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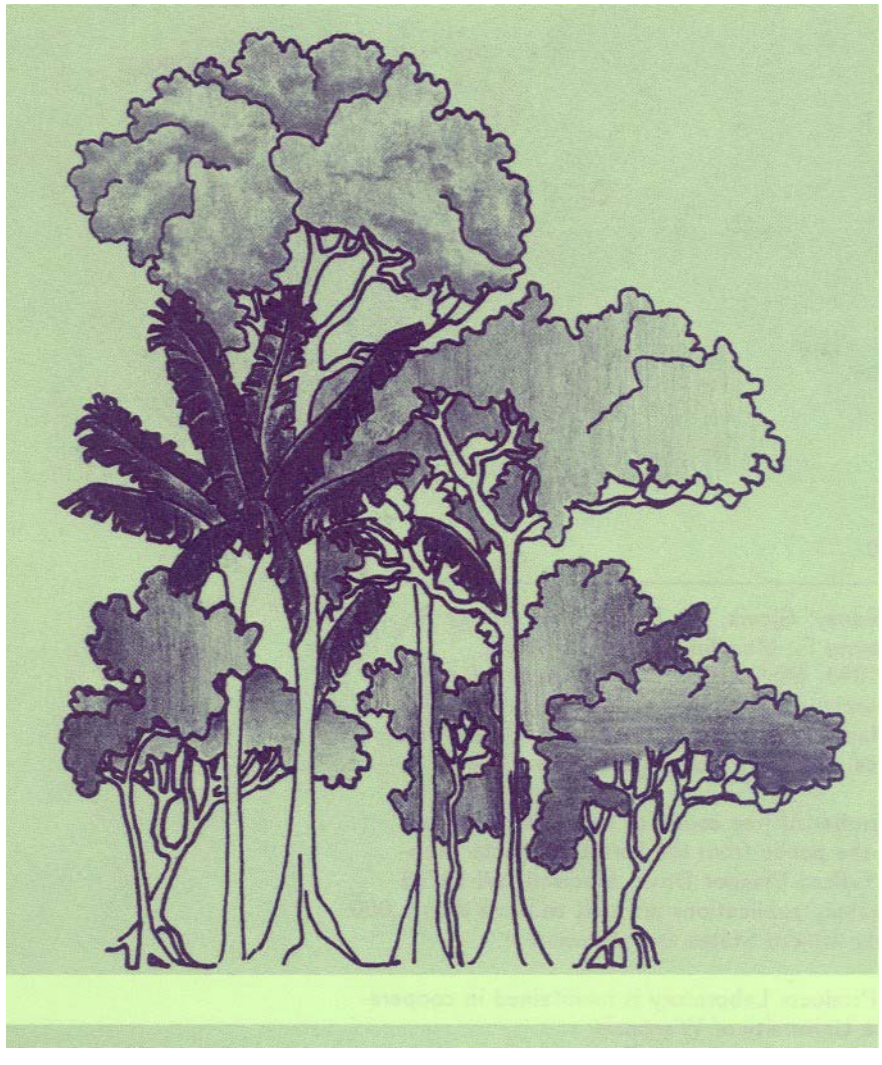
Bibliography of FPL Tropical Forest Utilization Research—1910 to 1989



Abstract

A complete annotated bibliography of all published and unpublished reports of the USDA Forest Service, Forest Products Laboratory, on the subject of tropical woods. Research on tropical woods began soon after the formation of the Forest Products Laboratory in 1910 and continues today.

Keywords: Forest products, Forest Products Laboratory, tropical timbers, utilization, wood, wood products, wood residues

Contents

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A limited number of free copies of this publication are available to the public from the Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53705–2398. Laboratory publications are sent to more than 1,000 libraries in the United States and elsewhere.

The Forest Products Laboratory is maintained in cooperation with the University of Wisconsin.

Bibliography of FPL Tropical Forest Utilization Research—1910 to 1989

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Preface

The cornerstone of USDA Forest Service philosophy was established by a letter from U.S. Secretary of Agriculture James Wilson to Gifford Pinchot, dated February 1, 1905–the same day President Theodore Roosevelt signed the act establishing the Forest Service (H.R. 8460), which transferred the Forest Reserves from the Department of Interior to the Department of Agriculture. In part, that letter reads,

> In the administration of the forest reserves it must be clearly borne in mind that all land is to be devoted to its most productive use for the permanent good of the whole people and not for the temporary benefit of individuals or companies. All the resources of forest reserves are for use, and this use must be brought about in a thoroughly prompt and businesslike manner, under such restrictions only as will insure the permanence of these resources. (James Wilson 1905)

In pursuit of this objective, the idea of a centralized wood utilization research laboratory was formulated. On March 5, 1909, Secretary of Agriculture James Wilson announced plans to locate a Forest Products Laboratory on the campus of the University of Wisconsin, Madison. The organization of the Laboratory called for six technical sections—timber testing, wood preservation, wood distillation, wood technology, pulp and paper, and wood chemistry.

The Forest Products Laboratory (FPL) officially opened on June 4, 1910, with a celebration attracting 500 visitors—including railroad engineers, pulp and paper manufacturers, the editor of the American Lumberman, a secretary of the Yellow Pine Manufacturers' Association, and the executive secretary of the American Forestry Association. A reporter for the "Hardwood Record" commented,

> The most noticeable thing in connection with the celebration was the apparent feeling of absolute confidence on the part of all those present in the full ability of the Laboratory . . . to solve many of the perplexing questions constantly presenting themselves before the woodworking industries of the country, and in the course of time to put conservative methods of manufacture on a basis which will render their adoption by lumbermen a money-saving departure . . . (Hardwood Record 1910)

Research at the FPL was directed towards the use of both softwood and hardwood species grown and used in the United States, but from the beginning research has also often been related to problems associated with the use of tropical woods. In the ensuing years, considerable research on tropical woods has been conducted at the FPL.

This bibliography lists published and unpublished reports generated by the USDA Forest Service, Forest Products Laboratory between 1910 and 1989, relating to the use of tropical timber.

It represents an effort to identity information that could help protect and promote the future productivity of tropical forest in Latin America though efficient utilization practices.

The references are listed chronologically within 11 major categories: wood anatomy and mechanical properties, chemistry, engineering, energy, pulp and paper, sawing and drying, veneer and plywood, wood preservation, hardboard and particleboard, general utilization, and miscellaneous. An abstract follows every reference citation.

Wood Anatomy and Mechanical Properties

1917 **Maudlin, C.V.** The mechanical properties of Panama mahogany. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 5 p.

