CHARACTERISTICS OF TEN TROPICAL HARDWOODS FROM CERTIFIED FORESTS IN BOLIVIA
PART I WEATHERING CHARACTERISTICS AND DIMENSIONAL CHANGE

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ABSTRACT

Ten tropical hardwoods from Bolivia were evaluated for weathering performance (erosion rate, dimensional stability, warping, surface checking, and splitting). The wood species were *Amburana cearensis* (roble), *Anadenanthera macrocarpa* (curupau), *Aspidosperma cylindrocarpon* (jichituriqui), *Astronium urundeuva* (cuchi), *Caesalpinia* cf. *pluviosa* (momoqui), *Diplotropis purpurea* (sucupira), *Guibourtia chodatiana* (sirari), *Phyllostylon rhamnoides* (cuta), *Schinopsis* cf. *quebracho-colorado* (soto), and *Tabebuia* spp. (lapacho group) (tajibo or ipe). *Eucalyptus marginata* (jarrah) from Australia and *Tectona grandis* (teak), both naturally grown from Burma and plantation-grown from Central America, were included in the study for comparison. The dimensional change for the species from Bolivia, commensurate with a change in relative humidity (RH) from 30% to 90%, varied from about 1.6% and 2.0% (radial and tangential directions) for *Amburana cearensis* to 2.2% and 4.1% (radial and tangential) for *Anadenanthera macrocarpa.* The dimensional change for teak was 1.3% and 2.5% (radial and tangential) for the same change in relative humidity. None of the Bolivian species was completely free of *warp* or surface checks; however, *Anadenanthera macrocarpa, Aspidosperma cylindrocarpon,* and *Schinopsis* cf. *quebracho-colorado* performed almost as well as teak. The erosion rate of several of the wood species was considerably slower than that of teak, and there was little correlation between wood density and erosion rate. Part 2 of this report will include information on the decay resistance (natural durability) of these species.

Keywords: Wood properties, weathering, density, growth rate, erosion rate, flat-grain, vertical-grain, durability, natural durability.

INTRODUCTION

The objective of this research was to evaluate the weathering performance (erosion rate, dimensional stability, warping, and surface checking) of ten tropical hardwoods from Bolivia compared with jarrah and teak.

Some tropical hardwoods have good natural durability. These species are resistant to decay, insect attack, and weathering (photodegradation caused by the ultraviolet (UV) radiation in sunlight). Teak (*Tectona grandis* L.f.) has

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good natural durability, and it has traditionally been used in many outdoor applications including boats, decking, and outdoor furniture. It has been a commercial species since 2000 B.C. (Simatupang et al. 1996). The demand for wood that has good weathering properties and durability continues to increase, but the harvest, even from intensively managed teak plantations, cannot keep up with this demand. The objective of this study was to evaluate the weathering properties of ten tropical hardwoods from Bolivia to determine if some of them could provide performance similar to that of teak.[2] For comparison, teak harvested from natural forests in Burma, plantation-grown teak from Central America, and jarrah (Eucalyptus *marginata* Donn ex Sm.) from Australia were included. The study was also aimed at determining which species would be suitable for manufacturing products for outdoor use and which ones would be better suited for indoor use. General information, such as strength and stiffness, density, general appearance, and green to oven-dry shrinkage is available on some of these species (Chudnoff 1984). However, there is no information on their weathering characteristics, particularly their dimensional stability when exposed to cyclic wetting and drying or changes in relative humidity. Nor was there information on the erosion rate of the surface during weathering.

Several reports had information on the decay, weathering, and dimensional stability characteristics of teak. Teak was included in a study by the Working Group on Utilization of Tropical Woods (Forestry and Forest Products Research Institute 1998, pp. 23-84). This group evaluated the anatomical structure, mechanical properties, and decay resistance of 23 tropical woods from Papua, New Guinea. They ranked teak among the most durable species. Burmester (1972, 1975) and Burmester and Wille (1975) reported that there was considerable anisotropy in the swelling of teak with changes in relative humidity (RH); half of the total swelling took place in the range of 86% to 100% RH. They attributed the dimensional stability of teak to its low percentage of hydrolysable hemicellulose compared with other wood species. Bhat (1998) evaluated the properties of fast-grown teak from intensively managed plantations. He reported that strength, specific gravity, and percentage heartwood were not adversely affected. Teak was included in accelerated weathering studies of tropical wood species from Taiwan (Wang et al. 1980a, b; Wang 1981, 1990). These authors reported that teak was ranked with the group of wood species most resistant to surface checking and end-grain splitting. The vertical-grained pieces had less end-grain splitting than the flat-grained pieces.

