Pacific Southwest
Forest & Range
Experiment Station

P. O. BOX 245
BERKELEY, CALIFORNIA 94701

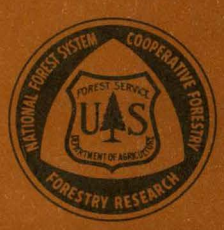
1968

U. S. Forest Service
Research Note
PSW-167

ABSTRACT: Six imported and eight Hawaii-grown species are being tested for their natural resistance to decay and insect attack. Damage to the heartwood has progressed far enough in 4 years to allow comparisons among some of the species.

RETRIEVAL TERMS: wood durability; wood decay; wood-destroying fungi; termites; Hawaii.

OXFORD: 814.1:844.2:845.3:(969).



Forest Service
U.S. Department of Agriculture

Natural Durability of Some Woods Used in Hawaii . . . *preliminary findings*

ROGER G. SKOLMEN

Hawaii, with its year-around warm, humid climate, provides an excellent breeding ground for wood-destroying fungi and insects. Unless properly treated with preservatives, few species of wood will last long outdoors if used in contact with the ground. And even when used indoors, most species are subject to attack by dry-wood termites (*Cryptotermes brevis*).

In late 1963, we established two test exposures to compare the natural durability of untreated heartwood of several species used in Hawaii. One exposure--a standard "graveyard" test--consists of 2 by 4 by 18-inch stakes set to half their length in the ground. The other exposure tests durability above the ground by using simulated post-rail units (fig. 1). Both tests will continue for several more years.

After 4 years of testing, we have obtained fairly conclusive information on several of the species.

Exposure Site

The tests are located at the Makiki Exposure Site in Makiki Valley, Honolulu, where annual rainfall has averaged 68 inches over the past 9 years. The climate in general is typical of the wetter parts of Honolulu,i.e., middle Palolo Valley, Manoa Valley, Makiki Heights and Tantalus, and Nuuanu Valley.

The humid climate provides ideal conditions for the development of decay organisms, but probably tends to inhibit slightly the activity of dry-wood and subterranean termites (*Coptotermes formosanus*). In addition to termite damage, damage from numerous other wood boring insects has been found at the site. A species of biting ant present there is almost always found occupying old termite galleries and, on numerous occasions, attacking both subterranean

