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An in-ground natural durability field test of Australian timbers and exotic reference species

VI. Results after approximately 21 years' exposure[1]

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1. Introduction

Three papers in this series have reported results from a field test of the atural durability of 77 timber species exposed in the ground at five Austra-an sites. These papers presented data on the condition of specimens after xposure for 10 years (J. D. THORNTON et al., 1983 a), 13 years (J. D. HORNTON et al., 1983 b) and 15 years (G. C. JOHNSON et al., 1986). This paper rovides data on these species after 21 years' exposure.

Under an Australian classification (STANDARDS ASSOCIATION OF AUSTRALIA, 980), heartwood of Class 1 durability timbers have lives of 25 years or

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more, while heartwood of Class 2 durability timbers have lives of 15 to 25 years. The authors consider that, at this stage, it would be appropriate to delay undertaking a comprehensive discussion of the between-timber performance of the more durable timber species until at least the 25 years' exposure data is collected and evaluated. However, in the present paper the condition of the most durable species will be presented and compared with the condition of the two preservative-treated controls.

2. Materials and methods

2.1 Timber species

In this test Australian hardwoods belonging to the Myrtaceae comprise species of *Eucalyptus*, *Lophostemon* and *Syncarpia*. The non-myrtaceous hardwood category contains species of *Acacia*, *Allocasuarina*, *Litsea* and *Nothofagus*, whereas the exotic hardwoods include species of *Anisoptera*, *Intsia*, *Pterocarpus*, *Quercus* and *Tectona*. Australian softwoods comprise *Agathis*, *Athrotaxis*, *Callitris*, *Lagarostrobos*, *Phyllocladus* and *Prumnopitys*, whereas the exotic softwoods include *Pinus*, *Pseudotsuga*, *Sequoia* and *Thuja*. Species names and their authorities were given in J. D. THORNTON et al. (1983a) and the nomenclature changes since 1983 were presented by G. C. JOHNSON et al. (1986). Changes in nomenclature since the latter report are shown in Table 1.

2.2 Test sites and inspection times

This paper reports data from specimens exposed at the five sites appearing in previous papers. Some problems have occurred at the fifth site (Mulgrave) since the last report (G. C. JOHNSON et al., 1986). After 16 years' exposure, around 25% of the remaining specimens at Mulgrave were vandalised and had to be removed. Furthermore, after the remaining specimens had been exposed for 18 years, the test site was sold and specimens inspected before they were transferred to a new site. Although the new site at Rowville is close to the previous one (2.5 km to the east) it has somewhat different characteristics of both soil type and vegetation cover. Care was taken to ensure that the time period between removal of stakes and their re-installation at the new site was less than one hour in order to keep moisture loss to a minimum.

There are many reasons why the authors have persisted with the study at this site despite the loss of the original test site. No termites were observed attacking specimens over the 18 years of exposure at Mulgrave or two years at Rowville. By comparison, specimens at each of the other test sites have recorded termite attack. Hence, of the Australian sites involved in this study, both Melbourne sites (Mulgrave and Rowville) offer a unique hazard. Also, they provide data for one of Australia's largest population centres. The authors consider that the decay hazards at Mulgrave and Rowville are similar.

Since the last report (G. C. JOHNSON et al., 1986), inspections were carried out at the following times (years since installation) and locations: 17.1, 19.0 and 21.1 years at both Brisbane and Innisfail; 16.0, 17.1, 19.1 and 21.3 years at Pennant Hills and 16.2, 17.3, 18.0, 19.0, 20.0 and 21.0 years at Walpeup. The site at Mulgrave was inspected at 16.0 and 18.2 years, whereas the alternative site at Rowville was inspected after a total exposure period of 21.0 years.