In another previous work, Hernandez (1993) studied the moisture sorption properties of several Peruvian wood species. They included *Amburana* sp. [ishpingo negro (probably *A. cearensis* (Allemao) A.C. Sm.)], *Aspidosperma* sp. (Pumaquiro), and *Tabebuia serratifolia* (Vahl) G. Nicholson (tahuari or ipe). These species are in the same genera as *Amburana, Aspidosperma,* and *Tabebuia* used in our study and their densities were quite similar. Hernández focused on characterizing the hysteresis effect during shrinking and swelling, and he reported volumetric swelling for these species of between 7.5% (*Amburana* sp.) and 18.1% (*Tabebuia serratifolia*). Florsheim and Tormazello-Filho (1996) studied the dependence of anatomical characteristics on the location in the tree where the wood came from for several tropical wood species from Brazil. *Astronium urundeuva* (Allemao) Engl. was included in their study.

[2] These species are harvested using environmentally sensitive techniques from sustainably managed forests in Bolivia that are certified by the Forest Stewardship Council (FSC). For information on FSC, see their web page at www.fscus.org and link to FSC in other parts of the world from there, These certified forests should ensure the continued existence of these ecosystems and give sustainable yields of forest products indefinitely.

EXPERIMENTAL

Materials

Short lengths of lumber of the various species were obtained from a mill in Bolivia. The species were *Amburana cearensis, Anadenanthera macrocarpa* (Benth.) Brenan, *Aspidosperma cylindrocarpon* Muell. Arg., *Astronium urundeuva, Caesalpinia* cf. *pluviosa* DC., *Diplotropis purpurea* (Rich.) Amshoff, *Guibourtia chodatiana* (Hassl.) J. Leonard, *Phyllostylon rhamnoides* (Poisson) Taubert, *Schinopsis* cf. *quebracho-colorado* (Schldl.) F. Barkley & T. Meyer, and *Tabebuia* spp. (lapacho group). Teak, both natively grown from Burma and plantation-grown from Central America, and *Eucalyptus marginata* were also included in this study for comparison.

Vertical- or flat-grained specimens 75 by 6 by 100 mm (radial, tangential, longitudinal or tangential, radial, longitudinal) were cut from the boards. These specimens were used to measure dimensional changes, density, warping, surface checking, and splitting after cyclic wetting and drying exposures. Specimens 25 by 6 by 25 mm (radial, tangential, longitudinal) were cut for determining wood loss from the surface (erosion) during weathering. Because some of the boards were cross-grain (neither radial nor tangential cut), it was not possible to get sufficient specimens for radial and tangential dimensional changes for all species. In some cases, only the volumetric change could be determined.

Methods

The densities were determined by weighing and measuring the specimens at approximately 6% and 12% moisture content (30% RH/27°C or 65% RH/27°C, respectively). The dimensional change in the radial, tangential, and longitudinal directions was determined by cycling specimens between environmental rooms that were at 30% RW27°C and 90% RH/27°C. It was found that approximately 2 weeks were required to reach constant weight for these species. Consequently, the specimens were conditioned for 3 weeks at each relative humidity. Volume change of the specimens was calculated from the change in length, width, and thickness with the change in RH. The weathering characteristics were determined from the erosion of wood from the surface during exposure in a xenon arc weathering apparatus (24 h of light and 4 h of water spray each day). The temperature in the weathering apparatus was maintained at 42°C to 45°C and the RH varied from 25% during the light only period (20 h per day) to 95+% during the water spray. The erosion was measured microscopically at 600-h intervals by the method reported by Black and Mraz (1974) and later by Feist and Mraz (1978). For each wood species, six measurements were made on each of three replicates to give eighteen observations for each erosion determination. To get an erosion measurement that was representative of the actual wood loss from the surface, the erosion measurements were made as far from the vessels as possible. A linear regression analysis of the erosion measurements was done to give erosion rates; the Y-intercept was not fixed to 0. The hardwood erosion values previously published by Sell and Feist (1986) were fit using a linear regression in the same way as the data obtained for this study. Specimens for determining warping and surface checking were also exposed to the same conditions as the erosion specimens. The warping and surface checking evaluations were given numerical evaluations according to the following: 10 = no change, 8 = slight change, 5 = moderate change, and 1 = severe change.

