch grains, should starch be present in sapwood a clear line of demarkation between the two bands of wood will be obtained.