EXECUTIVE SUMMARY

Objective

The objective of this study was to conduct a laboratory bioassay to determine the resistance of specimens of two Compact Laminate Cladding Products (Athlon/Virtuon Interior and Meteon Exterior) to attack by subterranean termites. For comparison, solid untreated *Eucalyptus regnans* (Mountain ash) heartwood test specimens were used as standard non-durable controls. This solid wood substrate is commonly used for flooring and mouldings in Australian buildings and constructions. *Pinus radiata* plywood (5 ply x 2.5 mm veneer thickness) specimens that had been vacuum pressure treated with copper-chromium-arsenate (CCA) to Hazard Level 3 (H3) (outside, aboveground) requirements were also included in the trial as a comparative control. Prior to bioassay, all specimens were artificially weathered to H3 requirements. Six replicate specimens of each product were exposed to attack by two of Australia's most economically important species of subterranean termites, *Mastotermes darwiniensis* and *Coptotermes acinaciformis.*

Key Results

The major results of the study were:

- Untreated *E. regnans* solid wood specimens were substantially attacked by both *M. darwiniensis* and *C. acinaciformis* (mean grams consumed of 11.2g and 10.3g, respectively) (mean mass losses of 84.9% and 80.2%, respectively).
- Specimens of *P. radiata* plywood treated to the approved H3 retention of CCA suffered little attack by *M. darwiniensis* and *C. acinaciformis* (mean grams consumed of 0.3g and 0.1g, respectively) (mean mass losses of 2.3% and 0.7%, respectively).
- Specimens of Athlon/Virtuon Interior were resistant to attack by both *M. darwiniensis* and *C. acinaciformis* (mean grams consumed of 0.0g and 0.0g, respectively).
- Specimens of Meteon Exterior were also resistant to attack by both *M. darwiniensis* and *C. acinaciformis* (mean grams consumed of 0.0g and 0.1g, respectively).

Application of Results

The results of this study can be used for marketing the two Compact Laminate Cladding Products (Athlon/Virtuon Interior and Meteon Exterior). A high resistance to attack by termites is a significant advantage in the marketing of building materials in Australia where "whole of house" protection from attack by this insect is often preferred.

Further Work

It would be useful to conduct an H3 field trial in order to provide results that support those obtained from this laboratory bioassay. Such a field trial would provide additional data on the resistance of both cladding products to attack by wood-rotting fungi.

Resistance of two untreated laminate cladding products to attack by subterranean termites

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5/12/03

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Information for CSIRO abstracting:

Contract number	FFP 03/183
Products investigated	Athlon/Virtuon Interior, Meteon Exterior
Wood species worked on	*Pinus radiata, Eucalytus regnans*
Other materials used	*Mastotermes darwiniensis, Coptotermes acinaciformis*
Location	The laboratory bioassay was carried out at the Clayton (Melbourne, Victoria) laboratories of CSIRO Forestry and Forest Products

INTRODUCTION

Recently, the Laminex Group has introduced into Australia both an internal compact laminate product and an external compact laminate product. Both products are manufactured from wood fibre (70%) and thermosetting resins (30%). The products are being marketed under the names Athlon/Virtuon Interior and Meteon Exterior. The laminate products have been subjected to a number of performance tests. However, these tests have not yet included resistance testing against Australian species of subterranean termites. Therefore, to assist in its marketing strategy, the Laminex Group has approached CSIRO Forestry and Forest Products (CSIRO) to conduct a laboratory bioassay on the resistance of its untreated laminate products to attack by two species of economically important termites, *Mastotermes darwiniensis* and *Coptotermes acinaciformis.*

RECOMMENDATIONS AND CONCLUSIONS

Results of the laboratory bioassay demonstrated that two Compact Laminate Cladding Products (Athlon/Virtuon Interior and Meteon Exterior) were resistant to attack by the economically important subterranean termites, *Mastotermes darwiniensis* and *Coptotermes acinaciformis*. Untreated *E. regnans* solid wood specimens were substantially attacked by both *M. darwiniensis* and *C. acinaciformis.* Specimens of *P. radiata* plywood treated to the approved H3 retention of CCA suffered little attack.