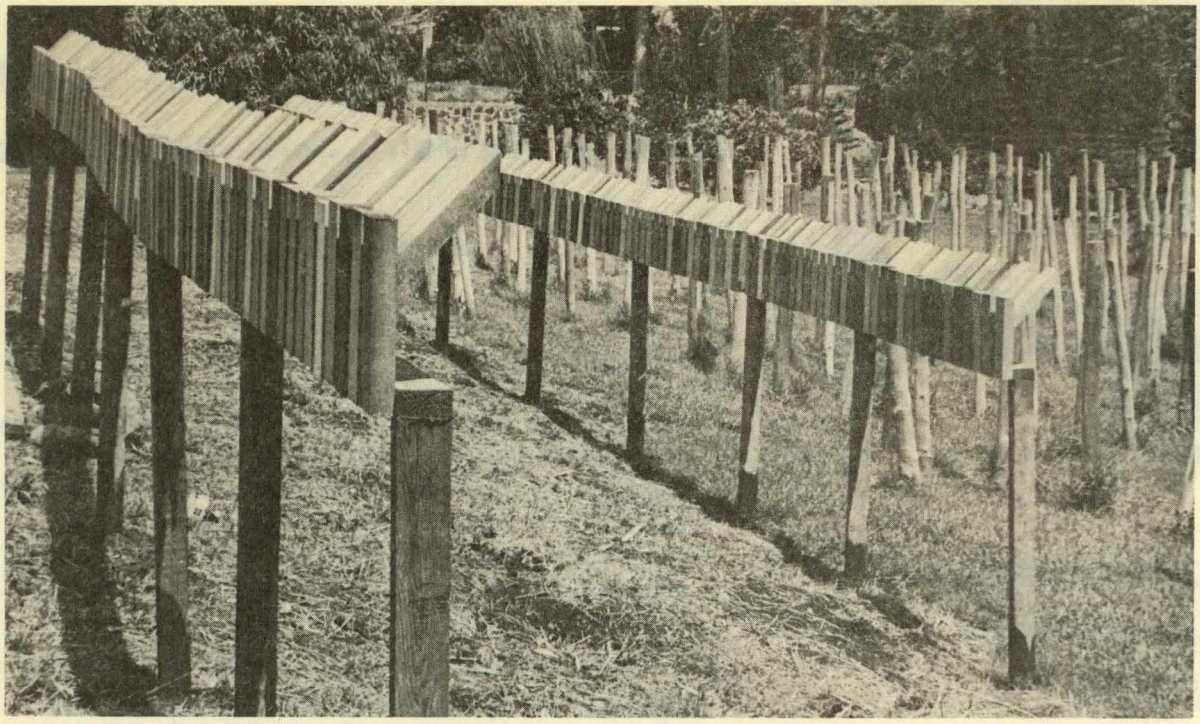


Figure 1.--*Post-rail unit exposure test.*

and dry-wood termite infestations and carrying off the termite larvae. This ant probably helps reduce termite damage at the site.

Durability in the Ground

Fourteen species of wood are being compared in the stake test (table 1). Six of the 14 are species imported to Hawaii and widely used here; the other eight are locally grown woods that, except for koa, ohia, and robusta, are now used only in minor amounts.

All samples in the test are considered to be representative of the wood available in the local market. Imported wood samples were cut from 10 or more boards of each species selected from separated parts of lumber piles in two or more lumber yards. Local wood samples were cut from five or more logs of each species that had been selected for the purpose. With the three softwoods, particular care was taken to include both slow-grown and fast-grown wood along with wood of more average growth rate.

Species tested have varied widely in durability. To date, redwood has been far more resistant to both decay and insects than any other species in the test (table 1). But it has not been fully immune to damage. Most redwood stakes showed some decay, and several had active termites in them at the last inspection. Western redcedar is proving to be surprisingly low in resistance to both decay and termites. Many tests on the mainland have shown it to be as durable as redwood, so it may be that our sample happened to come from less durable wood than is normal for the species. Douglas-fir is surprisingly high. White oak results are somewhat biased by the presence of sapwood in some of the stakes. Even so it appears to be the least-resistant species to termites.

Among the Hawaii-grown species, the two reddish-brown eucalypts saligna and robusta are the most resistant to decay. Tropical ash is decidedly the least resistant. Blackbutt

Table 1.--*Condition of 2-by 4-inch heartwood stakes after 4 years' exposure in the ground, Makiki Valley, Honolulu, Hawaii*

Species	Stakes in test	Removed due to[1]			Rating[2]		Average life[3]
		Decay	Decay and termites	Termites	Decay	Termites	
	No.	*Percent*					*Years*
Redwood *(Sequoia sempervirens)*	25	0	0	0	55	53	--
Saligna[4] *(Eucalyptus saligna)*	25	4	0	0	83	72	--
Robusta[4] *(Eucalyptus robusta)*	25	8	0	0	80	67	--
Douglas-fir *(Pseudotsuga menziesii)*	25	12	12	0	84	80	--
'Philippine mahogany'[5] (various spp.)	24	21	8	0	90	74	--
Blackbutt[4] *(Eucalyptus pilularis)*	24	33	0	0	91	65	--
Western redcedar *(Thuja plicata)*	25	24	16	0	99	85	--
'Meranti'[6] *(Shorea spp.)*	23	43	4	0	101	74	--
Silk-oak[4] *(Grevillea robusta)*	24	54	12	0	112	80	4.0
Ohia-lehua[4] *(Metrosideros collina)*	25	52	16	0	113	79	4.0
Australian toon[4] *(Toona ciliata v. australis)*	24	67	8	0	113	74	4.0
Koa[4] *(Acacia koa)*	24	54	25	0	118	84	3.5
White oak[7] *(Quercus spp.)*	25	40	44	0	119	94	3.0
Tropical ash[4] *(Fraxinus uhdei)*	25	64	36	0	125	86	2.0

[1]A stake is removed when 50 percent or more of its cross-section has been destroyed by the indicated agent or agents.