RESULTS AND DISCUSSION

The ten Bolivian species along with the teak are ranked for surface checking, warping, erosion rate, and volumetric swelling in Table I. The surface checking and warping ratings were obtained from cyclic wetting and drying during exposure to ultraviolet radiation. This exposure indicates how well a wood species will perform in outdoor exposure. Teak has the least surface checking and warping, which confirms its reputation for good weathering characteristics. Cyclic wetting and drying caused excessive warping and surface checking in *Phyllostylon rhamnoides, Guibourtia chodatiana,* and *Caesalpinia* cf. *pluviosa.* In

TABLE 1. *Ranking of cracking, warping, erosion rate, and volumetric swelling.*[a]

Cracking[b]		Warping[b]		Erosion raw (μm/1,000 h)		Swelling[c] (%)	
Burmese teak	10	Burmese teak	8	*Astronium*	14	*Amburana*	4.0
Plantation teak	10	Plantation teak	8	*Diplotropis*	18	Burmese teak	4.4
Anadenanthera	8	***Anadenanthera***	8	*Guibourtia*	21	Plantation teak	5.0
Aspidosperma	8	***Tabebuia***	8	***Anadenanthera***	24	***Aspidosperma***	5.7
Tabebuia	8	***Aspidosperma***	7	***Schinopsis***	26	*Guibourtia*	5.8
Diplotropis	8	***Schinopsis***	7	*Caesalpinia*	29	***Schinopsis***	6.6
Schinopsis	7	*Phyllostylon*	5	*Phyllostylon*	44	*Astronium*	6.9
Astronium	6	*Amburana*	4	*Amburana*	54	***Tabebuia***	7.1
Amburana	6	*Astronium*	3	***Tabebuia***	67	*Phyllostylon*	7.0
Caesalpinia	3	*Caesalpinia*	3	Burmese teak	71	***Anadenanthera***	7.3
Guibourtia	2	*Guibourtia*	2	Plantation teak	71	*Caesalpinia*	7.9
Phyllostylon	1	*Dipiotropis*	1	***Aspidosperma***	81	*Diplotropis*	7.0

[a] Species in bold type are those best suited for outdoor use. The two types of teak are underlined for comparison. The replications are listed in Table 4.
[b] Average rating on a scale of 1 to 10 with 10 being the best condition.
[c] Volumetric swelling from 30% to 90% relative humidity.

contrast, *Anadenanthera macrocarpa, Aspidosperma cylindrocarpon, Tabebuia* spp., and *Schinopsis* cf. *quebracho-colorado* showed only minor warping and surface checking. (These species are in bold type in Table 1 to make it easier to compare their properties.) These four species should perform well in outdoor exposure but probably not as well as teak. The erosion rates are probably not a very good indication of how well a wood species will perform. Note that teak is near the bottom of the list for erosion rate in Table 1. Although the dense woods such as *Astronium urundeuva, Diplotropis purpurea,* and *Guibourtia chodatiana* weather very slowly, they are prone to warping and splitting.