Table 1: Changes in timber nomenclature

Former Name	Current Name
stralian hardwoods (Myrtaceae)	
calyptus globulus Labill. var. *tjohnii* R. T. Bak.	*E. globulus* Labill. ssp. *bicostata* (Maid. *et al.*) Kirkpatr.
naidenii F. Muell.	*E. globulus* Labill. ssp. *maidenii* (F. Muell.) Kirkpatr.
nuellerana Howitt	*E. muelleriana* Howitt
adiata Sieb. ex DC.	*E. radiata* Sieb. ex DC. ssp. *radiata*
ideroxylon A. Cunn. ex Woolls	*E. sideroxylon* A. Cunn. ex Woolls ssp. *sideroxylon*
iminalis Labill.	*E. viminalis* Labill. ssp. *viminalis*
tania conferta R. Br.	*Lophostemon confertus* (R. Br.) Peter G. Wilson & Waterhouse
uaveolens (Sol. ex Gaertn.) m.	*L. suaveolens* (Sol. ex Gaertn.) Peter G. Wilson & Waterhouse
tralian hardwoods other than Myrtaceae	
uarina luehmanni R. T. Bak.	*Allocasuarina luehmannii* (R. T. Bak.) L. Johnson
tic hardwoods	
soptera polyandra Bl.	*A. thyrifera* (Blco.) Bl. ssp. *polyandra* (Bl.) Ashton
tralian softwoods	
this palmerstonii (F. Muell.) Muell. ex F. M. Bail.	*A. robusta* (C. Moore ex F. Muell.) Bailey
rydium franklinii Hook. f.	*Lagarostrobos franklinii* (Hook. f.) Quin

2.3 Inspection procedure and data evaluation

e assessment of the condition of each specimen, in relation to the cross-section(s) rmined to be most severely attacked by decay and/or by termites, was as ribed in Table 2. It should be noted that the relationship between the score and ent loss of cross-section presented in the table are not identical with those given D. THORNTON et al. (1983 a). The latter presented the method of assessment per-d in the working plan. Table 2 shows the range of deterioration of a given stake corresponds to each rating value and uses more precise language than the earlier on. Also, the present version is linear through all but the last stage of attack, eas the earlier version was curvilinear. Table 2 presents the rating system used in spections of this study.

Table 2: System for rating the condition of each stake at each inspection, including the range of percent cross-section loss, due to attack by microorganisms and/or insects, corresponding to each rating.[a]

Rating of stake	Condition of stake
8	No loss of cross-section
7	Any loss of cross-section up to 15% of cross-section
6	From slightly more than 15% up to 30% loss of cross-section
5	From slightly more than 30% up to 45% loss of cross-section
4	From slightly more than 45% up to 60% loss of cross-section
3	From slightly more than 60% up to 75% loss of cross-section
2	From slightly more than 75% up to 90% loss of cross-section
1	From slightly more than 90% and less than 100% loss of cross-section
0	Total loss of cross-section

a) Each stake is rated separately for condition with respect to microbial decay and/or insect attack, at the cross-section that is most destroyed by micro-organisms and also at the cross-section that is most destroyed by insects.

Ratings were recorded as separate values for the wood condition relative to termites and decay and were classified as ranging from 8 (completely sound) to 0 (completely failed) in whole numbers. A rating of 3, when from slightly more than 60% up to 75% of the cross-section was seriously affected, was considered as being equivalent to an unserviceable condition. The computing and handling of these data, for both the mean rating of specimen condition relative to decay and termites for each timber species (together with confidence intervals), were discussed by J. D. Thornton et al. (1983 a).

In the report on the 15-year data (G. C. Johnson et al., 1986) the cause of the unserviceability of a given species was determined by whether the majority of specimens were unserviceable because of decay or termites. In this report we have been more precise in defining the cause. If 75% or more of a given species' replicates reached unserviceability against, for example, decay, then decay was given as the cause (Tab. 3). For percentages greater than 25 but less than 75, the cause was attributed to both decay and termites.