[2]At inspection stakes are rated on a scale of 1 to 5 for severity of decay and severity of termite damage. Rating was determined by adding up the numerical ratings in the two categories. In the case of missing stakes (originally 25 of each) the last rating given that stake was counted. Best possible rating would be 25, worst 125.

[3]Average life is time at which 60 percent or more of stakes had been removed.

[4]Denotes wood was grown in Hawaii.

[5]'Philippine mahogany' lumber was obtained from a local lumber dealer as 'dark red Philippine mahogany.' The Forest Products Laboratory, Madison, Wis., determined it to be a mixture of *Shorea polysperma* (tangile), *Shorea almon*(Almon), and *Tarrietia javanica* (Lumbayau). The latter is not a 'Philippine mahogany.' Taken together the mixture may be considered representative of wood sold in Hawaii as dark red Philippine mahogany by yards dealing with mills in the Philippines.

[6]'Meranti' lumber was obtained from a different lumber dealer that supplied the 'Philippine mahogany,' also as dark red Philippine mahogany. The Forest Products Laboratory identified it as a mixture of several *Shorea* spp., all from Malaya or Borneo. The wood is representative of that sold in Hawaii as dark red Philippine mahogany by yards dealing with mills in Japan.

[7]Ten of the 25 white oak samples contained some sapwood. Though only the heartwood portion of these pieces was considered in condition rating, the presence of the susceptible sapwood probably increased the rate of heartwood infection. White oak heartwood should probably be considered about equal to ohia-lehua in decay resistance, but is more susceptible to termites.

eucalyptus, although not as decay resistant as the other eucalypts, has had less termite damage than any other species except redwood. Ohia-lehua, generally considered a durable wood in Hawaii, has not proved durable; in fact, it is no more resistant to decay or termites than silk-oak, which is generally considered a non-durable wood in Hawaii. Australian toon is a highly resistant wood when grown in its native Australia. But when grown in Hawaii it has proved to be somewhat resistant to termites but not resistant to decay. This is probably because the test sample was obtained from young (40-year-old), fast-grown trees. The koa stakes included some of the most dense wood ever encountered as well as some of low density, but koa has performed poorly regardless of density. Tropical ash does not produce a clearly defined heartwood and, as indicated by the results, may be all sapwood. When used in the ground, it should be considered completely non-resistant to both decay and insects.

The "ratings" given each species (table 1) are only tentative because, except for the removed stakes, they are based solely on external examination. They are included to provide a further indication of stake condition.

It is still too early in the test to assign final durability ratings--very resistant, resistant, moderately resistant, and non-resistant--to all species. After 4 years in the Makiki environment, redwood is very resistant to decay and subterranean termites, tropical ash is non-resistant to decay and subterranean termites, and the other species for which we have calculated an average life are moderately resistant to decay and--except for white oak and Australian toon--to subterranean termites. White oak is non-resistant to subterranean termites, while Australian toon may be resistant to them.

Durability Above the Ground

The post-rail unit test of durability includes the same species as the stake test and one other--western hemlock. Since western hemlock is already well-known to be non-resistant to decay and termites in the ground, we did not include it in the stake test. Its inclusion in the post-rail unit test was primarily to evaluate its resistance to dry-wood termites.

The test includes 15 replications of each species, all unpainted and untreated, but with the post and rail end matched by board. Their surfaces are examined twice a year. When it is judged that deterioration has progressed sufficiently, a randomly selected sample of three replications of each species is removed for inspection. Inspection consists of sawing the post and rail down the center, dividing each into tenths area-wise, and classifying each one-tenth unit area on a scale of 0 to 10 for severity of decay and insect damage. A rating for a species is established by adding up the units of area in the post or rail by their classifications, and averaging for the three replications (table 2).