Table 2 lists the erosion rates of each species along with some physical and anatomical properties that we suspect might influence weathering characteristics. The erosion rates were determined from a linear regression of the average erosion measurements. Several of

TABLE 2. *Physical properties.*

Species	Density[a] (kg/m^3)	*Erosion* rate (μm/ 1,000 h)	Color (heartwood)	Anatomical properties[b] I	II	III	IV	V
Amburana cearensis	640	54	Lt. brown	n	n	l	y	t-th
Anadenanthera macrocarpa	1,050	24	Dk. reddish brown	n	n	m	n	th-vt
Aspidosperma cylindrocarpon	730	81	Med. reddish tan	n	n	s	n	th
Astronium urundeuva	1,200	14	Dk. reddish brown	n	y	m	n	th-vt
Caesalpinia cf. *pluviosa*	980	29	Dk. brown	n	n	m	n	th
Diplotropis purpurea	910	18	Dk. brown	n	n	l	y	th
Guibourtia chodatiana	950	21	Med. reddish brown	n	n	m	n	th
Phyllostylon rhamnoides	990	44	Lt. yellowish tan	n	n	s	n	th
Schinopsis cf. *quebracho-colorado*	1,170	26	Dk. reddish brown	n	y	m	n	th-vt
Tabebuia	960	67	Dk. greenish brown	n	n	s	n	th-vt
Eucalyptus marginata	910	35	Dk. brownish red	n	y	1	n	th
Teak (native)	640	71	Lt. golden brown	y	y/n	m-l	n	t-th
Teak (plantation)	730	71	Lt. golden brown	y	y/n	m-l	n	t-th

[a]Volume and mass were measured at 65% RH (27°C), which corresponds to 12% EMC.
[b]Labels for columns are as follows:
I. Ring or semi-ring porous (n = no, y = yes)
II. Tyloses in vessels (n = no, y = yes)
III. Vessel size [s, small (>80 μm): m, medium (80-150 μm); l, large (>150 μm)]
IV Axial parenchyma abundant around vessels (n = no, y = yes)
V. Thickness of fiber walls (t, thin; th, thick; vt, very thick)

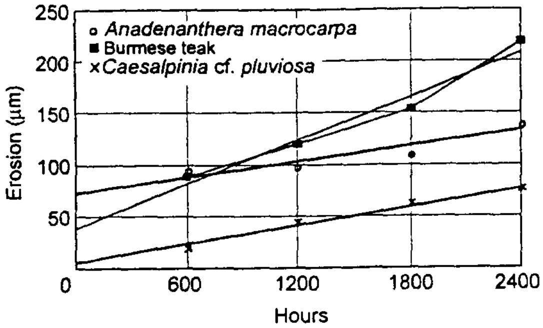

FIG. 1. Erosion of *Anadenanthera macrocarpa, Caesalpinia* cf. *pluviosa* (momoqui), and Burmese teak versus time of exposure in a weathering chamber (xenon arc radiation and periodic water spray). Each point is an average of 18 observations.

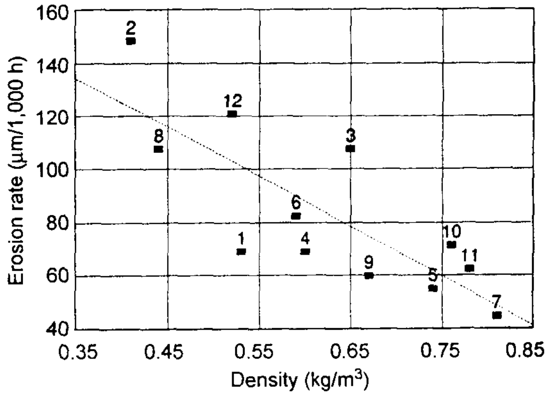

FIG. 2. Regression analysis of erosion rate versus density for temperate hardwoods determined from data by Sell and Feist (1986). R^2 = 0.64. 1. *Ulmus americana* (American elm), 2. *Tilia americana* (basswood), 3. *Betula alleghaniensis* (yellow birch). 4. *Prunus serotina* (black cherry), 5. *Fagus sylvatica* (European beech), 6. *Acer* sp. (maple), 7. *Carya* sp. (hickory). 8. *Alnus rubra* (red alder), 9. *Quercus rubra* (red oak), 10. *Fraxinus americana* (white ash), 11. *Quercus alba* (white oak), 12. *Liriodendron tulipifera* (yellow-poplar).

the erosion versus time plots are shown (Fig. 1). The Y-intercept was not fixed to 0 for the regression. During the first several hundred hours of exposure in the weathering chamber, the specimens undergo changes in the surface that seem to be unrelated to erosion (such as raised grain). Following this initial period, the erosion can be fit to a linear model if the time of weathering is not too long. In most cases, the R^2 values were above 0.90 for a regression of the average erosion.

