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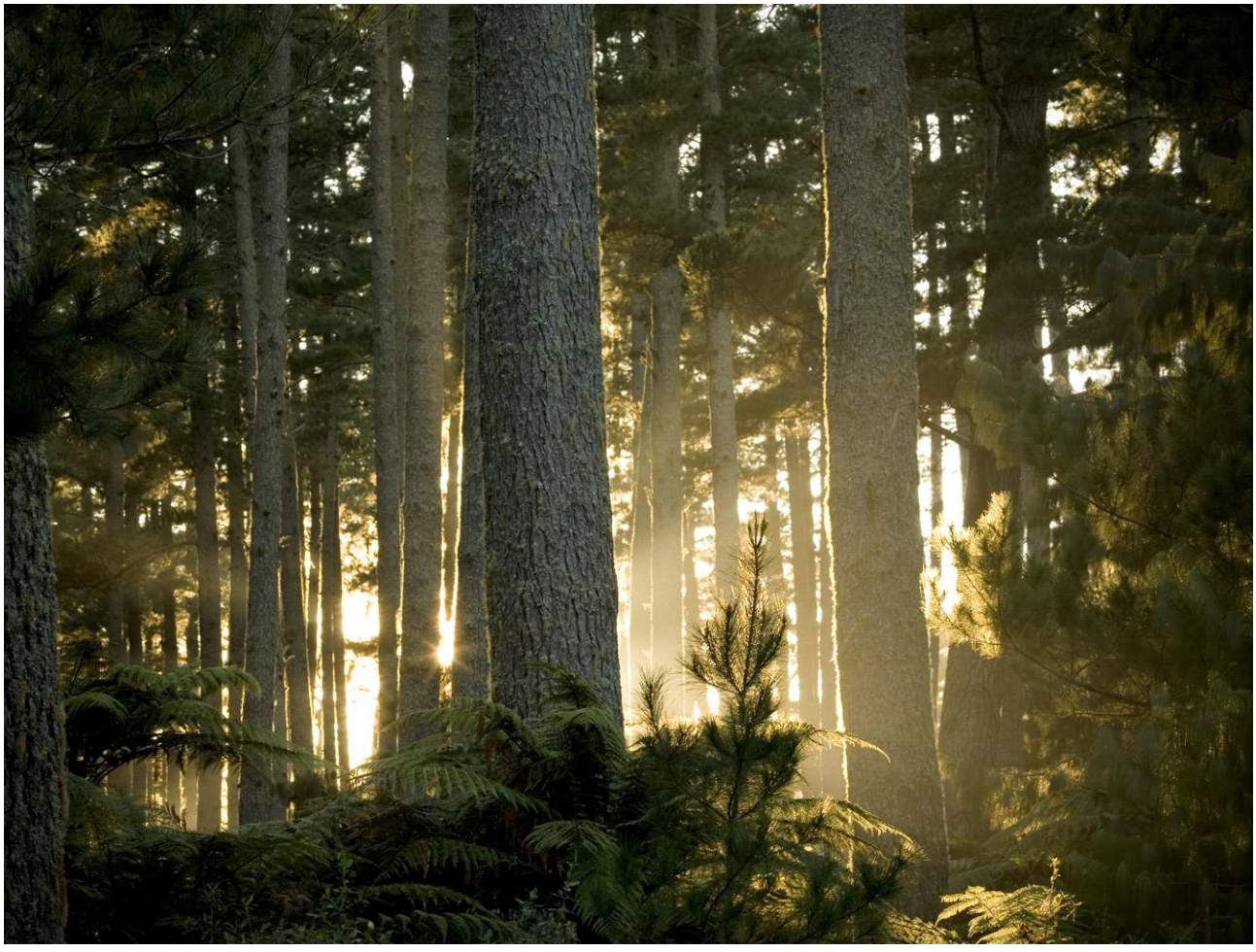
The decay resistance of some wood species used as framing

Progress report on the condition of samples

Ian Simpson and Tripti Singh



Report information sheet

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Executive summary

Sets of framing samples were exposed in high humidity conditions of 85-90% relative humidity and 25 – 27°C. The species included in this test were:

- Untreated *Cupressus luscitanica*.
- Untreated Douglas fir.
- Untreated *Eucalyptus nitens* (installation was delayed by approximately six months).
- Untreated *Eucalyptus regnans*.
- H1.2 treated radiata pine.
- Untreated radiata pine.

