CHARACTERISTICS OF TEN TROPICAL HARDWOODS FROM CERTIFIED FORESTS IN BOLIVIA. PART II. NATURAL DURABILITY TO DECAY FUNGI

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ABSTRACT

The natural durability of 10 lesser known, commercially available Bolivian hardwoods to decay fungi was evaluated using a modified ASTM soil-block analysis for 12 weeks. The blocks were then retested for an additional 12 weeks to determine their level of decay resistance, as determined by percentage of weight loss. *Astronium urundeuva, Caesalpinia* cf. *pluviosa, Schinopsis quebracho-colorado,* and *Tabebuia* sp. (lapacho group) were found to be highly resistant to decay; *Amburana cearensis, Anadenanthera colubrina* (syn: *A. macrocarpa*), *Aspidosperma cylindrocarpon, Diplotropis purpurea,* and *Guibourtia chodatiana,* resistant to decay; and *Phyllostylon rhamnoides,* moderately resistant to decay. We conclude that an extended soil-bottle test is an effective tool for assessing the level of natural durability of these and other tropical species.

Keywords: Natural durability, soil-block test, tropical hardwoods.

INTRODUCTION

Natural durability, weathering characteristics, and dimensional changes are important properties of wood for outdoor use. Much is known about some woods, like teak (*Tectona grandis* L.) and Honduras mahogany (*Swietenia macrophylla* King), but there are many gaps in our knowledge about some lesser known or lesser used species. This is especially true for woods from Bolivia, a country that has a large forest resource. Within the last 10 years, the development of this forest resource has expanded. The initial focus on harvesting mahogany (*S. macrophylla*) has shifted to the utilization of many species. To provide local land owners and operators of certified forests with information on weathering characteristics and decay resistance, we initiated a two-part project focused on 10

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Bolivian hardwoods. In Part I, we studied weathering characteristics and dimensional changes (Williams et al. 2001). The work reported here describes Part II, tests on decay resistance using a modified ASTM soil-block analysis (ASTM 1994).

Information on the properties and characteristics of Bolivian hardwoods, including natural resistance to decay fungi, is found in several publications. Chudnoff (1984), Berni et al. (1979), and Chichignoud et al. (1990) compiled data on Latin American species; Teixeira et al. (1988), IBDF (1981, 1988), and Mainieri and Chimelo (1989) focused on Brazilian species; and Gérard et al. (1996) studied timbers of Guyana. These reports provide data on some Bolivian species, but most often present data on other species in the same genera. In most cases, it is not possible to determine if the data on decay resistance were derived from soil-block or long-term stake tests.

Soil-block tests or other accelerated laboratory tests have been done on some Bolivian species growing in Peru and Paraguay. Highley and Scheffer (1970) evaluated 30 Peruvian species, and Greenwood and Tainter (1980) evaluated 16 Paraguayan species. Others (Monteiro and de Freitas 1977; Cavalcante et al. 1978; Silverborg et al. 1970) evaluated closely related South American species, i.e., species in the same genus. In the absence of other critical data, results from species in the same genus may suggest similar decay resistance if the woods are similar in other respects.

EXPERIMENTAL

Materials

Heartwood from one tree of each of 10 species was obtained from a certified forest in Bolivia. The species were *Amburana cearensis* (Allemao) A. C. Smith (roble or ishpingo in Peru), *Anadenanthera colubrina* (Vell.) Brenan (syn: *A. macrocarpa* (Benth.) Brenan) (curupau or curupay), *Aspidosperma cylindrocarpon* Muell. Arg. (jichituriqui), *Astronium urundeuva* Engl. (cuchi), *Caesalpinia* cf. *pluviosa* DC. (momoqui), *Diplotropis purpurea* (Rich.) Amsh. (sucupira), *Guibourtia chodatiana* (Hassl.) J. Leonard (sirari), *Phyllostylon rhamnoides* (Poisson) Taubert (cuta), *Schinopsis quebracho-colorado* (Schidl.) F. Barkley and T. Meyer (soto or quebracho), and *Tabebuia* sp. (lapacho group, tajibo or ipe). Red pine (*Pinus resinosa* Ait.) and yellow birch (*Betula alleghaniensis* Britt.) were used for sapwood control samples.

The fungi used in the tests were pure cultures of two brown-rot fungi (*Tyromyces palustris* (Berk. and M.A. Curtis) Murrill, MAD 6137) and *Gloeophyllum trabeum* (Pers.:Fr.) Murrill, MAD 617) and one white-rot fungus (*Trametes versicolor* (L.:Fr.) Pilat, MAD 697).