The bioassay methodology employed satisfied the minimum requirements for evaluating untreated and preservative-treated wood and wood products intended for exposure to H3 conditions[1] (AWPC 1997). Furthermore, the methodology satisfied the requirements for evaluating the termite resistance of materials as described in Section 6 of AS 3660.3-2003[2].

It would be useful to conduct an H3 field trial in order to provide results that support those obtained from this laboratory bioassay. Such a field trial would provide additional data on the resistance of both cladding products to attack by wood-rotting fungi.

[1] AWPC (1997). Protocols for the assessment of wood preservative treatment. Part 1: Sawn and round timber. Standards Australia, Strathfield, NSW.
[2] Australian Standard 3660.3 – 2000. Termite Management Part 3: Assessment criteria for termite management systems. Standards Australia, Strathfield, NSW.

RESULTS AND DISCUSSION

1. Evaluation of resistance of test specimens by termites

A comparison of mean mass losses of the laminate specimens with the mean mass losses for both controls (solid untreated *E. regnans* and CCA-treated *P. radiata* plywood) was used to assess termite resistance. Due to differing densities and volumes of the test specimens under test, the amount of grams (g) consumed by the termites was used as the main assessment criterion.

2. M. darwiniensis bioassay

Raw data on wood consumption (g) and the corresponding percentage (%) mass loss of each test specimen caused by *M. darwiniensis* are given in Appendix A. A summary of these data is given in Table 1. To show the variability among the replicates, standard errors of the means (SE) are also listed. As mentioned above, discussion will focus on grams consumed, rather than percentage mass loss. Percentage mass loss data are given solely to provide an impression of specimen appearance after exposure to attack by termites. A plot of the mean wood consumption (g) data obtained from this bioassay is given in Figure 1.

Table 1.: Mean[a] mass loss (g and %) of test specimens after exposure to *M. darwiniensis* in a laboratory bioassay for six weeks. Standard errors (SE) of the means are given in parentheses.

Product	Mean mass loss (g)	Mean mass loss (%)
Untreated *E. regnans*	11.2 (0.3)	84.9 (2.4)
CCA-treated *P. radiata* ply	0.3 (0.0)	2.3 (0.1)
Athlon/Virtuon Interior	0.0 (0.0)	0.0 (0.0)
Meteon Exterior	0.0 (0.0)	0.1 (0.1)