Abstract: The Panama mahogany specimens came from the west coast of Panama. Specific gravity was 25 percent less than that of true mahogany; however, when reduction is made for differences in moisture and weight, Panama mahogany shows strength values considerably above those of true mahogany. Marked improvement in manufacture of propellers would result from use of quarter-sawn (radial-cut) planks.

1918 **Horn, Eugene F.** Brazilian woods suitable for propeller manufacture. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 13 p.

Abstract: The most promising Brazilian woods for propeller manufacture are imbuia, canella parda, canella sassafraz, urucurana, and vinhatico. Retention of symmetry and shape under variable conditions of humidity is of paramount importance. Good propeller wood should be stiff, strong, hard, and fairly dense without being exceedingly heavy.

1920 **Heck, G.E.** Brazilian woods (nine species) tested for hardness, specific gravity and shrinkage. Office memorandum (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 4 p.

Abstract: Tests were conducted to assess suitability of nine Brazilian species (i.e., cabreuva, cedro, embuya, ipe, jacaranda, jatshy, jequetiba, marfim, and pereba) for furniture manufacture. Test results are compared with those of Central American mahogany, black walnut, and southern white oak. Because the sample basis was small, results were considered inconclusive.

1927 **Koehler, Arthur.** Report of tests on six Argentine woods sent by C.V. Pereda, Buenos Aires, in 1926. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 14 p.

Abstract: Logs of six different Argentine species were sent to the FPL for evaluations of their potential use in manufacturing lumber, veneer and plywood, furniture, millwork, and wine casks. Logs of the following species were received at the FPL in December of 1926:

Common name	Scientific name	Family
Roble	*Torresea cearensis* Fr. Allem	Leguminosae
Cedro	*Cedrela fissilis* Vell.	Meliaceae
Cebil colorado	*Piptadenia macrocarpa* Benth.	Leguminosae
Cebil moro	*Piptadenia communis Benth.*	Leguminosae
Palo blanco	*Calycophyllum multiflorum* Gris.	Rubiaceae
Palo amarillo	*Phyllostylon brasiliensis* Cap.	Ulmaceae

This report details FPL-determined specific gravity and shrinkage characteristics from green to ovendry conditions and describes the general appearance and physical characteristics of the six species.

1928 **Koehler, Arthur.** Tests on six Argentine woods. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 8 p.

Abstract: FPL processing and testing indicated the species (see Koehler 1927) did not offer any unusual drying problems, any particular difficulty in cutting veneer from flitches, or any problems in layup to produce plywood. General descriptions of the samples are reported.

1935 **Heck, G.E.** Results of tests of Cuban-grown teak *(Tectona grandis).* Unpublished report (Vault copy). (In cooperation with Prof. Thomas Barbour, Museum of Comparative Zoology, Harvard College, Cambridge, MA.) Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 4 p.

Abstract: Tests indicated that Cuban-grown teak is about the same as Asiatic teak from Burma and Malabar in density. It averaged higher in work values, compression perpendicular to grain, hardness, and shear; but it

averaged lower in bending strength and compression parallel to grain and in stiffness. Results were from a single Cuban-grown teak tree and therefore do not indicate likely tree-to-tree variations.

1946 **Baudendistel, Martin E.** Report on specific gravity and shrinkage determinations made on tropical woods collected by members of the Latin American Forest Resource Survey in Costa Rica and Panama, shipments 1581 and 1581a. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 15 p.

Abstract: Specific gravity and shrinkage characteristics for 67 species from Costa Rica and Panama are presented.

1946 **Baudendistel, Martin E.; Benson H. Paul.** Report on specific gravity and shrinkage determinations made on tropical woods collected by members of the Latin American Forest Resource Survey in Ecuador, shipments 1588 and 1595. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 20 p.

Abstract: Shipments of tropical wood samples were received at the FPL from trees grown in the vicinities of San Lorenzo, Quininde, and Playa de Oro, Ecuador. Thirty-seven species were evaluated to determine their specific gravity and shrinkage characteristics. It appeared that the heaviest species had the greatest volumetric shrinkage, but species low in specific gravity did not always shrink the least. The presence of extractives may have influenced the amount of shrinkage.

1947 **Dohr, A.W.** The compressive strength, hardness, and toughness of Ecuadorian woods. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: The Latin American Forest Resource Survey in 1943 furnished wood specimens from 41 different Ecuadorian woods that were identified and assessed for specific gravity and shrinkage at the Forest Products Laboratory in Madison, WI. This report presents the results of compression, hardness, and toughness tests for these materials. The materials received were limited in amount, size, and quality. Therefore, data presented by this report are not necessarily representative of the species.

1948 **Dohr, A.W.; Drow, J.T.** The mechanical properties of insignis pine *(Pinus radiata)* from Chile. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 13 p.

Abstract: Rapid growth and higher than normal hardness in relation to density are characteristic of insignis pine *(Pinus radiata)* grown in Chile. The material tends to be brittle, resulting in sudden and brash breaks when overloaded. This species is comparable to red (Noway) pine grown in the United States, with an average specific gravity of 0.44 at green volume and ovendry weight.

1949 **Davis, E.M.** Exploratory tests on machining and related properties of 15 tropical American hardwoods. Unpublished Report No. R1744 (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 15 p.

Abstract: In response to the increasing requests from American importers and manufacturers for information on tropical American hardwoods, study was directed to 15 woods for comparison with native hardwoods. Samples were assessed for machining, shaping, turning, sanding, boring, and mortising. In general, the tropical woods machined about as well as domestic hardwoods, and with most, it seems unlikely that machining difficulties will restrict their use.

1949 **Dohr, A.W.** The mechanical properties of coigue *(Nothofagus dombeyi)* from Chile. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 13 p.

Abstract: Study indicated that extreme precautions should be taken in comparing strength properties of coigue with those of other species because of great variability caused by internal scars, worm holes, deterioration in the pith area, and severity of checking, warping, and localized shrinkage peculiarities.

1951 **Pillow, Maxon Y.** Some characteristics of Brazilian Parana pine affecting its use for millwork. Unpublished report. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 12 p.

Abstract: Parana pine (softwood species, *Araucaria,* imported from Brazil) is used for general millwork, picture frames, venetian blinds, and other specialized purposes. Because of a tendency to warp, the FPL received many requests for information on the characteristics and kiln drying of Parana pine. Warping was found to be caused by compression wood and frequently occurred when boards were planed, ripped, or resawn, although rough lumber stayed reasonably straight. Experimental kiln runs indicated a need for equalization to produce uniformly dried lumber and for conditioning to relieve transverse case-hardening stresses. Neither high-temperature nor low-temperature kiln drying was found to be superior to air drying followed by kiln drying at moderate temperatures (150°F to 170°F).