METHODS

We used a modified ASTM D-2017 soil-block experimental method (ASTM 1994). Two matched sets of the Bolivian heartwood samples (19- by 19- by 19-mm blocks) and control sapwood samples were prepared. Each set contained four replicates for a total of eight samples per species. Both sets were placed in standard soil-block bottles (two blocks per bottle) in a decay chamber (27°C and 80% relative humidity) and exposed for 12 weeks to pure cultures of the decay fungi. After 12 weeks, one set of samples was removed, oven-dried at 80°C to a constant weight, and weighed to determine weight loss. The oven-dried samples were then steam-sterilized and transferred to freshly prepared soil-block bottles. The other set of samples was not oven-dried; these samples were steam-sterilized and transferred to freshly prepared soil-block bottles to extend the test period to 24 weeks. Both sets were then exposed for a second 12-week period, after which they were oven-dried and weighed.

RESULTS AND DISCUSSION

The average percentages of weight loss and standard deviation for each species and fungus after 12 and 24 weeks of exposure are shown in Table 1 and Figs. 1 to 3. Following the ex-

TABLE 1. *Percentage of weight loss for wood species after 12 and 24 weeks of exposure to decay fungi in soil-block tests.*[a]

Species	*G. trabeum* MAD-617 12 wk	*G. trabeum* MAD-617 24 wk	*T. palustris* TYP-6137 12 wk	*T. palustris* TYP-6137 24 wk	*T. versicolor* MAD-697 12 wk	*T. versicolor* MAD-697 24 wk
Pinus resinosa (control)	58.4 (9.3)	—	31.4 (7.5)	—	9.5 (1.4)	—
Betula alleghaniensis (control)	40.6 (4.0)	—	34.8 (6.1)	—	38.6 (3.0)	—
Amburana caerensis	1.9 (0.6)	2.4 (1.0)	13.4 (3.2)	21.3 (5.2)	12.2 (6.0)	21.6 (8.4)
Anadenanthera colubrina	2.3 (1.4)	2.2 (2.0)	10.7 (4.9)	23.1 (7.4)	1.9 (0.3)	2.2 (7.0)
Aspidosperma cylindrocarpon	6.9 (1.6)	9.6 (1.8)	16.8 (1.6)	33.0 (3.6)	1.0 (0.2)	3.2 (1.1)
Astronium urundeuva	0.2 (0.1)	−1.2 (1.5)	0.1 (0.2)	−0.5 (0.4)	1.5 (1.3)	0.6 (1.4)
Caesalpinia cf. *pluviosa*	2.8 (0.3)	3.1 (0.3)	4.5 (0.7)	7.7 (1.2)	4.0 (0.7)	6.5 (0.8)
Diplotropis purpurea	1.8 (0.0)	2.3 (0.5)	13.9 (1.3)	21.3 (1.8)	3.0 (0.2)	3.9 (0.9)
Guibourtia chodatiana	7.9 (1.1)	25.3 (6.1)	17.1 (1.0)	37.0 (3.6)	6.8 (3.8)	16.6 (7.1)
Phyllostylon rhamnoides	29.9 (5.3)	38.5 (2.7)	32.5 (2.2)	35.6 (3.6)	5.7 (1.9)	12.41 (2.6)
Schinopsis quebracho-colorado	1.2 (0.4)	0.7 (0.7)	0.6 (0.4)	4.3 (5.4)	1.2 (0.3)	0.6 (0.3)
Tabebuia sp. (lapacho group)	1.6 (0.2)	1.6 (0.3)	3.8 (3.8)	5.2 (5.9)	1.9 (0.4)	2.2 (0.7)

[a] Values in parentheses are standard deviation. n = 8 for each fungus-wood pairing.

ample of Highley and Scheffer (1970), we separated the species into four decay resistance classes: highly resistant, 0–10% weight loss; resistant, 11%–24%; moderately resistant, 25%–44%; and nonresistant, ≥45%. This arbitrary decay resistance classification is suggested in the ASTM standards (ASTM 1994) and has also been used by Clark (1969) and others. For each species, we used the most destructive fungus as the determinant of resistance (Highley and Scheffer 1970).

After 12 weeks of exposure, all Bolivian species had less than 13% weight loss and

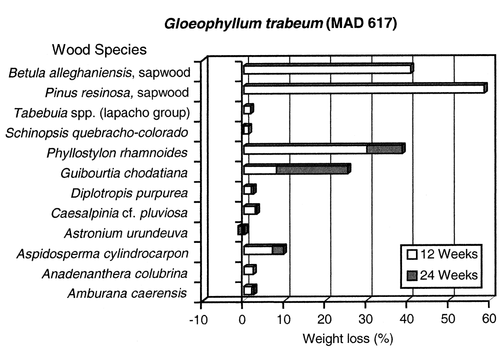

FIG. 1. Weight loss after 12 and 24 weeks of exposure to *Gloeophyllum trabeum* (MAD 617).