In previous reports of this test, the average specimen life (ASL) value of a timber species was the mean of the specimen life values of the replicates of that species. The specimen life of each replicate was, and is given here as, the time to reach unserviceability against the more severe of the two biodeteriogens. Specimen life was defined to be halfway between an inspection at which the specimen scored 4 to 8 (i.e. serviceable) and the next inspection at which it scored 0 to 3 (i.e. unserviceable). However, in this report the average specimen life value of a species is the median of the specimen life values of the replicates of that species. The median of the specimen life values, hereafter indicated by MEDSL, is the statistic for which 50% of the values, when arranged in order of magnitude, lie on each side. There are two reasons why the sample median is, and will in future be, used instead of the sample mean.

(i) As more data were gathered from additional inspections, we noted that the shapes of the distributions of the sample specimen life values were markedly skewed. In addition, the ranges of the sample specimen life values were wide. In this circumstance, the median is the preferred statistic, as the mean may be greatly affected by extreme values.

The mean cannot be calculated until all the replicates, n, of a particular species reached unserviceability. However, the median can be calculated when the ber of replicates of a particular species which have reached unserviceability is $(n + 1)$ if n is odd, or is $\geq \frac{1}{2}n + 1$ if n is even. C. L. LINK and R. C. DEGROOT (1990) recommend the use of the median rather than the mean in such circumstances.

r all five Australian sites, the difference between the average specimen life for given species calculated using the median and the mean was found to be between d 3.8 years at this stage of the test. It should be noted that the MEDSL values are om identical to ASL values given in earlier papers.

llowing the suggestion of C. L. LINK and R. C. DEGROOT (1990), we have included ible 3 the sample first quartile, Q_1, which serves a dual purpose: the first quartile as a lower bound for the MEDSL in the sense that 25% of the number of repli- have the specimen life values between it and the MEDSL value, and the first tile can be viewed as a conservative statistic of specimen life.

3. Results and discussion

ith this natural durability test having progressed a further six years e the last report detailing the condition of all timber species (G. C. NSON et al., 1986), the stage has been reached where a large number of the ies are contributing average specimen life values. This is due in part to authors having changed from use of mean values to median values (see ion 2.3). The MEDSL data is presented in Table 3, where the median for the replicates to reach an unserviceable condition is presented ther with the first quartile value and the causative biodeteriogen. This rt presents a total of 278 MEDSL values (72%) from a total number of for the 77 species at five sites. Fifteen years after the field trial began, ASL values (34%) could be calculated, whereas six years later 177 (46%) be calculated. The present paper provides MEDSL values, at each of the sites, for a total of 38 different timber species (49%). A MEDSL value is ented for each tested species with the exception of 13 timbers at Bris- e, 10 at Innisfail, 20 at Pennant Hills, 33 at Walpeup and 31 at Mulgrave/ vville.

om Table 3 it is obvious that Walpeup and Mulgrave/Rowville are the t severe of the five sites. Walpeup is the site that we intend to inspect e frequently in future than any other. The first reason is simply that rmation on the longer lasting timbers has yet to be obtained for this par- lar site. The second reason is that the Walpeup test is capable of provid- much valuable information on the distribution of termite species and the ciation of these species with the presence, and the type, of decay (J. D. RNTON et al., 1989).

ne causes of the biodeterioration noted in an earlier report of this study). THORNTON et al., 1986) are confirmed by the data in Table 3. At Bris- e, Pennant Hills and Mulgrave/Rowville, decay has had a more severe

Table 3: Median specimen life (MEDSL) values, first quartile[a)] and cause of unserviceability[b)] determined after 21 years' in-ground exposure of heartwood specimens at five sites.