All the samples were periodically sprayed with water at approximately two weekly intervals to maintain the wood moisture content at a level suitable for decay to progress. Before exposure in the high humidity condition, samples were also soaked in water for two hours.

The method of testing followed the procedure described in Australasian protocols in this case for the Hazard class H1.2. This test method simulates the common framing joint in house framing between studs and plates, where in a leaky building, moisture may become trapped and provide suitable conditions for fungi to establish.

After twelve month's exposure (in high humidity condition and including regular spraying with water on the test samples);

- Mycelium had developed on many of the samples of *Cupressus luscitanica*, Douglas fir**,** and *Eucalyptus regnans.*
- Decay had developed in many of the samples of *Cupressus luscitanica*, Douglas fir**,** and *Eucalyptus regnans.*
- None of the boron treated Radiata pine had decay, however one of the samples was showing the early signs of suspected soft rot. Severe mould had grown on many of the boron treated Radiata pine samples.

After six month's exposure (in high humidity condition and including regular spraying with water on the test samples);

- Decay had developed in many of the *Eucalyptus nitens* samples.
- Decay had developed in all of the untreated radiata pine sapwood samples.

After assessment, the samples were restacked and exposure to the high humidity conditions was continued. The samples will be assessed after two years exposure and recommendation for the suitability of the product for framing will be made at this time.

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Introduction

This trial was established to determine the decay resistance of four New Zealand grown species using an accelerated decay test developed by Scion (Hedley et al, 2009; Singh et al 2014) and described in the Australasian protocols for assessment of wood preservatives (Australasian Wood Preservation Committee; 2015). The species included in the test were *Cupressus luscitanica*, Douglas fir, *Eucalyptus nitens, Eucalyptus regnans*, and Boron treated radiata pine and untreated radiata pine were included as controls. This test method simulates the common framing joint in house framing between studs and nogs, where in a leaky building, moisture may become trapped and provide suitable conditions for fungi to establish.

Materials and methods

Preparation of samples

Timber species included in the trial and the source of the timber is listed in Table 1. Timber was selected to be either heartwood, sapwood or mixed heartwood\sapwood, by visual assessment. The wood colour and the presence of wane or pith was used to identify the type of wood. Preservative retention and penetration was not analysed for the H1.2 treated radiate pine.

Table 1: Summary of the groups of samples and types of wood (10 samples in each group)

Timber species	Source of timber	Size (mm)	Type of wood
Cupressus luscitanica	South Auckland sawmill, logs were between 25 and 34 years old from Tairua forest	95 x 50	Heartwood
			Heartwood\sapwood
Douglas fir	Stock held by Scion	90 x 40	Heartwood
			Heartwood\sapwood
Eucalyptus nitens	18 year old trees from a Southland forest	100 x 25	Heartwood
			Heartwood\sapwood
Eucalyptus regnans	30 year old trees from the King Country	105 x 50	Heartwood
			Heartwood\sapwood
H1.2 treated radiata pine	Rotorua retailer	90 x 45	Heartwood\sapwood
Untreated radiata pine	Retailer	90 x 45	Sapwood

Ten 900 mm long samples were cut for each group. A 100 mm long block was cut from both ends of the samples and both ends of the 100 mm blocks were end coated. The 100 mm blocks were then stapled across the ends of the 700 mm sample to form an “I” shape (Figure 1). The “I” shaped samples were soaked in a tank of water for two hours to raise the moisture content and to simulate rain wetting that may occur during building construction. Moisture meter measurements taken on the timber after water soaking were around 30% moisture content.

Feeder blocks were inoculated with *Antrodia xantha* and *Oligoporus placenta* fungus and grown in the laboratory until the fungi were established. The strain of these two fungi were isolates from the leaky buildings (Stahlhut 2008). The feeder blocks were nailed to each “I” sample, with *A. xantha* fungus attached approximately 5-10 mm from one end of the sample and *O. placenta* fungus attached approximately 5-10 mm from the other end of the sample (Figure 1).

The “I” frame samples were stacked in the Accelerated Decay House (a controlled environment room maintained at 25-27°C with more than 85% relative humidity). All the samples were periodically sprayed with water at approximately two weekly intervals to maintain the wood moisture content at a level suitable for decay to progress. The intention is to keep the moisture content of the timber above 30% to ensure fungal growth, as would be the case with a weather

tightness failure or leaks from water pipes. Installation of the "I" shaped samples for *Eucalyptus nitens* was delayed by approximately six months due to delays in receiving samples.