The average density (12% equilibrium moisture content (EMC)) for the wood used in this study is listed in Table 2. Most of the species had densities ranging from 900 to slightly more than 1,000 kg/m^3. The exceptions to this were *Amburana cearensis* and *Aspidosperma cylindrocarpon,* which had a density similar to teak. At a specific moisture content, the density is determined primarily by the cell-wall thickness. High-density woods have thick-walled fibers and low-density woods have thin-walled fibers. The lowest density woods tested were teak, *Amburana cerarensis,* and *Aspidosperma cylindrocarpon.* Compared with species from the United States, these species are about the same density as northern red oak (*Quercus rubra* L.) and sugar maple (*Acer saccharum* Marsh.), which are some of the higher density woods in the United States. The erosion rates of teak, *Amburana cerarensis,* and *Aspidosperma cylindrocarpon* are among the highest rates for the species tested. For temperate hardwoods, the erosion rate has been shown to be related to wood density (Sell and Feist 1986). The data reported by Sell and Feist for 12 temperate hardwoods, with specific gravities in the range of 0.41 to 0.81, were replotted (Fig. 2). Using the erosion measurement reported by Sell and Feist, we found the R^2 for the linear regression analyses of erosion rate versus density to be only 0.64 (Fig. 2). In the work reported here, the plot of erosion rate versus density gave an even poorer correlation (Fig. 3; R^2 = *0.57).* In an effort to explain these poor correlations, several anatomical characteristics were evaluated for their effect on the erosion rate. In many temperate species like oak, elm, and ash, the wood is distinctly ring-porous and these vessels tend to increase the erosion rate of the earlywood, particularly if they have large diameters (Williams et al. 2001).

As with most tropical species, all the species are diffuse-porous, except teak, which is ring- to semi-ring porous. The pore (vessel) diameter is directly related to grain coarse-

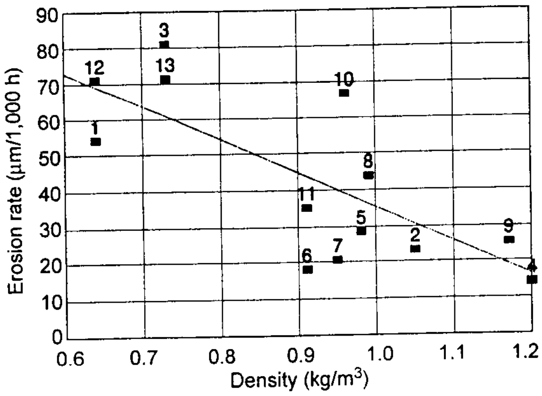

FIG. 3. Regression analysis of erosion rate versus density. R^2 = 0.57. 1. *Amburana cearensis,* 2. *Anadenanthera macrocarpa,* 3. *Aspidosperma cylindrocarpon,* 4. *Astronium urundeuva,* 5. *Caesalpinia* cf. *pluviosa,* 6. *Diplotropis purpurea,* 7. *Guibourtia chodatiana,* 8. *Phyllostylon rhamnoides,* 9. *Schinopsis* cf. *quebracho-colorado,* 10. *Tabebuia* spp., 11. *Eucalyptus marginata,* 12. *Tectona grandis* (teak, natively grown from Burma), 13. *Tectona grandis* (teak, plantation-grown from Central America).

ness—the smaller the vessel diameter, the finer the texture. Since the vessel is largely air space, wood with larger vessel diameters might be expected to erode faster than wood with smaller vessel diameters. We grouped vessel diameters into three classes, small (<80 µm), medium (80-150 µm), and large (>150 µm), which more or less correlates with fine, medium, and coarse texture. By comparing the pore sizes with the position of each species in Fig. 3, it appears that the species that have the largest vessel diameters (*Eucalyptus marginata, Diplotropis purpurea,* and *Amburana cerarensis*) lie below the average density/erosion rate line. Woods with small vessel diameters (*Phyllostylon rhamnoides, Aspidosperma cylindrocarpon,* and *Tabebuia* spp.) lie above this line. Thus, it appears that vessel diameter may have some effect on erosion rate for these species.