[a] the means of six replicate test specimens

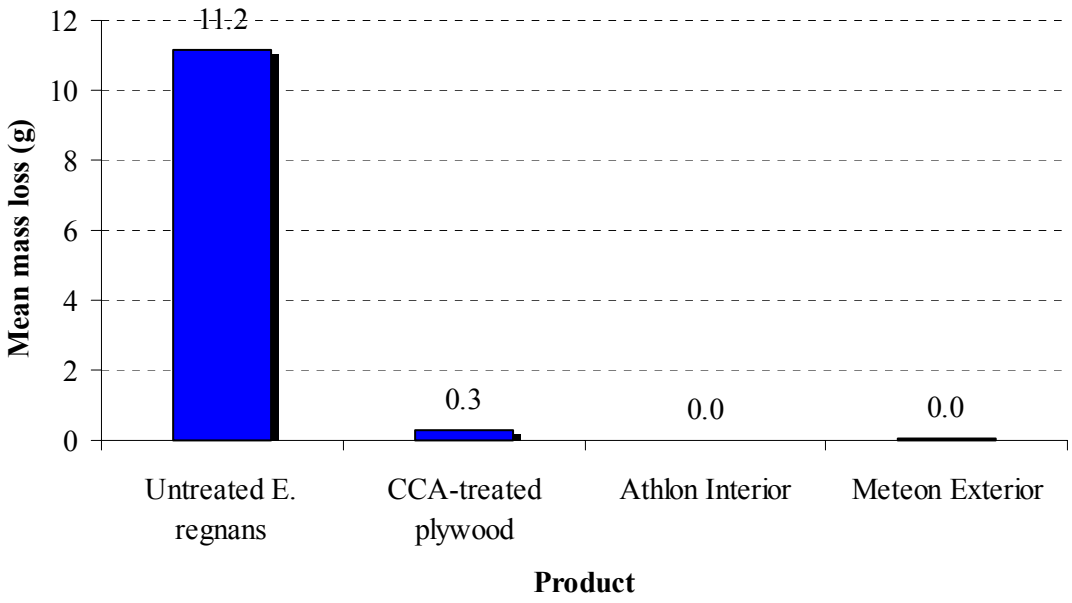

Figure 1: Mean mass loss (g) of test specimens after exposure to *M. darwiniensis* in a laboratory bioassay for six weeks.

The *E. regnans* solid wood specimens were substantially attacked by *M. darwiniensis* (mean g consumed = 11.2g, mean % mass loss of 84.9%). Such high mass losses demonstrate that the termite source was vigorous and that bioassay conditions were most satisfactory. As would be expected, the CCA-treated plywood specimens suffered only slight attack from *M. darwiniensis*, as reflected by the mean mass loss of 0.3g (2.3%).

The Athlon/Vitruon Interior specimens were resistant to attack by *M. darwiniensis* (mean mass loss of 0.0g). Similarly, the Meteon Exterior specimens were also resistant to attack by *M. darwiniensis* (mean mass loss of 0.0g).

The termites in all six replicate jars that contained CCA-treated plywood specimens died prior to the conclusion of the six-week bioassay. No other mortality of *M. darwiniensis* was observed, although the termites from all replicate jars containing the Athlon/Virtuon Interior and Meteon Exterior specimens appeared to be suffering from lack of food at the conclusion of the bioassay. These termites were "mottled" in appearance, and less active than termites from replicate jars containing untreated *E. regnans* specimens.

3. C. acinaciformis bioassay

Raw data on wood consumption (g) and the corresponding percentage (%) mass loss of each test specimen caused by *C. acinaciformis* are given in Appendix B. A summary of these data is given in Table 2. To show the variability among the replicates, standard errors of the means (SE) are also listed. Again, discussion will focus on grams consumed, rather than percentage mass loss. Percentage mass loss data are given solely to provide an impression of specimen appearance after exposure to attack by termites. A plot of the mean wood consumption (g) data obtained from this bioassay is given in Figure 2.

Table 2.: Mean[a] mass loss (g and %) of test specimens after exposure to *C. acinaciformis* in a laboratory bioassay for eight weeks. Standard errors (SE) of the means are given in parentheses.

Product	Mean mass loss (g)	Mean mass loss (%)
Untreated *E. regnans*	10.3 (0.7)	80.2 (5.3)
CCA-treated *P. radiata* ply	0.1 (0.0)	0.7 (0.1)
Athlon/Virtuon Interior	0.0 (0.0)	0.0 (0.0)
Meteon Exterior	0.1 (0.1)	0.2 (0.2)