The units have been inspected twice, so far. The first inspection was made 1-1/2 years after installation. The second, 4 years after installation, when we noted that considerable deterioration had occurred to some units (figs. 2, 3).

Damage due to decay exceeded damage by insects, but insect damage, predominantly by dry-wood termites, was common to badly decayed specimens (figs. 4, 5). Damage by carpenter bees was also noted in one tropical ash and in the sapwood portion of one white oak specimen. Very slight trial nibbling by an unknown insect had occurred at the post-rail junction in one silk-oak and one ohia-lehua unit, but was too slight to classify.

Table 2.--*Ratings of interior condition of post-rail units after 1-1/2 and 4 years' exposure, Makiki Valley, Honolulu, Hawaii*

Species[1]	1½ years' exposure Average rating[2]		4 years' exposure Average rating[3]				Units[4] failed
			Posts		Rails		
	Decay	Termites	Decay	Termites	Decay	Termites	
							Percent
Redwood	0	0	0	0	0	0	--
Saligna[5]	0	0	0	0	0	0	--
Robusta[5]	0	0	0	0	0	0	--
'Meranti'	0	0	0	0	0	0	--
Ohia-lehua[5]	0	0	0	0	0	0	--
Silk-oak[5]	0	0	0	0	0	0	--
Western redcedar	2	0	0	0	0	0	--
'Philippine mahogany'	0	0	1	0	1	0	--
Blackbutt[5]	3	0	0	0	1	0	--
Australian toon[5]	3	0	2	0	2	2	--
Koa[5]	2	0	3	3	6	6	--
Douglas-fir	4	0	31	10	2	0	8
White oak	8	3	7	8	33	34	17
Western hemlock (*Tsuga heterophylla*)	9	0	34	9	31	19	8
Tropical ash[5]	46	1	84	83	86	69	42

[1]See Table 1 for scientific names.

[2]Ratings are based on a scale of 0-no deterioration to 10-complete destruction, for decay and for termite damage by tenth part areas of post and rail. Total ratings for posts and rails are combined.

[3]Given separately for posts and rails because deterioration adequate for appraisal.

[4]Failed units are those that have fallen apart in place or were about to when observed.

[5]Denotes grown in Hawaii.

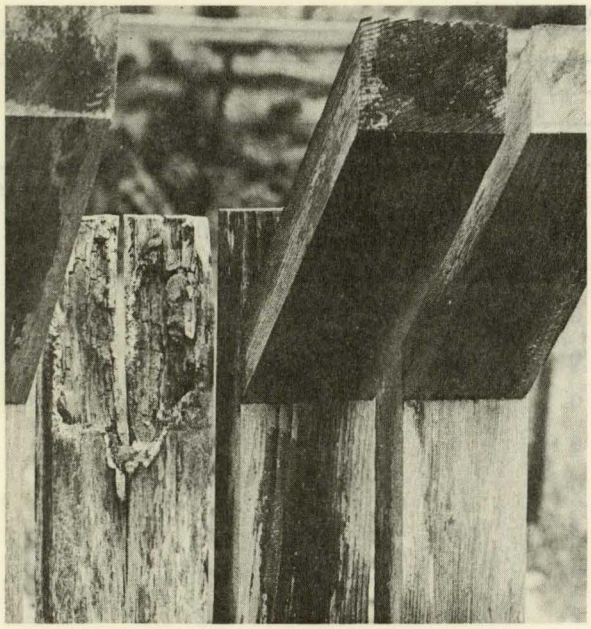


Figure 2.--*Tropical ash post destroyed by decay and termites. Rail has been completly destroyed.*