Assessment methods

All samples were assessed for mould, mycelium and decay using the ASTM D 1758 based rating systems. Decay assessment was conducted both on the surface and at the end joints. The assessment was conducted after twelve months exposure for *Cupressus luscitanica*, Douglas fir, *Eucalyptus regnans* and H1.2 treated radiata pine. The *Eucalyptus nitens* and untreated radiata pine was assessed after six months exposure due to delays in receiving samples.

Mould and surface mycelium is common in a damp environment. Mould and mycelium can be hazardous to health. Presence of mould and surface mycelium can provide an optimal environment for the initiation of decay. However, the presence of surface mycelium or mould does not always indicate that decay is present or likely to occur.

The rating systems (ASTM D 1758) for the deterioration were as follows:

Description of assessment rating's

Mycelium spread

- **1** No mycelium development onto the sample surface from the feeder block
- **2** Mycelium growth from the feeder block onto the surface, spread less than 5 mm.
- **3** Mycelium from the feeder block on the surface, spread 5-50 mm.
- **4** Active mycelium from the feeder block on the surface, spread greater than 50 mm.
- **5** Extensive mycelium over the sample surface, less than 50% of the surface area.
- **6** Extensive mycelium over the sample surface, more than 50% of the surface area.

Decay ratings

- **10** No decay or insect damage.
- **T** Trace, discolouration, mycelium or softening, not positively identified as decay.
- **9** First stages of decay, small areas, not more than 1 mm deep.
- **8** Lightly established decay, patches 1-5 mm deep.
- **7** Well established decay, extensive surface decay or patches to 20 mm deep.
- **6** Established and progressive decay over wide areas with patches greater than 20 mm deep.
- **4** Severe decay over the majority of the surface with patches more than 40 mm deep.
- **0** Failed. Decay completely through the sample.

Mould ratings

- **1** No perceivable mould.
- **2** Light mould in small patches or widely scattered spots.
- **3** Extensive mould as numerous scattered spots or widespread light mould.
- **4** Severe mould, up to 50% of the surface covered.
- **5** Severe mould, more than 50% of the surface covered.

At assessment time, the stacks were dismantled, samples were removed, weighed and visually assessed for spread of mould, and spread of mycelium from the feeder blocks. The surfaces of each sample were tested with a blunt probe to determine whether decay fungi were damaging the framing. Staples were removed from one side of the sample so that end joints could be opened and the internal joint area could also be assessed for decay.

Results

Assessment results after twelve month's exposure are summarised in Table 2. Full assessment results for individual samples are in Appendix 1.

Table 2: Summary of assessment results after twelve month's exposure (Average of 10 samples)

Timber species	Type of wood	Mycelium (Lower rating is better)		Decay - Surface (Higher rating is better)		Decay - Joint (Higher rating is better)		Mould (Lower rating is better)	
		Op[1]	Ax[1]	Op	Ax	Op	Ax	Op	Ax
Cupressus luscitanica	Heartwood	5.2	4.6	8.1	9.0	7.5	7.5	1.9	1.7
	Heartwood\ sapwood	6.0	5.9	6.6	7.6	5.0	5.0	2.8	1.9
Douglas fir	Heartwood	4.9	5.4	6.4	4.7	5.1	5.1	1.6	1.9
	Heartwood\ sapwood	5.4	5.9	5.7	4.4	4.8	4.8	1.6	1.4
Eucalyptus regnans	Heartwood	5.1	5.3	8.4	6.3	6.9	6.9	1.6	1.0
	Heartwood\ sapwood	3.7	3.5	8.7	7.3	8.3	8.3	1.5	1.6
H1.2 treated radiata pine	Heartwood\ sapwood	1.1	1.0	10.0	10.0	10.0	10.0	4.7	4.2

[1] *Op and Ax represent different ends of the "I frame" samples with feeder blocks inoculated with Oligoporous placenta and Antrodia xantha.*

Assessment results for *Eucalyptus nitens* and untreated radiata pine after six month's exposure are summarised in Table 3. Full assessment results for individual samples are in Appendix 1.