[a] the means of six replicate test specimens

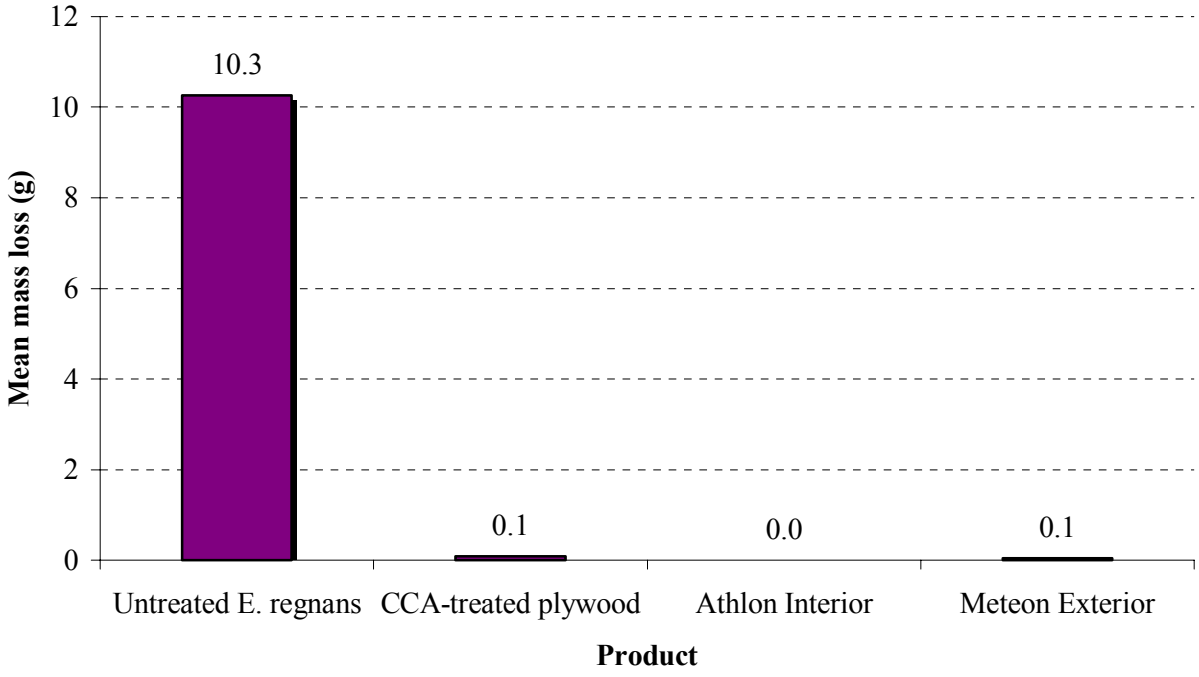

Figure 2: Mean mass loss (g) of test specimens after exposure to *C. acinaciformis* in a laboratory bioassay for eight weeks.

The *E. regnans* solid wood specimens were substantially attacked by *C. acinaciformis* (mean g consumed = 10.3g, mean % mass loss of 80.2%). Such high mass losses demonstrate again that the termite source was vigorous and that bioassay conditions were most satisfactory. As would

be expected, the CCA-treated plywood specimens suffered only negligible attack from *C. acinaciformis*, as reflected by the mean mass loss of 0.1g (0.7%).

The Athlon/Vitruon Interior specimens were resistant to attack by *C. acinaciformis* (mean mass loss of 0.0g) Similarly, the Meteon Exterior specimens were resistant to attack by *C. acinaciformis* (mean mass loss of 0.1g).

The termites in three replicate jars that contained CCA-treated plywood substrate died prior to the end of the eight-week bioassay. Those in the remaining three replicate jars containing this treated product were in a state of decline at the conclusion of the bioassay, as evidenced by a marked decrease in termite numbers, with survivors “mottled” in appearance. No other mortality of *C. acinaciformis* was observed.

MATERIALS AND METHODS

1. Products evaluated

Athlon/Virtuon Interior: The Laminex Group supplied six samples (90 x 90 mm) of different colours/finishes and profiles for bioassay against termites. Thicknesses ranged from 12 mm (five samples) to 16 mm (one sample). Three test specimens (90 x 25 mm) were cut from each sample. The samples consisted of 70% softwood fibres (derived from fast growing plantation pine) and 30% thermosetting resin.

Meteon Exterior: The Laminex Group supplied six samples (300 x 210 x 12 mm thick) of different colours/finishes and profiles for bioassay against termites. Three test specimens (90 x 25 mm) were cut from each sample. The samples again consisted of 70% softwood fibres (derived from fast growing plantation pine) and 30% thermosetting resin.