Axial parenchyma cells are very thin-walled cells that occur in various patterns in wood. Since these cells are thin-walled, the abundance of axial parenchyma surrounding the vessels might affect the erosion rate. *Diplotropis purpurea* and *Amburana cearensis* have an abundance of axial parenchyma surrounding their vessels, and both lie below the line in Fig. 3. This would indicate that the erosion is slower for those species, which is the opposite of what was expected. As mentioned previously, the erosion measurements were made as far from the vessels as possible. Since the axial parenchyma cells are found close to the vessels, their presence is probably not reflected in the measurements. This might explain the apparent inconsistency.

The occurrence of tyloses in the vessels appears to have no effect on the erosion rate (Table 2). Thus, the deviation from a linear relationship between density and erosion rate appears to be related to the pore size in these dense diffuse-porous species. The evidence for this is rather tenuous, and additional studies are planned to investigate this further.

Color of heartwood and extractives content had no noticeable effect on the erosion rate. All species lost almost all color (surface extractives) within 1,200 h of weathering (Table 3). The shades of gray differed among the species. In the absence of mildew growth in the xenon arc weathering chamber, the color of several of the wood species was an attractive silver gray (Figs. 4-8).

A summary of the surface checking and warping observations is given in Table 3. *Anadenanthera macrocarpa, Aspidosperma cylindrocarpon, Schinopsis* cf. *quebracho-colorado,* and *Tabebuia* spp. were reasonably stable through numerous wetting and drying cycles. However, none of the specimens was as stable as the Burmese and plantation-grown teak. Because the cycling was done in a weathering device, we could also evaluate the specimens for surface roughness. Many of the wood species performed similarly to the teak. Figures 4 to 8 show the warping, splitting, checking, and surface changes of the specimens caused by cyclic weathering. *Anadenanthera macrocarpa* (Fig. 4) is an example of the species that had properties similar to teak (Fig. 5). Warping was rather severe with some species as shown by *Astronium urundeuva* (Fig. 6). Examples of severe surface checking

TABLE 3. *Color change, surface roughness, warping, and cracking of 75- by 10- by 6-mm specimens exposed to xenon arc UV radiation and intermittent water spray for 2,400 h.*[a,b]

Species	Color change				Surface roughness				Warping				Surface checking			
	600 h[c]	1,200 h	1,800 h	2,400 h	600 h	1,200 h	1,800 h	2,400 h	600 h	1,200 h	1,800 h	2,400 h	600 h	1,200 h	1,800 h	2,400 h
Amburana cearensis	5	1	1	1	5	5	5	1-5-1	5-8-1	1-8-1	5-8-1	1-8-1	5-10-8	5-8-8	5-8-5	5-8-5
Anadenanthera macrocarpa	5	1	1	1	5-5-8	5	5	5	8	8	8	8	10	8	8	8
Aspidosperma cylindrocarpon	1	1	1	1	8	8	8	8	5-8	5-8	8	5-8	8-10	8	8	8
Astronium urundeuva	1	1	1	1	5	5	5	5	5-1-5	1-1-5	5-1-5	1-1-5	8	8	5-8-8	5-8-5
Caesalpinia cf. *pluviosa*	5	1	1	1	8	8	8	5	1-5	1-5	1-5	1-5	5-8	5-8	5-8	5-8
Diplotropis purpurea	5	1	1	1	1	1	1	1	5	1	1	1	8	8	8	8
Guibourtia chodatiana	5	1	1	1	8	8	8	8	5-5-1	5-5-1	5-5-1	1-5-1	5-1-5	5-1-5	1-1-5	1-1-5
Phyllostylon rhamnoides	5	1	1	1	8	8	8	8	5	5	5	5	5	5-1	1	1
Schinopsis cf. *quebracho-colorado*	1	1	1	1	8-5	8-5	8-5	8-5	5-8	5-8	5-8	5-8	8-10	8-10	8-10	5-8
Tabebuia	5	1	1	1	5-8-5	5-8-5	5	5	8-8-5	8-8-5	8	8	10	10-8-8	8	8
Teak (native)	5	1	1	1	5	5	5	5-1-1	8	8	8	8	10	10	10	10
Teak (plantation)	1	1	1	1	8	8	8-5	8-5	10-8	8	8	8	10	10	10	10

[a] 10 = no change, 8 = slight change, 5 = moderate change, 1 = severe change.
[b] One number implies that all specimens were the same (two or three replicas per species).
[c] Hours of exposure.