Table 3: Summary of assessment results after six month's exposure (Average of 10 samples)

Timber species	Type of wood	Mycelium (Lower rating is better)		Decay - Surface (Higher rating is better)		Decay - Joint (Higher rating is better)		Mould (Lower rating is better)	
		Op[1]	Ax[1]	Op	Ax	Op	Ax	Op	Ax
Eucalyptus nitens	Heartwood	4.9	4.4	7.3	7.1	7.4	7.4	1.0	1.0
	Heartwood\ sapwood	5.4	4.2	6.1	7.2	5.3	5.3	1.1	1.0
Untreated radiata pine	Sapwood	5.6	6.0	6.3	5.0	6.6	6.3	4.3	1.3

[1] *Op and Ax represent different ends of the "I frame" samples with feeder blocks inoculated with Oligoporous placenta and Antrodia xantha.*

Cupressus luscitanica after twelve months exposure

After twelve months exposure, extensive mycelium was observed on the surface of many of the *Cupressus luscitanica* samples (Figure 2). The presence of mycelium does not necessarily indicate the presence of wood decay. Decay was observed in most samples, either on the surface or in the joint. There were higher levels of decay in the samples with mixed heartwood\sapwood (Figures 3) than the heartwood samples (Figures 4). Low levels of mould were observed on *C. luscitanica* samples.

Douglas fir after twelve months exposure

After twelve months exposure extensive mycelium was observed on the surface of many of the Douglas fir samples (Figure 5). Decay was observed in all of the Douglas fir samples with some samples having severe decay (Figure 6). On average, slightly higher levels of decay were observed in the samples that had mixed heartwood\sapwood compared to heartwood only samples

(Table 2). Low levels of mould were observed on both heartwood and mixed heartwood/sapwood samples.

***Eucalyptus regnans* after twelve months exposure**

After twelve months exposure extensive mycelium was observed on the surface of many of the *Eucalyptus regnans* samples (Figure 7). Decay was observed in most samples either on the surface or in the joint (Figure 8). Low levels of mould were observed on *E. regnans* samples.

H1.2 treated radiata pine after twelve months exposure

After twelve months exposure low levels of mycelium were observed on the H1.2 boron treated radiata pine samples. No cross-sectional damage or decay was observed on boron treated radiata pine. An area of softening, which could not be positively identified as decay but was suspected to be soft rot, was observed on the bottom edge of one of the boron treated radiata pine sample (Figure 9). No decay was observed in the other samples. High levels of mould were observed on all of the samples (Figure 10).

***Eucalyptus nitens* after six months exposure**

After six months exposure, mycelium had extended from the feeder blocks onto the surface of many of the *Eucalyptus nitens* samples (Figure 11). Decay was present on the surface and in the joint of many samples, with slightly higher levels of decay in the samples with mixed heart\sapwood (Figure 12). Low levels of mould were observed.

Untreated radiata pine after six months exposure

After six months exposure, extensive mycelium was observed on the surface of the sapwood of untreated radiata pine samples. Established decay was observed on the surface and in the joint of all samples (Figure 13). Extensive mould was observed on all samples.

Conclusions

After twelve month's exposure;

- Decay had developed in many of the samples of *Cupressus luscitanica*, Douglas fir**,** and *Eucalyptus regnans.*
- For the all three tested species, decay rate is higher at the joints compared to decay rating at the surface of the samples.
- Boron treated Radiata pine samples are generally free from decay except one sample which is showing suspected soft rot.

After six month's exposure;

- Decay had developed in many of the samples of the *Eucalyptus nitens* samples.
- Established decay was observed on all of the sapwood of untreated radiata pine samples.

References

Australasian Wood Preservation Committee; 2015. Protocols for assessment of wood preservatives.

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Singh, T., Page, D., and van der Waals, J.; 2014. The development of accelerated test methods to evaluate the durability of framing timber. International Biodeterioration & Biodegradation 94 (2014) 63-68.

Stahlhut, D.; 2008. Decay Fungi from New Zealand Leaky Buildings: Isolation, Identification and Preservative Resistance. PhD Thesis. The University of Waikato, New Zealand.