Controls: For comparison, solid untreated *Eucalyptus regnans* F. Muell. (Mountain ash) heartwood test specimens (90 x 25 x 10 mm long) were used as standard non-durable controls. *E. regnans* is commonly used for flooring and mouldings in Australian buildings and constructions. This control was also deemed necessary for monitoring termite vigour throughout the conduct of the laboratory bioassay. *E. regnans* specimens were cut from several seasoned boards that were obtained from Marbut Sawmills, Murrindindi, Victoria, Australia. Eighteen test specimens were prepared.

Pinus radiata D. Don plywood (12 mm-thick), vacuum pressure treated with copper-chromium-arsenate (CCA) to the approved retention for Hazard Level 3 (H3) (outside, aboveground) conditions (0.38% m/m total active elements) was also included in the bioassay as a comparative control. The plywood was 5 ply by 2.5 mm-thick veneer construction. Eighteen test specimens (90 x 25 mm) were prepared.

2. Preparation of test specimens for bioassays

Prior to bioassay against termites, test specimens were artificially weathered to H3 conditions as specified in the Australasian Wood Preservation Committee Protocols for Assessment of Wood Preservatives (AWPC 1997)[1].

In this weathering schedule, specimens were exposed to vacuum whilst immersed in water for 30 minutes, and allowed to stand for a further 30 minutes in vessels of a volume at least three times greater than the volume of the specimens. The water was then replaced with fresh water, and the vessels that carried the specimens were transferred to a shaking water bath. The vessels remained there at 35^{o}C for five days, with daily changes of water. After this leaching cycle was completed, the specimens were removed and allowed to air dry for four days. The specimens were then vacuum oven dried for five days at 40^{o}C and –95 kPa.

The weathering schedule was used to remove from specimens any water soluble compounds and residual solvents and volatiles that may be deleterious to termite health and vigour as well as to provide artificial ageing. After removal from the vacuum ovens, specimens were cooled in a desiccator before being weighed to obtain initial masses.

3. Termite bioassay

The test specimens were subjected to bioassay in accordance with the minimum requirements specified for H3 conditions using two species of subterranean termite, *Mastotermes darwiniensis* Froggatt and *Coptotermes acinaciformis* (Froggatt). *M. darwiniensis* is a tropical species, the southern limit of its distribution approximates to the Tropic of Capricorn, in both

coastal and inland localities. In this zone it is by far the most destructive termite[3]. *C. acinaciformis* is widely distributed throughout mainland Australia and is responsible for greater economic loss than all the other Australian species of termites combined (Gay and Calaby 1970)[3].

Only fresh, field-collected stocks of termites were used for the bioassay. These termites were collected from the Northern Territory, transported by air to the CSIRO Clayton laboratory and used promptly.

Six replicate test specimens of each laminate product (as well as the solid *E. regnans* and *P. radiata* plywood controls) were exposed to each species of termite. A further six specimens of each product and control were designated as vacuum oven controls i.e. three specimens assigned to each species of termite.

The *M. darwiniensis* bioassay utilized 700 ml glass jars (80 mm diameter, 140 mm deep) in which a mixture of 18g of vermiculite (5-10 mm particle size range) and 6g of *Eucalyptus regnans* F. Muell sawdust was placed. A single test specimen was then embedded upright in the vermiculite/sawdust matrix close to the inside wall of each jar. Water was then added to the matrix to achieve 275% moisture content (m.c.). Fifteen grams of *M. darwiniensis* were added to each jar, and a metal lid, with a central 9 mm diameter ventilator, closed the jar. The duration of the bioassay was six weeks.

For the *C. acinaciformis* bioassay, a single test specimen was embedded upright in a moist matrix of *Coptotermes lacteus* (Froggatt) mound material (150g, 80% m.c.) within a 1.2 L glass jar (115 mm square, 125 mm deep). Ten grams of *C. acinaciformis* were added to each jar. A Bakelite® lid, with a central 9 mm diameter ventilator, closed the jar. The duration of the bioassay was eight weeks.