1952 **Dohr, A.W.** The mechanical properties of araucaria wood from South America. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 30 p.

Abstract: Strength values of *Araucaria,* commonly known as Parana pine, compare favorably with those of domestic softwood species of similar density. However, Parana pine is especially high in shear but noticeably low in compression across grain. Strength values are influenced by presence of compression wood, which is also responsible for much of the warping observed in this species.

1953 **Dohr, A.W.** Mechanical properties of Brazilian Araucaria (Parana pine) compared to certain United States species. Unpublished report. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 6 p.

Abstract: Parana pine is a large softwood species of southern Brazil and parts of Paraguay and Argentina and is the most exploited species in South America. Parana pine was found to have strength values that compare favorably with those of U.S. softwood species of similar density (0.496 specific gravity at 12.8 percent moisture content), with especially good shear strength, hardness, and nail-holding, but deficient in strength in compression across the grain. Strength values were found to be influenced by the presence of compression wood and wood having excessive longitudinal shrinkage thought to contribute to warping.

1954 **Gerry, Eloise: Kryn, J.M.** Cativo: *Prioria copaifera* Gris. Fam.: Leguminosae (Caesalpiniaceae). Foreign Woods Information Leaflet No. 52. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 13 p.

Abstract: Describes wood anatomy mechanical properties, drying, shrinkage, durability, gluing, and pulping characteristics of cativo, a tropical wood of Latin America.

1958 **Kukachka, B.F.; Kryn, J.M.** Cativo: *Prioria copaifera* Gris. FPL Rep. No. 1998. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 13 p.

Abstract: Describes wood anatomy mechanical properties, drying, shrinkage, durability, gluing, and pulping characteristics of cativo, a tropical wood of Latin America.

1964 **Bendtsen, B.A.** Some strength and related properties of yagrumo hembra *(Cecropia peltata)* from Puerto Rico. Res. Note FPL–053. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 11 p.

Abstract: Specimens from five yagrumo hembra trees were evaluated. Although these specimens were lower in specific gravity and strength properties than material previously reported, they were about the same with respect to toughness and modulus of elasticity in both bending and compression parallel to grain. A wide range of specific gravity was evident, from approximately equal to twice that of balsa.

1964 **Kukachka, B.F.** Spanish-cedar: Cedrela spp. Res. Note FPL-078. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 7 p.

Abstract: Describes the tropical woods known as cigar cedar or cedro, including characteristics for identification, uses, and drying properties.

1965 **Kukachka, B.F.** Cativo: *Prioria copaifera* Gris. Res. Note FPL-095. Madison, WI: U.S. Department of Agricutture, Forest Service, Forest Products Laboratory. 13 p.

Abstract: Describes wood anatomy mechanical properties, drying, shrinkage, durability, gluing, and pulping characteristics of cativo, a tropical wood of Latin America.

1970 **Kukachka, B.F.** Properties of imported tropical woods. Res. Pap. FPL 125. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 67 p.

Abstract: Describes several imported tropical woods listing their scientific and common names and working properties such as drying, shrinkage, and machining. Also lists tropical properties such as density.

1976 **Chudnoff, Martin.** Density of tropical timbers as influenced by climatic life zones. Commonwealth Forest Review. 55(3): 103-217.

Abstract: Investigation was made to determine if the xylem pool, as well as forest physiognomies, vary with tropical life zones. Histograms were prepared to show percentages of species in six specific gravity classes. Sampling included 26 survey sites located in 6 lowland frostfree life zones. A preponderance of species in the >0.69 specific gravity class are shown. Histograms of percentage of volume and percentage of species showed agreement with the properties of species over 0.69 specific gravity.

1977 **Wahlgren, H.E.; Laundrie, J.F.** Properties of 50 Philippine, 22 Ghanaian, and 18 Colombian hardwood barks. AID Report No. 10. Washington, DC: U.S. Department of State, Agency for International Development.

Abstract: Describes physical properties of 90 tropical woods from the Philippines, Ghana, and Colombia, listing bark properties, silica and ash content, specific gravity, thermal values, and pulping properties.

1978 **Koeppen, R.C.** Some anatomical characteristics of tropical woods. In: Proceedings of conference on improved utilization of tropical forests.

Abstract: Describes anatomical characteristics including identifying characters of 90 tropical woods.

1978 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: IV. *Achrouteria.* Res. Pap. FPL 328. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 8 p.

Abstract: Describes the wood anatomy of the genus *Achrouteria,* family Sapotaceae, that are found in Guyana, Surinam, Brazil, Amazon, and Guiana.

1978 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: V. *Calarpum.* Res. Pap. FPL 329. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 5 p.

Abstract: Describes the wood anatomy of the genus *Calcarpum,* family Sapotaceae, that are found in Mexico and Central America.

1978 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: VI. *Chloroluma.* Res. Pap. FPL 330. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 5 p.

Abstract: Describes the wood anatomy of the genus *Chloroluma,* family Sapotaceae, that are found in Brazil, Argentina, Paraguay, and Bolivia.

1979 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: VIII. *Diploon.* Res. Pap. FPL 349. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 4 p.

Abstract: Describes the wood anatomy of the genus *Diploon,* family Sapotaceae, that are found in Venezuela and Brazil.

1979 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: X. *Micropholis.* Res. Pap. FPL 351. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 16 p.

Abstract: Describes the wood anatomy of the genus *Micropholis,* family Sapotaceae, that are found in Peru, Panama, Argentina, Bolivia, Colombia, Ecuador, West Indies, Mexico, Belize, Guatemala, and the Guianas.

1979 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XI. *Prieurella.* Res. Pap. FPL 352. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 8 p.

Abstract: Describes the wood anatomy of the genus *Prieurella,* family Sapotaceae, that are found in Peru, Brazil, Venezuela, and Colombia.

1979 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XII. *Neoxythece.* Res. Pap. FPL 353. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 10 p.

Abstract: Describes the wood anatomy of the genus *Neoxythece,* family Sapotaceae, that are found in Brazil, Amazon Basin, and South America.

1980 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XIV *Elaeoluma.* Res. Pap. FPL 358. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 6 p.

Abstract: Describes the wood anatomy of the genus *Elaeoluma,* family Sapotaceae, that are found in Brazil and Peru.

1980 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XV. *Sandwithiodoxa.* Res. Pap. FPL 359. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 6p.