Species	Brisbane			Innisfail			Pennant Hills			Walpeup			Mulgrave/Rowville		
	Median	(Q_1)	Cause	Median	(Q_1)	Cause	Median	(Q_1)	Cause	Median	(Q_1)	Cause	Median	(Q_1)	Cause
Australian hardwoods (Myrtaceae)															
E. acmenoides	20.0	(13.9)	D		(18.1)			(20.2)			c)			c)	
E. amygdalina	3.1	(3.1)	D	3.2	(1.1)	T	10.3	(8.6)	D	8.8	(8.8)	T	6.3	(4.3)	D
E. astringens	8.5	(8.5)	D	5.2	(3.2)	T		(15.6)		16.0	(8.8)	T		c)	
E. bosistoana	20.0	(8.5)	D&T	8.5	(3.2)	T		(12.0)		20.0	(12.4)	T		c)	
E. botryoides	6.8	(3.1)	D	4.2	(1.1)	T	12.0	(12.0)	D	18.5	(14.8)	D&T	14.0	(12.3)	D
E. calophylla	3.1	(3.1)	D	5.2	(1.1)	T	12.0	(12.0)	D	12.4	(8.8)	D&T	10.9	(8.3)	D
E. camaldulensis	8.5	(8.5)	D	11.9	(8.5)	T		(8.4)			(18.5)			c)	
E. capitellata	5.2	(3.1)	D	1.1	(1.1)	T	8.6	(4.7)	D	8.8	(5.3)	T	12.3	(4.3)	D
E. cladocalyx	19.0	(12.0)	D		(16.0)			c)			c)			c)	
E. cloeziana		c)		13.9	(1.1)	T		(20.2)			c)			c)	
E. consideniana	8.5	(8.5)	D	3.2	(1.1)	T	16.1	(8.6)	D		(12.4)		16.8	(14.0)	D
E. cornuta		(8.5)		3.2	(1.1)	T	15.6	(14.6)	D&T	12.4	(8.8)	T		(12.3)	
E. cypellocarpa	4.2	(2.0)	D	1.1	(1.1)	T	12.0	(8.6)	D	8.8	(8.8)	D&T	12.3	(8.3)	D
E. diversicolor	6.8	(5.2)	D	1.1	(1.1)	T	12.8	(8.6)	D	8.8	(8.8)	D&T	15.5	(12.3)	D
E. dives	5.2	(3.1)	D	2.2	(1.1)	T	10.3	(4.7)	D	14.8	(8.8)	D&T	10.9	(8.3)	D
E. elata	1.0	(1.0)	D	1.1	(1.1)	D&T	4.7	(1.6)	D	5.3	(3.3)	T	4.3	(4.3)	D
E. eugenioides	4.2	(2.0)	D	3.2	(3.2)	T	8.6	(4.7)	D	16.3	(12.4)	T	12.3	(10.9)	D
E. eugenioides (formerly *E. wilkinsoniana*)	8.5	(3.1)	D	5.2	(3.2)	T	10.3	(4.7)	D	10.6	(8.8)	T	8.3	(8.3)	D
E. fastigata	4.2	(3.1)	D	1.1	(1.1)	T	8.6	(4.7)	D	8.8	(3.3)	D&T	4.3	(4.3)	D
E. globulus ssp. *bicostata*	6.8	(3.1)	D	1.1	(1.1)	T	12.0	(4.7)	D&T	8.8	(3.3)	T	12.3	(10.9)	D
E. globulus ssp. *maidenii*	5.2	(3.1)	D	1.1	(1.1)	T	12.0	(8.6)	D	14.3	(11.5)	D&T	10.9	(8.3)	D
E. gomphocephala	20.0	(13.9)	D	4.2	(1.1)	T		(8.6)		18.5	(13.8)	T		c)	
E. goniocalyx	8.5	(4.2)	D	3.2	(1.1)	T	10.3	(8.6)	D		(16.6)		15.5	(14.0)	D
E. grandis	6.8	(3.1)	D	6.8	(3.2)	T	8.6	(8.6)	D	14.8	(12.4)	D&T	8.3	(4.3)	D
E. guilfoylei	8.5	(5.8)	D&T	1.1	(1.1)	T	14.6	(12.0)	D&T	13.1	(12.4)	T		(13.9)	
E. haemastoma	5.2	(5.2)	D	2.2	(1.1)	T	12.0	(12.0)	D	19.5	(18.5)	D	14.0	(12.3)	D
E. jacksonii	3.1	(3.1)	D	1.1	(1.1)	T	8.6	(4.7)	D	7.1	(5.3)	T	10.9	(8.3)	D
E. leucoxylon	15.0	(8.5)	D	10.2	(1.1)	T	8.6	(8.6)	D		(20.5)			c)	
E. longifolia		(8.5)		8.5	(3.2)	T		(13.6)			c)			c)	
E. macrorhyncha	8.5	(8.5)	D	8.5	(3.2)	T	12.0	(8.6)	D	20.5	(18.5)	D&T	14.8	(8.3)	D
E. maculata	8.5	(8.5)	D	8.5	(1.1)	T	15.1	(8.6)	D	18.1	(14.8)	T		c)	
E. marginata	6.8	(3.1)	D	8.5	(8.5)	D&T	12.0	(12.0)	D	20.5	(16.8)	D&T		(14.0)	
E. megacarpa	6.8	(4.2)	D&T	1.1	(1.1)	T	12.0	(4.7)	D	8.8	(6.1)	T	13.9	(11.6)	D
E. melliodora	19.0	(12.0)	D&T		(11.9)			c)			c)			c)	
E. microcorys		c)			(18.1)			(15.6)			c)			c)	
E. moluccana		(16.0)		8.5	(8.5)	T		c)			c)			c)	
E. muelleriana	5.2	(5.2)	D	1.1	(1.1)	T	8.6	(8.6)	D	14.8	(8.8)	D&T	15.5	(8.3)	D
E. obliqua	3.1	(1.0)	D	1.1	(1.1)	T	8.6	(4.7)	D	8.8	(8.8)	T	8.3	(4.3)	D