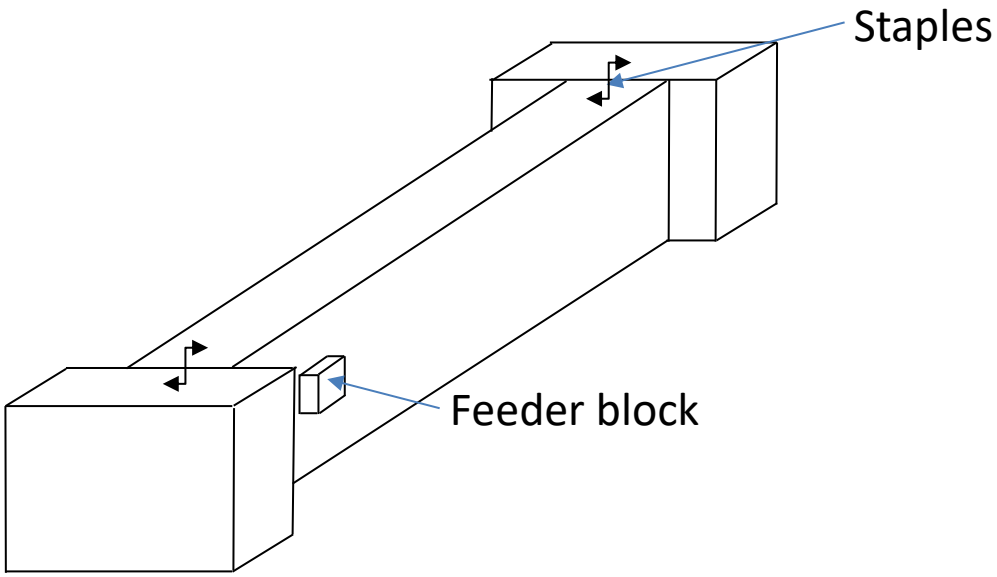

Figure 1: Diagram showing I-frame

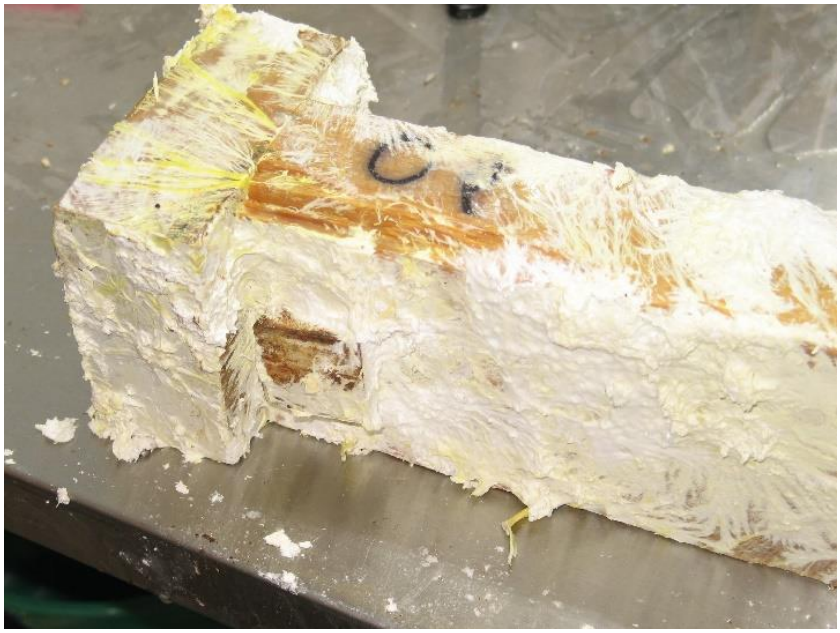

Figure 2: Mycelium growth on the surface of a *Cupressus luscitanica* sample after twelve months exposure (sample 206).