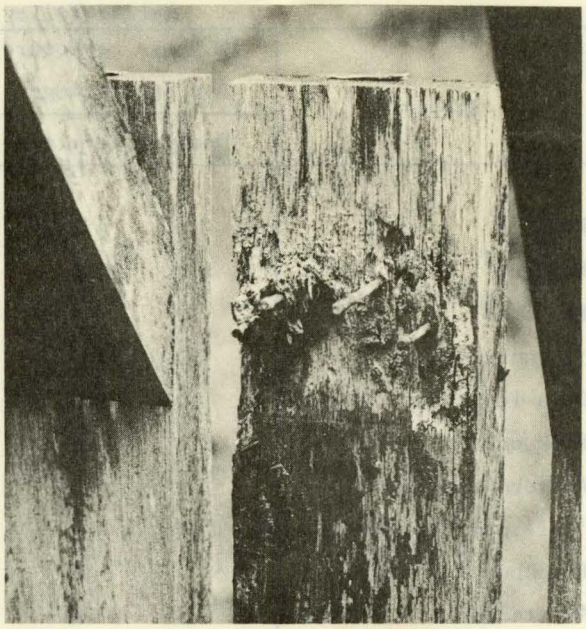


Figure 3.--*Dry-wood termite damage in heartwood portion of white oak post. Rail has been destroyed by decay and termites.*

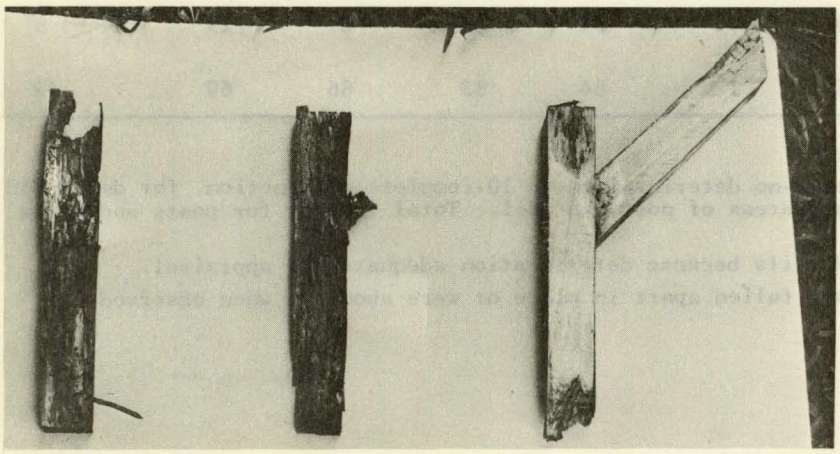


Figure 4.--*Interiors of tropical ash units after 4 years' exposure.*

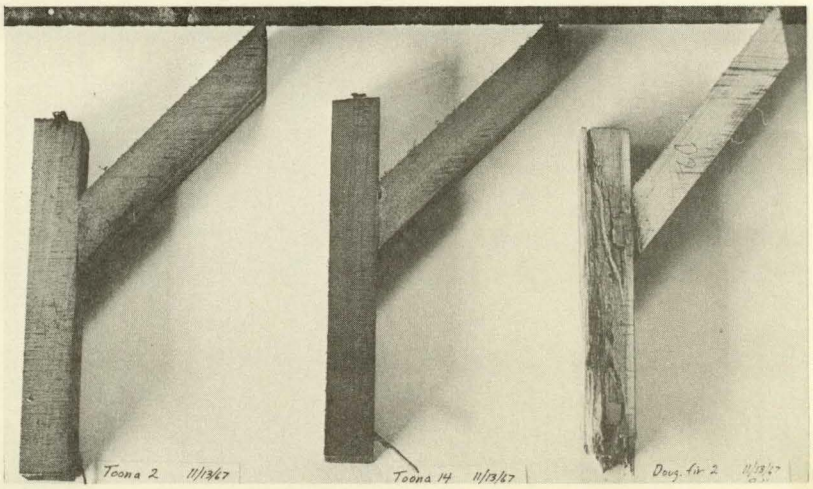


Figure 5.--*Interiors of Australian toon, left two, and Douglas-fir, right, units after 4 years' exposure.*