Abstract: Describes the wood anatomy of the genus *Sandwithiodoxa,* family Sapotaceae, that are found in Africa, Amazonia, Mexico, and Peru.

1980 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XVIII. *Gomphiluma.* Res. Pap. FPL 362. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 3 p.

Abstract: Describes the wood anatomy of the genus *Gomphiluma,* family Sapotaceae, that are found in Brazil.

1981 **Bendtsen,B.Alan:Chudnoff,Martin.** Properties of seven Colombian woods. Res. Note FPL–0242. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 12 p.

Abstract: This paper presents evaluations for mechanical properties of seven Colombian woods. Results are supplemented by information from world literature concerning other wood properties considered important for effective utilization.

1981 **Cassens,Daniel: Miller,R.B.** Woodanatomy of the new world Pithecellobium (sensu lato). Journal Paper No. 7752. West Lafayette, IN: Purdue University, Agricultural Experiment Station.

Abstract: Describes wood anatomy for identification purposes of the species of Pithecellobium in the new world.

1982 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XXVIII. *Labatia.* Res. Pap. FPL 416. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 8 p.

Abstract: Describes the wood anatomy of the genus *Labatia,* family Sapotaceae, that are found in Venezuela, Guianas, Panama, Brazil, Haiti, and the Dominican Republic.

1982 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XXIX. *Eglerodendron.* Res. Pap. FPL 417. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 4 p.

Abstract: Describes the wood anatomy of the genus *Eglerodendron,* family Sapotaceae, that are found in the Amazon Basin of Brazil.

1982 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XXX. *Pseudocladia.* Res. Pap. FPL 418. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 6 p.

Abstract: Describes the wood anatomy of the genus ***Pseudocladia,*** family Sapotaceae, that are found in Guyana, Surinam, and Brazil.

1982 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XXXIII. *Englerella.* Res. Pap. FPL 421. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 10 p.

Abstract: Describes the wood anatomy of the genus *Englerella,* family Sapotaceae, that are found in Colombia, Ecuador; Peru, Venezuela, and Brazil.

1982 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XXXIV. *Franchetella–Eremol.* Res. Pap. FPL 422. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 10 p.

Abstract: Describes the wood anatomy of the genus *Franchetella–Eremol,* family Sapotaceae, that are found in Peru and French Guiana.

1982 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XXXV. *Urbanella.* Res. Pap. FPL 423. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 6 p.

Abstract: Describes the wood anatomy of the genus *Urbanella,* family Sapotaceae, that are found in Brazil, Peru, and Martinique.

1982 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XXXVII. *Genus* novo. Res. Pap. FPL 425. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. **4** p.

Abstract: Describes the wood anatomy of the genus *Genus* novo, family Sapotaceae, that are found in Brazil, Surinam, Panama, and Venezuela. Also noted is the use for turning–squares and furniture.

1982 **Kukachka, B.F.** Wood anatomy of neotropical Sapotaceae: XXXVIII. Miscellaneous. Res. Pap. FPL 426. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. *7* p.

Abstract: Describes the wood anatomy of the family Sapotaceae that is found in Columbia and Brazil.

1983 **Quirk, J.T.** Data for computer-assisted wood identification system. IAWA Bulletin n.s. 4(2/3): 118–130.

Abstract: Describes the wood anatomy of 39 species in 13 genera of the family Leguminosae that are found in southeastern Asia and Australia. An identification key to species is presented.

1984 **Chudnoff, Martin.** Tropical timbers of the world. Agric. Handbook No. 607. Washington, DC: U.S. Department of Agriculture, Forest Service. 466 p.

Abstract: This handbook contains descriptions of 370 species or generic groupings of tropical trees and their timbers grouped by regional origin: Tropical America, Africa, and Southeast Asia and Oceania. Standardized descriptions emphasize physical and mechanical properties, processing characteristics, and uses. Data have been compiled, evaluated, and synthesized from the world literature. Extensive tables of technical data are coded to permit easy comparison of species properties and to aid in the selection of woods most suitable for particular end uses.

1986 **Miller, R.B.** Timbers of Central and South America. In: Bever, Michael B., ed. Encyclopedia of Materials Science and Engineering; vol. 8. Elmsford, NY: Pergamon Press, Inc.: 5025–5031.

Abstract: The author discusses the timbers of Central and South America and summarizes the properties and uses of these woods.

1987 **Miller, R.B.: Pearson, R.G.;** Wheeler, E.A. Creation of a large database with IAWA standard list characters. IAWA Bull. 8(3): 219-232.

Abstract: This paper is intended to contribute to the discussion leading to a revised IAWA Standard list of characters suitable for computer-assisted wood identification.

Chemistry

1913 **Schorger, A.W.** Report on analysis of leaf and twig oil of Cuban pine. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 5 p.

Abstract: The range of chemical properties are reported for five samples of Cuban pine oil.

Engineering

1975 **Sherwood, G.: Wilkinson, T.** Fastenersfor timber construction in high wind areas. In: FY 1975 progress report on design criteria and methodology for construction of low-rise buildings to better resist typhoons and hurricanes. National Bureau of Standards, Center for Building Technology, Washington, DC. Report NBSIR 75–790. Appendix F, Chapter 3, p. 46-89.

Abstract: Describes construction techniques for tropical storm areas, for example, tropical areas of Jamaica, Bangladesh, and the Philippines.

1977 **Sherwood, G.: Wilkinson, T.** Fastenersfortimber construction in high-wind areas. In: Proceedings of IAHS international symposium on housing problems; 1976 May 24–28;Atlanta, GA. Clemson, SC: Clemson University 2: 1290–1303.

Abstract: Describes low-rise construction in tropical areas with poles, wood, concrete, and masonry materials. Includes discussion of wind and the use of fasteners such as nails, screws, bolts, lag–screws, and split-rings.

1977 **Sherwood, G.; Wilkinson, T.** Fastenersfortimber construction in high wind areas. NBS Building Science Series 100, vol. 3. National Bureau of Standards; 27-46. In cooperation with: U.S. National Bureau of Standards.

Abstract: Describes construction techniques for tropical areas including Jamaica, Bangladesh, and the Philippines.

Energy

1981 **Baker, A.; Jeffries, T.** Status of wood hydrolysis for ethanol production. Report to USDA Forest Service for Agency for International Development, Development Support Bureau, Office of Energy. 66 p.

Abstract: Reviews alcohol production research as reported in world literature.

1981 **Zerbe, J.; Baker, A.; Jeffries, T.** Estimating commercial-scale pilot plant for alcohol from biomass. LDC's report to Timber Management Research. Washington, DC: U.S. Department of Agriculture, Forest Service.