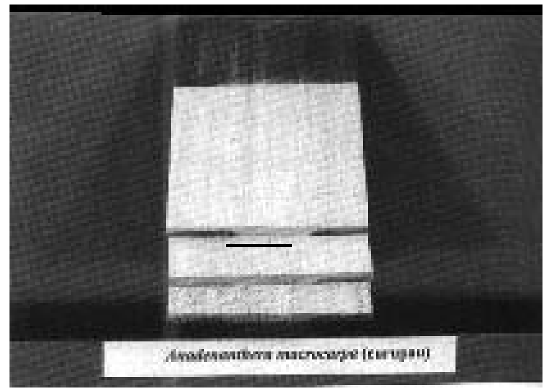

FIG. 4. *Anadenanthera macrocarpa* after 2,400 h exposure to accelerated weathering.

and cracking are also shown for *Amburana cearensis* and *Guibourtia chodatiana* (Figs. 7 and 8).

The ranking of volumetric swelling in Table 1 probably gives a good indication of performance indoors. Note that teak is near the top of the list. Although *Amburana cearensis* and *Guibourtia chodatiana* probably would not perform very well outdoors, they have good dimensional stability in the range of 30% to 90% RH and probably would perform well indoors. The longitudinal swelling of *Aspidosperma cylindrocarpon* was rather high (0.31%), and this may cause problems if long pieces are used (Table 4). The longitudinal swelling was high for some of the other species (*Astronium urundeuva* (0.20%), *Guibour-*

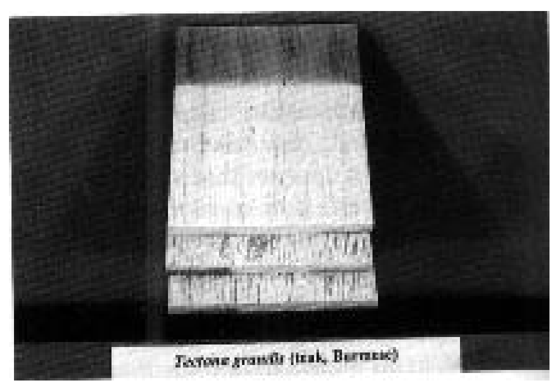

FIG. 5. *Tectona grandis* (teak) after 2.400 h exposure to accelerated weathering.

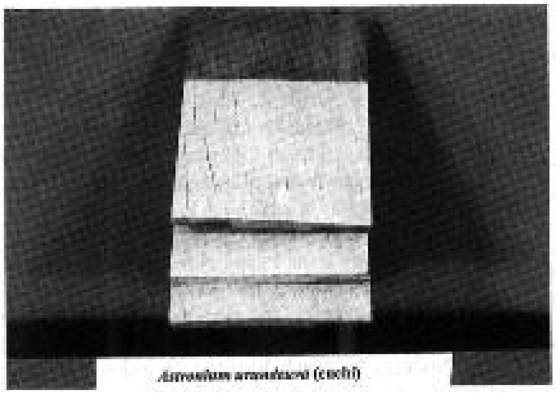

FIG. 6. *Astronium urundeuva* after 2,400 h exposure to accelerated weathering.