E. regnans	2.0 (1.0) D	1.1 (1.1) T	8.6 (4.7) D	5.3 (5.3) T	8.3 (1.1) D
E. resinifera	12.0 (8.5) D	8.5 (8.5) D&T	13.3 (12.0) D	(18.5)	c)
E. rubida	1.0 (1.0) D	1.1 (1.1) T	4.7 (4.7) D	6.1 (3.3) T	4.3 (4.3) D
E. saligna	4.2 (3.1) D	5.2 (3.2) D&T	12.0 (8.6) D	13.8 (8.8) D	14.0 (12.3) D
E. salmonophloia	(20.0)	2.2 (1.1) T	13.6 (12.0) D	(12.4)	c)
E. sideroxylon ssp. *sideroxylon*	(18.0)	c)	(12.0)	c)	c)
E. sieberi	5.2 (1.0) D	1.1 (1.1) T	12.0 (8.6) D	13.8 (8.8) T	13.2 (10.9) D
E. tereticornis	13.0 (12.0) D	18.1 (13.9) T	(13.6)	(17.7)	c)
E. viminalis ssp. *viminalis*	1.0 (1.0) D	1.1 (1.1) D&T	4.7 (4.7) D&T	5.3 (1.0) D&T	4.3 (4.3) D
E. wandoo	c)	(20.0)	c)	c)	c)
L. confertus	3.1 (1.0) D	3.2 (3.2) D	8.6 (4.7) D	13.8 (5.3) D	8.3 (8.3) D
L. suaveolens	13.9 (8.5) D	8.5 (8.5) D	15.6 (12.0) D	c)	16.3 (10.9) D
S. glomulifera	10.3 (8.5) D	8.5 (8.5) D&T	16.1 (8.6) D	(14.8)	c)
S. hillii	6.8 (5.2) D	8.5 (8.5) T	12.0 (8.6) D	c)	(19.6)
Australian hardwoods other than Myrtaceae					
A. acuminata	(16.0)	16.0 (11.2) D&T	(20.2)	c)	c)
A. harpophylla	(13.9)	c)	(13.6)	c)	c)
A. luehmannii	(16.0)	c)	c)	(8.8)	c)
L. reticulata	3.1 (3.1) D	5.2 (1.1) D&T	8.4 (4.7) D	12.4 (8.8) D	8.3 (8.3) D
N. cunninghamii	1.0 (1.0) D	1.1 (1.1) T	6.7 (1.6) D&T	2.1 (1.0) T	8.3 (8.3) D
Exotic hardwoods					
A. thyrifera ssp. *polyandra*	4.2 (3.1) D	8.5 (3.2) D&T	8.6 (4.7) D	8.8 (5.3) D&T	6.3 (4.3) D
I. bijuga	8.5 (5.2) D	8.5 (5.2) D&T	10.3 (4.7) D	(17.7)	15.5 (10.9) D
P. indicus	8.5 (5.2) D	5.2 (3.2) D&T	8.6 (8.6) D	(16.8)	12.3 (12.3) D
Q. alba	2.0 (1.0) D	1.1 (1.1) T	8.6 (8.6) D	8.8 (7.1) T	4.3 (4.3) D
T. grandis	12.0 (8.5) D	10.2 (5.2) D	15.9 (12.0) D	c)	c)
Australian softwoods					
A. robusta	1.0 (1.0) D	1.1 (1.1) D&T	1.6 (1.6) D	8.8 (5.3) D&T	4.3 (4.3) D
A. selaginoides	6.8 (5.2) D	8.5 (5.2) D&T	8.6 (8.6) D	c)	10.9 (10.9) D
C. columellaris	10.3 (8.5) D	8.5 (4.2) D&T	12.0 (8.6) D	(13.8)	c)
L. franklinii	8.5 (6.8) D	4.2 (3.2) D&T	10.3 (8.6) D	8.8 (8.8) T	10.9 (10.9) D
P. asplenifolius	10.3 (6.8) D	5.2 (3.2) D&T	8.4 (4.7) D	(8.8)	10.9 (10.9) D
P. amara	1.0 (1.0) D	1.1 (1.1) D&T	3.2 (1.6) D	12.4 (8.8) D&T	4.3 (4.3) D
Exotic softwoods					
P. radiata	1.0 (1.0) D	1.1 (1.1) T	1.6 (1.6) T	1.0 (1.0) T	6.3 (4.3) D
P. menziesii	3.1 (3.1) D	1.1 (1.1) T	4.7 (4.7) D	3.3 (1.0) T	8.3 (8.3) D
S. sempervirens	5.8 (3.1) D	5.2 (2.2) D&T	8.6 (8.6) D	c)	13.2 (8.3) D
T. plicata	6.8 (5.2) D	5.2 (3.2) D&T	8.6 (4.7) D	19.1 (13.8) D&T	10.9 (10.9) D