Abstract: Describes research and pilot studies for production of alcohol from biomass in the Philippines and Brazil.

Pulp and Paper

1911 **Kirsch, Simon.** Microscopic examination of two samples of pulp from Mexican mill waste *(Pinus ponderosa).* Chemistry and Paper Research Project L–147. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Examinations were made on a soda and a bisulphite pulp made in an autoclave at the FPL. Average fiber length was 2.49 mm and average fiber width was 0.41 mm. The bisulphite fibers were much more kinked and twisted than the soda fibers. This is probably due to the greater weakness of their walls. It was concluded that the soda pulp would probably make a much stronger paper than the bisulphite pulp.

1913 **Gerry, E.** A preliminary microscopical examination of certain Argentine woods in respect to their pulp making qualities. Unpublished report (Vault Copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Seven temperate zone woods with common names of coigue, cipres, radal, niri, manui, lenge, and alerce had average fiber lengths of 0.66, 1.93, 0.88, 0.64, 1.36, 0.72, and 2.06 mm, respectively. Pulping tests were not made.

1915 **Wells, S.D.** Experiments to determine the suitability of certain Chilean woods for the manufacture of paper pulp. Chemistry and Paper Research Project 168. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Semicommercial digester cooks were made using olivillo, coigue, lingue, and quila. Bleaching experiments were run and the resulting pulps were used in papermaking with a fourdrinier machine. Olivillo was found suitable for natural colored wrapping paper, bleached coigue and lingue soda pulp suitable for book and similar papers, unbleached quila suitable for news or wrapping, and bleached quila suitable for writing, book, and similar papers.

1915 **Wells, S.D.** Preliminary analysis of autoclave tests using the soda process on samples of certain Chilean woods. Unpublished report (Vault Copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Pulping tests were made on six individual species with common names of olivillo, laurel, coigue, lingue, roble, and quila, using 20 and 25 percent sodium hydroxide. Pulp from olivillo was low in yield, had exceptionally long fibers for a hardwood, was dark in color, and would probably be suitable for use in wrapping papers. Pulps from laurel, coigue, and lingue were similar to aspen soda pulp but somewhat darker in color. Pulp from roble was extremely dark in color. Pulp from quila (a bamboo) was the most promising because the yield was high, the color light, and the fiber long enough for use alone in all but papers where strength is paramount.

1929 **Curran, C.E.; Schafer, E.R.; Carpenter, L.A.** Pulping trials on the Dominican woods, almacigo and jobo. Chemistry and Paper Research Project 168–1J45. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Good yields of bleachable sulphate pulp were obtained from both woods. Jobo produced a short-fibered pulp that in the

bleached state would be suitable for book or other printing papers. Almacigo also produced a short-fibered pulp, was more readily bleached than pulp from jobo, and developed sufficient strength to indicate its possible use in wrappings and container liners when used unbleached. Also, almacigo could be used in book or magazine and the cheaper grades of writing papers when used as a bleached pulp.

1930 **Bray, M.W.; Martin, J.S.** The suitability of wallaba wood, a British Guiana species, for pulping purposes. Chemistry and Paper Research Project 168–1J52. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Wallaba *(Eperua falcata)* does not appear amenable to the sulphite process for the production of pulps of a quality commensurate with commercial grades of sulphite pulps now made from either conifers or hardwoods. A very low yield of pulp with a high bleach requirement is obtained by the soda process, thus probably offsetting any saving in the original cost of wood. Pulp of good bursting strength but of comparatively low tear and folding endurance is possible by the sulphate or kraft process, which shows the greatest promise for utilization of this species.

1942 **Bray, M.W.; McGovern, J.N.** Pulping and bleaching experiments on selected Chilean species, coigue and tepa. Chemistry and Paper Research Project 302-3. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Coigue and tepa were chemically analyzed, examined for their physical characteristics, and pulped experimentally by the sulphate, the acid sulphite, and the neutral sulphite semichemical (NSSC) processes. Samples of the sulphate and acid sulphite pulps were bleached by a multistage method for subsequent viscose production trials. Unbleached pulps were made into paper and board on the experimental paper machine, Shortness of fiber in both species was not conducive to the production of strong pulps by any of the pulping methods employed.

1947 **Martin, J.S.; Kingsbury, R.M.** Production of paper-grade unbleached and bleached sulfate pulps from Chilean insignis pine. Chemistry and Paper Research File 1050. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Practicable cooking and bleaching conditions were determined for producing kraft and bleachable sulfate pulps from Chilean insignis pine. The experimental pulps compared favorably with similar grades produced commercially in the United States from southern pines.

1948 **McGovern, J.N.; Hyttinen, A.** Pulping experiments on three deciduous woods *(Nothofagus)* from Tierra del Fuego, Argentina. Chemistry and Paper Research File 1122. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Three hardwoods, nire, lenga, and guindo of the *Nothofagus* genus from Tierra del Fuego, Argentina, made very weak, very fine, dark-colored groundwood pulps. Nire was also pulped by the neutral sulphite semichemical (NSSC) and sulfate processes. The 78.4 percent yield NSSC pulp was quite weak, although of the same order of strength as NSSC from coigue, another species of the same genus, and American beech. The nire sulfate pulp at 47.7 percent yield showed good strength for a short-fibered pulp. All three woods showed small promise for any considerable commercial applications as groundwood or NSSC. The nire sulfate pulp, however, could possibly find use in paper grades not requiring the strongest pulps and in blends with strong, long-fibered pulps in products requiring some strength.

1948 **Schwartz, S.L.** Production of insulating boards and hardboards from jobo *(Spondias mombin)* and caracoli *(Anacardium excelsum).* Chemistry and Paper Research File 1114. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: The suitability of jobo and caracoli for wallboard production was investigated. Chips of these woods were steam-cooked to yields of 92 percent, processed in a double-rotating disk refiner, and made into sheathing-grade insulating board. Hardboards made from the same stock were substandard in strength and water resistance. Using these woods for the production of hardboards of standard quality requires further study.

1949 **Martin, J.S.; Keller, E.L.** Production of paper-grade sulfate and sulfite pulps from Chilean ulmo. Chemistry and Paper Research File 1075. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Ulmo is readily pulped by the sulfate process, requiring smaller amounts of cooking chemicals than for most hardwood species. Ulmo sulfate pulps were considerably lower in strength than commercial hardwood sulfate pulps made in the United States and offer little possibility for use in paper products alone. Ulmo was satisfactorily pulped by the normal acid sulfite process, yielding weak, dark-colored pulps. The strengths of both types of pulp indicate that their best use would be as filler stocks.