4. Bioassay conditions

The *M. darwiniensis* bioassay was conducted in an insectary maintained at 32°C, 75 % relative humidity (RH). The *C. acinaciformis* bioassay was conducted in an insectary maintained at 27°C, 70% RH.

5. Assessment of mass loss of test specimens

At the conclusion of the bioassay, test specimens were removed from the jars and cleaned. Test specimens, as well as vacuum oven controls, were then vacuum oven dried under the same conditions as were used to obtain the initial masses (i.e. 5 days at 40 ºC and –95 kPa). After cooling and weighing the specimens, the final and initial masses were compared to obtain mass loss. If necessary, mass losses of test specimens exposed to termites were adjusted to accommodate any changes recorded in the vacuum oven controls.

6. Visual examination of test specimens

Test specimens were also visually examined to determine whether any attack by termites was general or localised.

7. Observation of termite mortality

Throughout the bioassay, any visible signs of termite mortality were recorded.

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[3] Gay, F.J. and Calaby, J.H. (1970). *Termites of the Australian region. In* Krishna, K. and Weesner, F.M. (*Eds*). Biology of Termites, Vol II. New York and London, Academic Press, pp. 393-448.

APPENDIX A: Raw data on wood consumption (g and %) of specimens after exposure to *M. darwiniensis* in a laboratory bioassay for six weeks

Product	Replicate No.	Mass loss (g)	Mean mass loss [a] (g)	Mass loss (%)	Mean mass loss [a] (%)
Untreated *E. regnans*	1	10.6	11.2 (0.3)	78.0	84.9 (2.4)
	2	10.2		76.7	
	3	12.1		90.7	
	4	11.6		86.9	
	5	11.4		88.1	
	6	11.0		88.7	
CCA-treated *P. radiata* plywood	1	0.3	0.3 (0.0)	2.1	2.3 (0.1)
	2	0.3		2.4	
	3	0.3		2.5	
	4	0.3		2.5	
	5	0.3		2.3	
	6	0.2		2.0	
Athlon/Virtuon Interior	1	0.0	0.0 (0.0)	0.0	0.0 (0.0)
	2	0.0		0.0	
	3	0.0		0.0	
	4	0.0		0.0	
	5	0.0		0.0	
	6	0.0		0.0	
Meteon Exterior	1	0.3	0.0 (0.0)	0.8	0.1 (0.1)
	2	0.0		0.0	
	3	0.0		0.0	
	4	0.0		0.0	
	5	0.0		0.0	
	6	0.0		0.0	

[a] Standard errors of the means are given in parentheses.

APPENDIX B: Raw data on wood consumption (g and %) of specimens after exposure to *C. acinaciformis* in a laboratory bioassay for eight weeks

Product	Replicate No.	Mass loss (g)	Mean mass loss [a] (g)	Mass loss (%)	Mean mass loss [a] (%)
Untreated *E. regnans*	1	12.1	10.3 (0.7)	93.4	80.2 (5.3)
	2	12.1		97.3	
	3	9.8		75.9	
	4	9.0		69.4	
	5	10.4		81.0	
	6	8.2		64.4	
CCA-treated *P. radiata* plywood	1	0.1	0.1 (0.0)	0.5	0.7 (0.1)
	2	0.1		0.8	
	3	0.1		1.0	
	4	0.1		0.9	
	5	0.1		0.5	
	6	0.1		0.6	
Athlon/Virtuon Interior	1	0.0	0.0 (0.0)	0.0	0.0 (0.0)
	2	0.0		0.0	
	3	0.0		0.0	
	4	0.0		0.0	
	5	0.0		0.0	
	6	0.0		0.0	
Meteon Exterior	1	0.3	0.1 (0.1)	1.0	0.2 (0.2)
	2	0.0		0.0	
	3	0.0		0.0	
	4	0.0		0.0	
	5	0.0		0.0	
	6	0.0		0.0	

[a] Standard errors of the means are given in parentheses.