a) MEDSL values are the medians of specimen life values of the replicates of each species (see Section 2.3). Each MEDSL value is followed by the first quartile, Q_1, in brackets.

b) The cause of replicates having reached an unserviceable rating is shown as: D, at least 75% of the numbers of replicates unserviceable, due to decay; T, at least 75% due to termites; D&T, either decay or termites contributing greater than 25% but less than 75% to the numbers of replicates unserviceable.

c) Not enough replicates have become unserviceable and, therefore, a Q_1 value cannot yet be calculated for this particular timber species at this particular site.

effect than have the termites. However, at Innisfail and Walpeup termites or termites plus decay appear to have been the major cause(s) of deterioration. Only one timber, *L. confertus,* has become unserviceable at all sites due only to decay. This list may be expected to expand since *L. suaveolens* and *T. grandis* have yielded MEDSL values from their decay scores at the seemingly higher termite hazard site of Innisfail.

The most durable timber species in this test are very likely to be those for which no MEDSL values are yet available. In particular, those without a first quartile value (Tab. 3) will prove to be the most durable of the timbers in this test. However, Table 3 does not give the type of information that, currently, enables meaningful comparison to be made between such timbers at this stage of the test. In order to do so, it is necessary to provide the mean rating values in the format presented in earlier papers (J. D. THORNTON et al., 1983a, 1983b; G. C. JOHNSON et al., 1986). Accordingly, Table 4 gives these data for each of the 13 timbers that have not yet, for at least four of the five sites, biodeteriorated sufficiently to have yielded MEDSL values. It is noteworthy that the 13 naturally durable species in this table are Australian hardwoods. None of the softwoods and none of the overseas hardwoods performed as well under the Australian exposure conditions. Also included in the table are the ratings for the two preservative treatments in the sapwood of *P. radiata*. Because they have thus far resisted significant biodeterioration, neither MEDSL data nor first quartile values can be determined for either of these treated softwood sapwoods at any site.