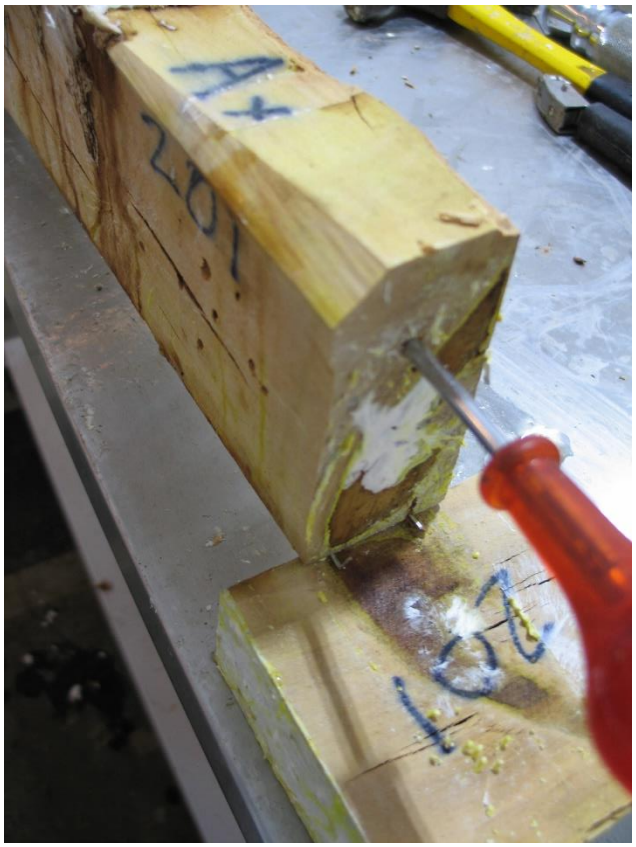

Figure 3: Decay on the surface and in the joint of a mixed heartwood\sapwood *Cupressus luscitanica* sample after twelve months exposure (sample 201).

Figure 4: Decay in the joint of a heartwood *Cupressus luscitanica* sample after twelve months exposure (sample 235).

Figure 5: Mycelium growth on the surface of a Douglas fir sample after twelve months exposure (sample 502).

Figure 6: Decay in the joint of a Douglas fir sample after twelve months exposure (sample 503).

Figure 7: Mycelium growth on the surface of a *Eucalyptus regnans* sample after twelve months exposure (sample 409).

Figure 8: Decay in the joint of a *Eucalyptus regnans* sample after twelve months exposure (sample 408).

Figure 9: Suspected soft rot on the bottom edge of a boron treated radiata pine sample after twelve months exposure (sample 604).

Figure 10: Mould growth on the surface of a boron treated radiata pine sample after twelve months exposure (sample 601).

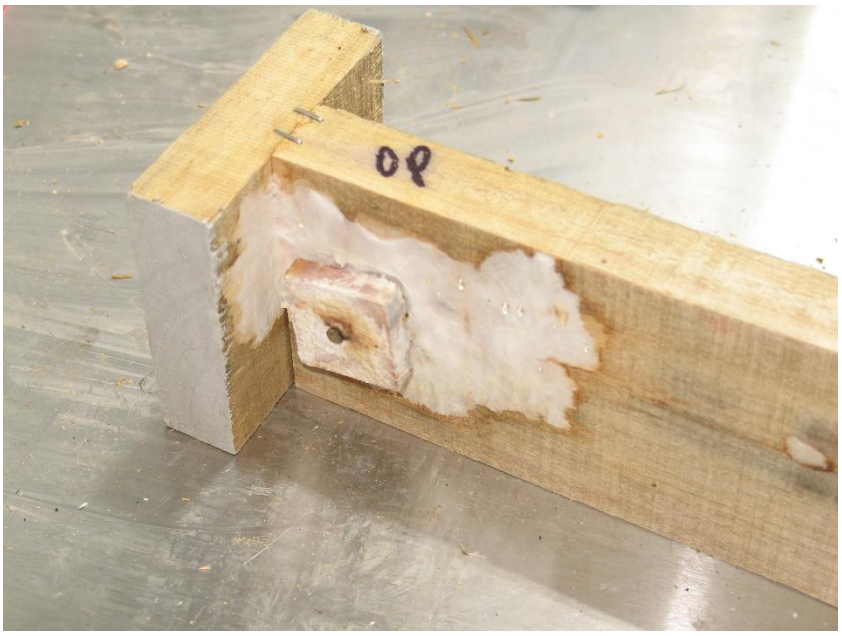

Figure 11: Mycelium growth around the feeder block of a *Eucalyptus nitens* sample after six months exposure (sample 801).