1949 **Martin, J.S.; Keller, E.L.** Production of paper grade unbleached sulphate and sulphite pulps from Chilean ulmo. Chemistry and Paper Research Project 168-9J72. Madison, wl: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Ulmo is readily pulped by the sulphate process, requiring smaller amounts of cooking chemicals than are necessary for most hardwood species, and ulmo gives medium-high yields of sulphate semichemical and sulphate pulps. Strength of the sulphate semichemical pulps obtained in yields of 64 to 71 percent indicated their best use might be in corrugating paperboard. Sulphate pulps are considerably lower in strength than commercial hardwood sulphate pulps made in the United States and offer little possibility for use alone in paper products. They have sufficient strength, however, for use in pulp mixtures with long-fibered softwood sulphate pulps in paperboard and specialty papers of moderate strength. Ulmo was satisfactorily pulped by normal acid sulphite pulping procedures, yielding weak, dark-colored pulps that have relatively high alpha cellulose content, low pentosan content, and low solubility in organic solvents. The strength of the pulps indicated that their best use would be as filler stocks.

1949 **Simmonds, F.A.; Kingsbury, R.M.** Preparation and evaluation of viscose-rayon pulps from coigue, tepa, and ulmo. Chemistry and Paper Research File 1073 and 1074. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Unbleached pulps were made from coigue, tepa, and ulmo by (1) a semichemical process with and without steam prehydrolysis of the chips prior to cooking with a NSSC liquor, (2) a conventional sulfate process following hydrolysis with water, and (3) a sulfite process. The pulps were evaluated by measuring their reactivity toward the viscose-making process. Commercially acceptable yarns were obtained in laboratory spinning trials.

1949 **Yunis, L.** Alkaline pulping of Peruvian congola. Chemistry and Paper Research File 1139. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: This report gives the results of sulfate, semichemical sulfate, and soda pulping on a sample of congola from Peru. The sulfate process gave screened yields from 48.1 to 45.7 percent and permanganate numbers from 17.4 to 14.3. The semichemical pulps with yields up to 70 percent met the strength requirements for corrugating board. Strength of the sulfate pulps approached those of most commercial hardwood sulfate pulps made in the United States. The soda pulp was appreciably weaker than comparable sulfate pulp.

1951 **Simmonds, F.A.; Kingsbury, R.M.** Viscose-rayon pulps from Chilean hardwoods coigue, tepa, and ulmo. Report No. R1906. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Unbleached pulps were made from coigue, tepa, and ulmo by (1) the NSSC process with and without steam prehydrolysis, (2) a water prehydrolysis sulphate process, and (3) the sulphate process. These pulps were purified by the conventional process of chlorination, alkaline extraction, oxidation, and acidic extraction. Pulp yields, which contained 2 to 7.5 percent of pentosans, ranged from 38 to 45 percent of the woods. Results indicate that pulps acceptable for continuous-thread viscoserayon can be produced from the three woods by any of the processes indicated.

1952 **Chidester, G.H.; McGovern, J.N.** Sulfatepulping and paper making experiments on Yucatan woods. Chemistry and Paper Research File 1233. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Fourteen Yucatan hardwoods were tested individually and in mixture. Considerable variation between species was found. Tatsi and huano had low chemical requirements and kitanche, ceiba, and kanchunup had high chemical requirements. The highest yield pulps were obtained from kochle

and tatsi and the lowest yield pulps ekule and kanchunup. The range and average of yields of bleachable pulp obtained from the 14 woods were about 10 percent lower than those from temperate hardwoods. The woods were pulped with and without the bark removed. The strength of pulps from ramon, kochle, and huano compared favorably with temperate hardwood pulps. Most of the other pulps were comparatively low in strength. The bleached pulps had high brightness and were satisfactorily clean. Various mixtures of these 14 woods and 48 other Yucatan woods were pulped similarly. Judged by pulp quality, any mixture of eight or more woods gave about the same results. A bleached pulp made from a mixture of eight woods was made into printing, bond, writing, tissue, and towel grades of paper. The papers were clean, bright, well formed, and appeared to have acceptable quality. A corrugating medium made from sulfate semichemical pulp (69 percent yield) prepared from the unpeeled mixture of 14 woods met commercial requirements.

1954 **Brown, K.J.; Kingsbury, R.M.; McGovern, J.N.** Use of bleached cold soda and bleached sulfate pulps from Brazilian eucalyptus in newstype paper. Chemistry and Paper Research File 1246. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Equal parts of *E. saligna, E. kirtoniana, E. tereticornis,* and *E. alba* were pulped using the cold soda process. *E. saligna* and *E. kirtoniana* were pulped individually by the sulfate process. The sulfate pulps used moderate amounts of chemical, gave moderate yields, were high in density, and had excellent strength properties. Fiber length averaged about 0.9 for both pulps. The cold soda pulp was bleached to a brightness of 69 percent with calcium chlorate using 15 percent available chlorine. The sulfate pulps were easily bleached to 75 percent brightness with 5 percent available chlorine as calcium chlorate. Newsprint made entirely from the semibleached cold soda pulp was adequate in strength but low in opacity. Papers made from the semibleached sulfate pulps were high in strength, density, and brightness, but were also somewhat low in opacity.

1954 **Chidester, G.H.; Brown, K.J.** Use of bleached cold soda pulps from certain mixtures of Latin American hardwoods in newsprint. Report No. 2013. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Mixtures of equal parts of eight hardwoods from the Yucatan and four Brazilian eucalypts were pulped under varying conditions. Quantities of the cold soda pulps prepared under optimum conditions were semibleached and used in newsprint papermaking trials. Newsprints made from 100 percent semibleached cold soda pulps were more than adequate in strength and brightness but were more transparent than standard newsprint and the porosity was high. Opacity was improved by adding either groundwood pulp or clay or both.

1954 **Chidester, G.H.; Schafer, E.R.** Pulping of Latin American woods. Report No. 2012. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: This report briefly describes various pulping experiments at the FPL on 39 individual species and 10 mixtures of species. The various mixtures were comprised of some of these woods and 70 additional ones, making a total of 109 woods tested individually, or in mixtures, or both. The mixtures ranged in composition from 2 to 32 different woods.