At the present time, *E. wandoo* has the highest mean rating of the untreated timbers against decay (Tab. 4) at both Brisbane and Pennant Hills where the main cause of unserviceability was decay. *A. luehmanii* has the highest mean rating of the untreated timbers against termites at Innisfail where the main cause of unserviceability is, or at least appears to be, termites. At Walpeup, *A. acuminata* has the highest decay rating of the untreated specimens whereas *E. polyanthemos* has the highest termite rating. At Mulgrave/Rowville seven of the 13 species have a mean rating value against decay of more than 5.5. However, *P. radiata* sapwood treated with CCA to 12 kg/m^3, is generally performing far better at the present time than any of the untreated timber species in this test (Tab. 4). The better performance of a well-treated, nondurable, species in direct comparison to that of the very best of the durable timber species in this study is a finding which should be of considerable commercial significance.

Table 4: Mean rating[a)] of heartwood specimens of the most resistant hardwood species, and preservative-treated *P. radiata* sapwood, with respect to decay and termites at the 21 year inspection[b)].

Species	Brisbane		Innisfail		Site and Hazard Pennant Hills		Walpeup		Mulgrave/Rowville	
	Decay	Termites	Decay	Termites	Decay	Termites	Decay	Termites	Decay	Termites
Australian hardwoods (Myrtaceae)										
E. acmenoides	(2.0)^{c}	(6.5)^{c}	4.4	(3.6)	4.2	7.2	4.7	5.3	5.7	8.0
E. cladocalyx	2.3^{c}	6.6^{c}	4.7	(3.5)	4.3	6.9	4.3	5.0	5.1	8.0
E. cloeziana	4.0	(5.9)	(3.0)^{c}	(1.4)^{c}	(3.6)	7.0	5.0	4.8	5.6	8.0
E. melliodora	(2.4)^{c}	(5.6)^{c}	(4.5)	(3.1)	4.9	7.3	4.9	5.3	5.7	8.0
E. microcorys	4.2	6.1	4.7	(3.7)	3.6	7.6	4.7	5.2	5.8	8.0
E. moluccana	(2.8)	5.0	5.0^{c}	(2.4)^{c}	(3.8)	6.9	4.8	4.2	(4.6)	8.0
E. paniculata	(3.4)	(5.2)	5.0	(2.8)	5.3	6.9	3.8	4.5	(4.4)	8.0
E. polyanthemos	4.7	6.7	5.0	(4.0)	(4.2)	8.0	4.7	(6.5)	5.0	8.0
E. sideroxylon ssp. *sideroxylon*	(3.6)	6.0	5.0	(3.8)	(3.6)	7.3	4.3	5.0	5.8	8.0
E. wandoo	4.9	6.0	5.3	(4.4)	5.8	7.7	4.6	5.2	5.8	8.0
Australian hardwoods other than Myrtaceae										
A. acuminata	(3.3)	5.5	(2.7)^{c}	(2.3)^{c}	4.1	7.2	5.3	5.1	(5.0)	8.0
A. harpophylla	(2.8)	7.1	3.6	4.6	(3.0)	7.6	4.1	4.3	5.6	8.0
A. luehmannii	(3.3)	(7.5)	5.2	(5.5)	5.2	(7.0)	(3.0)	(3.7)	(4.2)	8.0
Preservative-treated *P. radiata* sapwood										
CCA at 12 kg/m^3	6.7	8.0	6.2	6.8	7.1	7.8	7.3	7.9	7.0	8.0
K55 Creosote at 175 - 210 kg/m^3	5.5	6.4	4.9	(5.4)	6.0	6.9	6.9	7.1	5.7	8.0