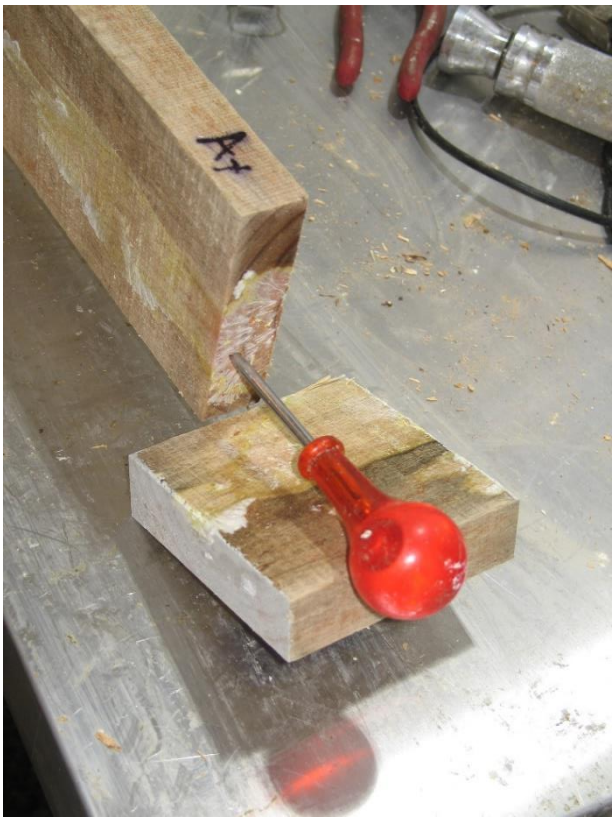

Figure 12: Decay in the joint of a *Eucalyptus nitens* sample after six months exposure (sample 802).

Figure 13: Decay in the joint of an untreated radiata pine sample after six months exposure (sample U10).

Appendix 1

Table 4: Individual sample rating after six and twelve month's exposure in accelerated conditions

Sample ID	Op[1] Mould	Op Mycelium	Op Decay Surface	Op Decay Joint	Ax[1] Mould	Ax Mycelium	Ax Decay Surface	Ax Decay Joint
Cupressus luscitanica, Heartwood – after twelve months exposure								
231	1	6	4	4	1	6	8	10
232	3	1	10	6	3	4	10	10
233	1	4	8	8	1	6	10	10
234	1	6	9	10	1	6	10	10
235	1	6	8	6	1	6	8	4
236	1	6	10	10	1	6	8	8
237	5	6	10	10	5	4	10	10
238	4	5	7	7	1	1	6	6
239	1	6	8	10	1	6	10	10
240	1	6	7	4	2	1	10	10
Cupressus luscitanica, Heartwood\sapwood – after twelve months exposure								
201	4	6	6	4	1	6	7	4
202	3	6	6	4	2	6	10	8
203	3	6	7	4	1	6	10	7
204	2	6	7	6	2	6	10	4
205	3	6	4	4	1	6	9	8
206	1	6	10	10	1	6	4	4
207	3	6	8	6	3	5	4	6
208	3	6	6	4	3	6	8	10
209	3	6	6	4	2	6	4	4
210	3	6	6	4	3	6	10	4

[1] Op and Ax represent different ends of the "I frame" samples with feeder blocks inoculated with *Oligoporous placenta* and *Antrodia xantha*.

Sample ID	Op[1] Mould	Op Mycelium	Op Decay Surface	Op Decay Joint	Ax[1] Mould	Ax Mycelium	Ax Decay Surface	Ax Decay Joint
Douglas fir, Heartwood – after twelve months exposure								
501	1	1	8	6	1	6	7	4
502	1	6	6	4	4	6	4	4
503	2	6	7	4	1	6	4	4
504	2	5	7	4	3	5	4	4
505	1	6	6	4	1	6	6	6
506	3	6	4	6	3	5	4	4
507	3	2	7	6	1	6	4	4
508	1	6	8	6	1	5	4	4
509	1	6	7	7	3	3	6	4
510	1	5	4	4	1	6	4	4
Douglas fir, Heartwood\sapwood – after twelve months exposure								
511	1	6	4	4	1	6	4	4
512	1	6	7	6	1	6	6	6
513	3	6	4	4	1	6	4	4
514	1	6	4	4	3	6	6	6
515	2	6	6	4	1	6	4	4
516	2	3	7	7	1	6	4	4
517	1	6	6	4	1	6	4	4
518	3	3	6	4	3	5	4	4
519	1	6	6	4	1	6	4	4
520	1	6	7	7	1	6	4	4

[1] Op and Ax represent different ends of the “I frame” samples with feeder blocks inoculated with *Oligoporous placenta* and *Antrodia xantha*.