1954 **Martin, J.S.; Kingsbury, R.M.; Hyttinen, A.** Production of bleached pulps from Nicaraguan woods. Chemistry and Paper Research File 1317. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Thirty-two species were used to make five mixtures of chips containing, respectively, 2, 8, 11, 14, and 25 species. All of the mixtures were satisfactorily pulped by cooking conditions simulating those used commercially for the production of bleachable sulfate pulps from softwoods. Yields of 45 to 48 percent and small amounts of screening rejects were obtained using liquors containing 17.6 to 21.5 percent active alkali. Bleached pulps obtained from all the mixtures were satisfactorily clean and bright and had well-balanced strength properties. Chlorine requirements of 4.2 to 5.9 percent were comparable with those of pulps made from temperate woods.

1954 **McGovern, J.N.; Brown, K.J.; Fahey, D.J.; Kingsbury, R.M.** Newsprint and wrapping papers from sulfate pulp from Colombian woods. Chemistry and Paper Research File 1253. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Four woods, caracoli *(Anacardium excelsum),* ceiba bruja *(Ceiba pentandra),* gambombo *(Schizolobium parahybum),* and jobo *(Spondias mombin),* were pulped individually and in a 40/30/15/15 mixture. Wrapping papers of considerable promise were made from the unbleached pulp of the mixture. The papers were well formed, had good texture, and had about 90 percent of the bursting strength of the highest quality softwood kraft wrapping paper, 80 percent of the tearing resistance, and 60 percent of the folding endurance. Satisfactory bleaching was obtained using a two-stage process consisting of chlorination and hypochlorite stages. Newsprint made from the semibleached pulp was very strong and bright with low air resistance amd high oil absorption but was low in opacity.

1954 **Schafer, E.R.; Hyttinen, A.** Groundwood pulping of Colombian hardwoods: gambombo, ceiba bruja, ceiba amarilla, jobo, and mangrove. Chemistry and Paper Research File 1309. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Based on strength and color, gambombo appeared to be the most promising for the making of newsprint-grade groundwood. The strength was, however, somewhat lower than that of an average of U.S. newsprint grades of groundwood. Ceiba bruja groundwood pulp was equal in strength to gambombo groundwood, but much darker in color. Pulp from ceiba amarilla and jobo were much lower in strength, and pulp from mangrove was very dark in color and low in freeness.

1955 **Brown, K.J.; Kingsbury, R.M.** Effect of hydrostatic pressure in the production of *E. saligna* cold soda pulp. Chemistry and Paper Research File 1349. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Brazilian *E. saligna* was pulped by the cold soda process using atmospheric and hydrostatic steeping methods. The strength of pulp made from the hydrostatic pressure treatment of 1 h using sodium hydroxide at 50 g/L was approximately the same as that of a pulp from an atmospheric steep using sodium hydroxide at 75 g/L. The pulp was bleached to 63.9- and 65.5-percent brightness using 10- and 15-percent chlorine as calcium chlorate. Brightnesses of 51 and 60 percent were obtained using 2- and 3-percent hydrogen peroxide.

1956 **Chidester, G.H.; Schafer, E.R.** Groundwood pulping and newsprint papermaking experiments on pines from Michoacan, Mexico. Chemistry and Paper Research File 1359. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory

Abstract: Nine pines, *P. oocarpa, leiophylla, pseudostrobus, teocote, montezuma, lawsoni, pringlei, tenuifolla,* and michoacana, were used to make groundwood pulps for use in newsprint. Pulps made from the individual species varied considerably, some being quite low in, strength and the brightness being low compared to commercial newsprint groundwood pulps. However, a mixture of the nine species produced a groundwood pulp suitable for the making of newsprint. Newsprint containing 80-percent groundwood pulp and 20-percent kraft pulp was comparable in most properties to average commercial newsprint.

1956 **Chidester, G.H.; Schaffer, E.R.** Pulping and papermaking experiments on Colombian woods. Chemistry and Paper Research file 1341. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Thirty-one species from the Magdalena River valley were pulped in a single mixture and in 3 selected mixtures of 6, 9, and 25 species each. Groundwood, cold soda, NSSC, and sulfate pulps were made and used in varying amounts in making newsprint, wrapping, and writing papers, linerboard, insulating board, and hardboard.

1957 **Keller, E.L.; Kingsury, R.M.; Fahey, D.J.** NSSC pulping of guaba *(Inga vera),* yagrumo hembra *(Cecropia peltata),* and eucalyptus *(E. robusta)* from Puerto Rico. Report No. 2127. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: The yagrumo hembra cooked rapidly and gave unbleached pulp that

approached the best of North American NSSC pulps in quality. Following a conventional three-stage bleach that yielded 56 pounds of pulp per 100 pounds of wood, this pulp was converted into a bond paper of excellent brightness and appearance. The eucalyptus showed average resistance to pulping compared to woods. The resulting pulps had moderate strength and contained much more lignin than the yagrumo hembra pulps did at equal yield. The chemical requirement for cooking guaba was high and the cooking time unusually long. These pulps were weaker than those of the eucalyptus. A mixture of the eucalyptus and guaba was cooked to 74-percent yield and formed into a corrugating medium that had good general strength and excellent ring crush resistance.

1957 **Kingsbury, R.M.; Martin, J.S.; Keller, E.L.; Fahey, D.J.; Hyttinen, A.** Pulping and bleaching methods for *E. saligna* from Brazil and use of selected pulps in book, writing, and wrapping papers. Chemistry and Paper Research File 1397. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: A comprehensive study was made to determine (I) suitable conditions for pulping by mechanical, chemical, and semichemical processes; (2) the bleaching characteristics of the different types of pulps; and (3) the suitability of selected unbleached and bleached pulps for papers such as wrapping, book, and writing.

1957 **Martin, J.S.** Sulfate pulping experiments on cativo wood waste. Chemistry and Paper Research File 1377. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Pulping characteristics were found to be similar to those of a mixture of 31 Colombian hardwoods pulped previously. The cativo pulp was 26 percent lower in tearing resistance and 45 percent higher in folding endurance than the Colombian hardwood mixture pulp, and was 10 percent higher in bursting strength and 24 percent lower in folding endurance than corresponding average values for six different U.S. hardwood pulps. The cativo pulp made from sound veneer waste appears to have sufficient strength for use after bleaching and blending with softwood pulps in a variety of bond, printing, and other high-grade papers.

1958 **Anon.** Pulping and papermaking experiments on insignis pine. Report No. 2124. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: This report is a summary of the results of four different pulp and paper research studies made on insignis pine from New Zealand and Chile. There appeared to be no essential difference between the wood from the two countries.

1958 **Anon.** Summary of pulping and papermaking experiments on eucalyptus. Report No. 2126. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: This report is a summary of the results of pulp and papermaking experiments using various eucalyptus species for the period 1926–1957. Woods grown in Chile and Brazil are included.