a) Rating values range from 8 for a completely sound timber to 0 for a comletely failed one, with 3 representing unserviceability. Figures in parenthesis are means for which the length of the 95% confidence interval is 3.0 or greater. These values are, therefore, to be viewed as less reliable estimates than the unbracketed values.
b) Timber species are listed here only if, for at least four of the five sites, they have not yet deteriorated sufficiently to yield an MEDSL value (see Table 3).
c) Indicates that a sufficient number of replicates have bevome unserviceable to be able to calculate an average specimen life (based on median values – see Table 3 and Section 2.3).

4. Summary

The condition of untreated heartwood specimens after 21 years' exposure in a field test of in-ground durability, at each of five Australian sites is discussed. By using the median of the times for individual replicates to reach an unserviceable rating, rather than the mean as was given in earlier reports, median specimen life (MEDSL) values are provided at each site for a total of 38 of the 77 timbers in test. Additionally, the separate rating values against decay and termites are given for the 13 timbers that, for at least four of the five sites, have not yet deteriorated sufficiently to enable the calculation of MEDSL values. However, the rating values for the controls show that sapwood of *Pinus radiata* D. Don originally treated to $12 kg/m^3$ with CCA is presently performing better, at all sites, than the very best of the naturally durable timber species in this test.

Zusammenfassung

Ein Erd-Eingrabe-Versuch zur Prüfung der natürlichen Dauerhaftigkeit australischer Hölzer und ausländischer Vergleichsholzarten

VI. Ergebnisse nach ca. 21jähriger Versuchsdauer

Der Zustand von unbehandelten Laubholzstäben nach 21jährigem Erd-Eingrabe-Versuch in 5 verschiedenen Versuchsfeldern in Australien wird besprochen. Unter Verwendung der mittleren Zeiten, nach denen einzelne Kontrollproben unbrauchbar wurden, anstelle der Mittelwerte, die in früheren Berichten angegeben worden waren, werden für jedes Versuchsfeld Medianwerte für die Lebensdauer der Proben (MEDSL) in den einzelnen Versuchsfeldern für insgesamt 38 der 77 geprüften Holzarten angegeben. Außerdem werden getrennte Werte für die Fäulnis- und Termitenwiderstandsfähigkeit für die 13 Holzarten gegeben, die in wenigstens 4 der 5 Versuchsfelder noch nicht so weit zerstört sind, daß eine Berechnung der MEDSL erfolgen könnte. Die Bewertung der Kontrollen zeigt jedoch, daß das Splintholz von *Pinus radiata* D. Don, das ursprünglich mit $12 mg/m^3$ CKA-Salz behandelt worden war, auf allen Versuchsfeldern besser abschneidet als die besten der natürlich dauerhaften Holzarten, die in diesem Freilandversuch verwendet worden waren.

Résumé

Un essai de terrain de la durabilité naturelle dans le sol d'espèces de bois australiennes et exotiques

VI. Résultats après une exposition après environ 21 années

La condition d'éprouvettes de bois feuillus non-traitées après 21 ans d'exposition dans 5 sites en Australie est discutée. En utilisant les temps médianes des contrôles pour atteindre une condition inutilisable au lieu de valeurs moyennes indiquées dans des rapports préalables les valeurs médianes de la durée d'utilisation (MEDSL) sont données pour toutes les sites pour 38 de 77 espèces de bois examinées. En outre, des valeurs sont indiquées de la résistance aux attaques des champignons et des termites pour les 13 espèces qui ne sont pas encore tellement détruites pour calculer les valeurs

DSL. Les contrôles montrent, cependant, que l'aubier de *Pinus radiata* D. Don té à une rétention de 12 kg/m^3 avec un sel CCA est en meilleure condition aujourui que les meilleures espèces de bois de durabilité naturelle qui ont été utilisées s ces essais.

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