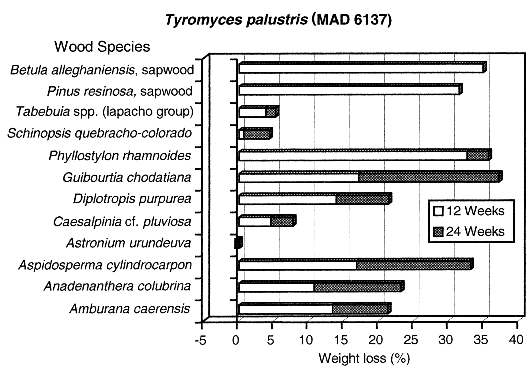

FIG. 2. Weight loss after 12 and 24 weeks of exposure to *Tyromyces palustris* (MAD 6137).

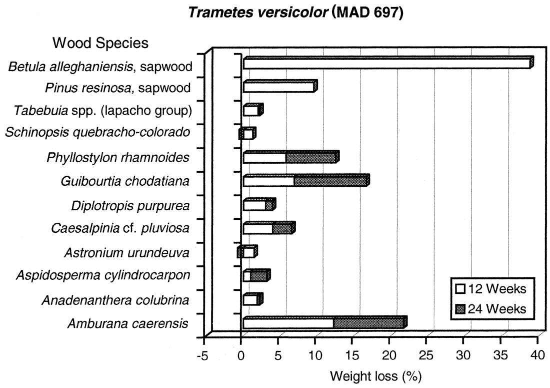

FIG. 3. Weight loss after 12 and 24 weeks of exposure to *Trametes versicolor* (MAD 697).

most had less than 10% weight loss as a result of decay by the white-rot fungus *Trametes versicolor*. For both brown-rot fungi, the controls and *Phyllostylon rhamnoides* had at least 30% weight loss. For all other Bolivian species, *Tyromyces palustris* caused less than 18% weight loss and *Gloeophyllum trabeum* less than 10% weight loss. Table 2 lists the decay resistance ratings of the Bolivian species after 12 weeks of exposure.

Because some species were suspected to be very resistant to decay, we designed the study to continue for more than the standard 12 weeks. If soil-block bottles are incubated for 24 weeks, they lose moisture, rendering the fungi less active. To make the test as severe as possible, we used two back-to-back 12-week tests. The two sets of samples for the 24-week test—one set oven-dried, weighed, and steam-sterilized; the other set only-steam-sterilized—showed similar weight losses. However, the oven-dried samples cracked, checked, and in some cases fell apart during drying. For future 24-week studies, we recommend that samples be transferred from 12-week-old bottles to fresh bottles without oven-drying. The sapwood control blocks were too decayed to be replaced into bottles for the second 12-week period.

Only two species showed a difference in decay resistance after 24 weeks compared with that after 12 weeks. *Guibortia chodatiana* and *Aspidosperma cylindrocarpon* shifted from the resistant to the moderately resistant category.

We compared our soil-block test results to reports in the literature. In some cases, results from laboratory, graveyard, or stake tests are reported; more often, the only sources of information are general observations and experience in service. Very little information was available for *Caesalpinia pluviosa, Guibourtia chodatiana,* and *Phyllostylon rhamnoides.* For *Aspidosperma cylindrocarpon,* we compared our results with results from a soil-block test (Highley and Scheffer 1970). In both studies, the white-rot fungus *T. versicolor,* MAD 697, and the brown-rot fungus *G. trabeum,* MAD 617, caused less than 10% weight loss. In our study, however, the very aggressive brown-rot fungus *T. palustris,* MAD 6137, caused 17% weight loss. In contrast, in the 1970 study, *Po-*

TABLE 2. *Decay resistance of wood species after 12 weeks of fungal exposure.*[a]

Species	Decay resistance class[b]
Amburana caerensis	Resistant
Anadenanthera colubrina	Resistant
Aspidosperma cylindrocarpon	Resistant
Astronium urundeuva	Highly resistant
Caesalpinia cf. *pluviosa*	Highly resistant
Diplotropis purpurea	Resistant
Guibourtia chodatiana	Resistant
Phyllostylon rhamnoides	Moderately resistant
Schinopsis quebracho-colorado	Highly resistant
Tabebuia sp. (lapacho group)	Highly resistant

[a] For each species, the most destructive fungus was used as the determinant of resistance (Highly and Scheffer 1970).
[b] Highly resistant, 0–10% weight loss; resistant, 11%–24%; moderately resistant, 25%–44%; and nonresistant, ≥45%.

ria monticola (syn. *Postia placenta*) (MAD 698) caused only 8% weight loss. In a similar study, Monteiro and de Freitas (1997) found that *Aspidosperma polyneuron* Mull. Arg. and an unidentified species of *Astronium* from Brazil were very decay resistant. Greenwood and Tainter (1980) evaluated the decay resistance of 16 species from Paraguay using soil-block tests. They also found that species of *Astronium, Anadenanthera, Aspidosperma,* and *Tabebuia* (lapacho group) were highly resistant to decay.

The use of a second 12-week period of exposure to decay fungi in soil-block bottles is an effective method of separating the decay-resistance ratings of durable tropical timbers. Species that show virtually no weight loss after 12 weeks do not change decay resistance categories. Those species that border between two categories can be more accurately classified after a second 12-week exposure period.

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