Sample ID	Op[1] Mould	Op Mycelium	Op Decay Surface	Op Decay Joint	Ax[1] Mould	Ax Mycelium	Ax Decay Surface	Ax Decay Joint
Eucalyptus regnans, Heartwood – after twelve months exposure								
401	1	2	8	10	1	3	8	7
402	1	6	10	9	1	5	7	6
403	1	4	10	8	1	6	7	7
404	1	6	8	7	1	6	7	6
405	1	6	9	6	1	6	6	6
406	3	5	7	6	1	5	4	4
407	2	5	8	6	1	5	6	4
408	4	6	7	4	1	5	6	4
409	1	6	8	6	1	6	4	4
410	1	5	9	7	1	6	8	6
Eucalyptus regnans, Heartwood\sapwood – after twelve months exposure								
411	1	6	8	8	1	5	7	4
412	1	1	10	8	2	5	6	6
413	3	3	9	9	4	1	7	6
414	1	5	7	8	1	2	8	9
415	1	5	10	9	1	6	8	8
416	1	1	10	10	1	2	10	10
417	1	6	9	9	1	6	7	7
418	1	6	7	6	1	5	4	4
419	2	3	9	6	1	2	8	7
420	3	1	8	10	3	1	8	8

[1] Op and Ax represent different ends of the "I frame" samples with feeder blocks inoculated with *Oligoporous placenta* and *Antrodia xantha*.

Sample ID	Op[1] Mould	Op Mycelium	Op Decay Surface	Op Decay Joint	Ax[1] Mould	Ax Mycelium	Ax Decay Surface	Ax Decay Joint
H1.2 treated radiata pine, Heartwood\sapwood – after twelve months exposure								
601	4	1	10	10	3	1	10	10
602	5	1	10	10	5	1	10	10
603	5	1	10	10	4	1	10	10
604	5	2	10	10	5	1	10	T
605	5	1	10	10	5	1	10	10
606	5	1	10	10	5	1	10	10
607	5	1	10	10	5	1	10	10
608	5	1	10	10	1	1	10	10
609	4	1	10	10	5	1	10	10
610	4	1	10	10	4	1	10	10

[1] Op and Ax represent different ends of the "I frame" samples with feeder blocks inoculated with *Oligoporous placenta* and *Antrodia xantha*.

Sample ID	Op[1] Mould	Op Mycelium	Op Decay Surface	Op Decay Joint	Ax[1] Mould	Ax Mycelium	Ax Decay Surface	Ax Decay Joint
Untreated radiata pine – after six months exposure								
U1	3	6	4	4	1	6	4	4
U2	3	6	7	7	3	6	4	8
U3	4	6	4	7	1	6	7	7
U4	4	6	6	6	2	6	4	7
U5	5	5	7	8	1	6	7	8
U6	5	6	7	7	1	6	4	4
U7	4	6	7	7	1	6	4	7
U8	5	4	6	6	1	6	6	6
U9	6	5	8	7	1	6	6	6
U10	4	6	7	7	1	6	4	6

[1] Op and Ax represent different ends of the "I frame" samples with feeder blocks inoculated with *Oligoporous placenta* and *Antrodia xantha*.

Sample ID	Op[1] Mould	Op Mycelium	Op Decay Surface	Op Decay Joint	Ax[1] Mould	Ax Mycelium	Ax Decay Surface	Ax Decay Joint
Eucalyptus nitens, Heartwood – after six months exposure								
801	1	4	7	8	1	4	8	8
802	1	3	8	7	1	6	7	4
803	1	4	7	6	1	3	7	6
804	1	3	6	7	1	5	7	6
805	1	3	7	6	1	4	7	6
806	1	3	7	8	1	4	6	6
807	1	4	8	6	1	3	8	4
808	1	5	8	9	1	6	8	8
809	1	5	7	10	1	5	7	8
810	1	3	8	7	1	4	6	7
Eucalyptus nitens, Heartwood\sapwood – after six months exposure								
811	1	6	7	4	1	3	8	7
812	1	4	6	6	1	4	7	7
813	1	5	6	4	1	1	6	4
814	2	6	4	4	1	4	8	6
815	1	4	7	4	1	5	6	6
816	1	5	4	6	1	3	6	4
817	1	5	7	6	1	5	8	8
818	1	5	6	6	1	6	8	7
819	1	5	8	6	1	6	8	4
820	1	5	6	7	1	5	7	6

[1] Op and Ax represent different ends of the “I frame” samples with feeder blocks inoculated with *Oligoporous placenta* and *Antrodia xantha*.