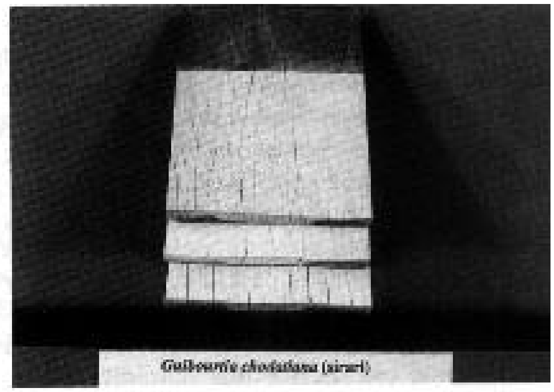

FIG. 8. *Guibourtia chodatiana* after 2,400 h exposure to accelerated weathering.

tia chodatiana (0.21%), and *Phyllostylon rhamnoides* (0.23%)), including plantation-grown teak (0.23%).

CONCLUSIONS

The weathering characteristics and dimensional stability of the ten species varied considerably. None of the Bolivian wood species was as resistant to surface checks and warping as teak; however, *Anadenanthera macrocarpa, Aspidosperma cylindrocarpon*, *Schinopsis* cf. *quebracho-colorado*, and *Tabebuia* spp. were next best. Of these four species, *Anadenanthera macrocarpa* and *Schinopsis* cf. *quebracho-colorado* were much more resistant to erosion than teak, probably because of their high density. The dimensional stability for *Amburana cearensis* and *Guibourtia chodatiana* was about the same as teak, but they warped and checked. On the basis of the limited number of samples of each species, it appears that *Anadenanthera macrocarpa*, *Aspidosperma cylindrocarpon, Schinopsis* cf. *quebracho-colorado,* and *Tabebuia* spp. could be used to manufacture furniture and similar items for use outdoors. However, this study did not address the machining characteristics of these species, and the more dense species may be difficult to machine. Durability with regard to the decay or insect attack was not

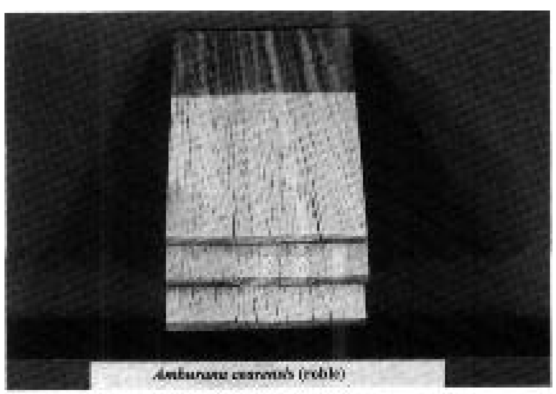

FIG. 7. *Amburana cearensis* after 2,400 h exposure to accelerated weathering.

TABLE 4. *Average dimensional change (30% to 90% RH).*[a]

Species	Dimensional change (%)	
	Longitudinal	Volume
Amburana cearensis	0.06 (4)	4.0 (4)
Anadenanthera macrocarpa	0.16 (4)	7.3 (4)
Aspidosperma cylindrocarpon	0.31 (2)	5.7 (2)
Astronium urundeuva	0.20 (4)	6.9 (4)
Caesalpinia cf. *pluviosa*	0.17 (4)	7.9 (4)
Diplotropis purpurea	0.09 (3)	7.0 (3)
Guibourtia chodatiana	0.21 (4)	5.8 (4)
Phyllostylon rhamnoides	0.23 (4)	7.0 (4)
Schinopsis cf. *quebracho-colorado*	0.16 (4)	6.6 (4)
Tubebuia	0.13 (4)	7.0 (4)
Eucalyptus marginata	0.09 (6)	7.7 (6)
Teak (native)	0.09 (3)	4.4 (3)
Teak (plantation)	0.23 (2)	5.0 (2)

[a]The number in parentheses is the number of specimens used to obtain the average value.

determined but will be reported in part 2. *Astronium urundeuva, Diplotropis purpurea,* and *Amburana cearensis* showed considerable warp. *Phyllostylon rhamnoides, Caesalpinia* cf. *pluviosa,* and *Guibourtia chodatiana* were badly checked and split. With changes in relative humidity in the range of 30% to 90%, all species showed good dimensional stability. They all seem to have excellent properties for manufacturing products for indoor use. However, some species had fairly high longitudinal dimensional change for this humidity range. These may not be suitable for flooring, unless short lengths are used.

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