1958 **Chidester, G.H.; Schafer, E.R.** Pulping and papermaking experiments on Colombian woods. FPL Report No. 2117. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Thirty-one species were pulped in four different mixtures by the groundwood, NSSC, cold soda, and sulfate methods and used to make newsprint, wrapping, and writing papers, insulating board, and hardboard.

1958 **Chidester, G.H.; Schafer, E.R.** Pulping and papermaking experiments on *P. oocarpa* from Honduras. Chemistry and Paper Research File 1417. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Two samples of wood, one known as ocote in some areas and the other as pinabete rojo elsewhere in Honduras, were tested for groundwood and sulfate pulping and the making of newsprint, wrapping, writing, and tissue papers. Groundwood pulps of both woods when mixed with 20 to 25 percent of southern pine bleached sulfate pulp made acceptable quality newsprint. The papers made from the unbleached groundwood were slightly darker in color than the average for commercial newsprint, but paper with good color was made from the bleached groundwood pulps. The newsprint containing bleached groundwood pulp was not quite so opaque as commercial newsprint, but this property was improved by the addition of a

small amount of clay filler. The two wood samples were much alike and similar to the pines of the southern United States in their sulfate pulping and bleaching characteristics. The different papers were made from either the unbleached or bleached sulfate pulps produced from equal parts of the two woods. Good quality bond and wrapping papers were made.

1958 **Chilson, W.A.; Martin, J.S.; Fahey, D.J.; Hyttinen, A.** Evaluation of six hardwoods and a palm leaf from Panama for the manufacturing of wrapping, printing, and writing papers. Chemistry and Paper Research File 1467. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Sulfate pulping trials were made (1) individually on four hardwoods, orey, miguelario, mayo blanco, and mayo negro; (2) a mixture of miguelario, mayo blanco, and mayo negro; and (3) a mixture of cerillo and sangrillo. All pulps possessed strength properties equal to or greater than those of sulfate pulps made from North American hardwoods. Bleaching and papermaking experiments were conducted on the orey pulp, on a mixture of equal parts of orey, cerillo, and sangrillo pulps, and on a mixture of equal parts of cerillo, sangrillo, miguelario, mayo blanco, and mayo negro pulps. Bleaching requirements to a brightness of 83 percent using a three-stage process were the same for these three pulps and were within the ranges used for North American hardwood pulps. Papermaking qualities of the orey pulp and the two mixtures were similar to North American pulps. To produce wrapping paper, it was necessary to add an equal amount of a commercial softwood sulfate pulp. Well-formed bond and book papers of adequate strength were made from each of the bleached pulps without the addition of long-fibered pulp.

1959 **Fahey, D.J.; Hyttinen, A.; Chilson, W.A.** Newsprint from Brazilian eucalyptus bleached cold soda pulp. Chemistry and Paper Research File 1479. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory,

Abstract: Bleaching and papermaking experiments using Brazilian cold soda pulp were made in a continuous process. The pulp was easily bleached to a brightness of 63 percent using hypochlorite and a second stage of peroxide. The bleached pulp had good appearance and strength properties. Newsprint\made entirely from the eucalyptus pulp was low in strength and opacity. The addition of 15 percent long-fibered pulp increased the strength of the wet web and also gave a sheet with more favorable strength for newsprint. Opacity was improved by refining the cold soda pulp to a freeness more comparable to that of groundwood, and it also was improved by the addition of clay to the papermaking furnish. Lowering of the freeness was also beneficial to the strength of the paper:

1960 **Chilson, W.A.; Laundrie, J.F.; Fahey, D.J.** Kraft wrapping and multiwall bag papers from Mexican ponderosa pine. Chemistry and Paper Research File 1506. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Kraft pulps with yields of 50, 60, and 70 percent were produced and processed to freenesses comparable to those used in commercial operations. These pulps then were made into wrapping and multiwall bag papers on an experimental paper machine. Wrapping paper made from the 50-percent yield pulp was equal to or stronger than commercial kraft wrapping papers of the same weights. Multiiall bag paper made from this pulp had higher bursting and tensile stengths and equal folding endurance but lower tearing resistance than commercial bag papers. Wrapping and bag papers made from the 60-percent yield pulp had lower strengths than commercial papers. All strength properties of the papers made with the 70-percent yield pulps were much lower than commercial U.S. papers. However, wrapping paper made with the 70 percent yield pulp was equal or stronger than a commercial semikraft paper made in Mexico from a mixture of kraft pulp and wastepaper:

1960 **Chilson, W.A.; Laundrie, J.F.; Fahey, D.J.** Linerboards and multiwall bag, wrapping, and bond papers from mixtures of Colombian woods. Chemistry and Paper Research File 1504. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: One hardwood mixture of 22 species from the Opon Forest in the Magdalena River area and one of 26 species from the Buenaventura Forest on the Pacific Coast were pulped by the sulfate process. Each

pulp was used with a mixture of two commercial softwood sulfate pulps to produce multiwall bag, wrapping, and linerboard. The pulp from the Pacific Coast woods was bleached and used as the furnish for bond paper. The pulps from the two mixtures were comparable in strength and were fully as strong as pulps from North American hardwoods and even exceeded North American pulps in tearing strength. As much as 50-percent hardwood pulp can be used in multiwall bag paper that will meet U.S. specifications. If the weight is increased by 10 percent, a furnish containing 60-percent hardwood pulp could be used. Wrapping paper containing 50 percent of either hardwood pulp did not have all the strength of U.S. commercial papers. A higher percentage of softwood pulp is required for this grade. Linerboard with as much as 70-percent hardwood met the bursting strength and exceeded the edgewise compressive resistance specifications for 26-, 42-, and 69-pound weights. The caliper of the 26-pound board was lower than the specified nine points, however. Bond paper made from l00-percent bleached hardwood pulp had good formation but was not as strong as typical commercial papers.

1961 **Chilson, W.A.; Laundrie, J.F.; Fahey, D.J.** Soda sulfur pulps from mixed Colombian hardwoods for use in multiwall bag papers and linerboard. Chemistry and Paper Research File 1521. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: A mixture of 26 hardwoods from the Buenaventura Forest on the Pacific Coast was pulped by a series of soda sulfur combinations and cooking conditions to evaluate this process in comparison with a normal sulfate process. Selected pulps were used with a mixture of two commercial softwood sulfate pulps to produce multiwall bag paper and linerboard. The pulps produced experimentally following mill cooking conditions and having yields of 58.0 and 69.5 percent were stronger than the mill pulp with the lower yield being the stronger. Pulps that cooked rapidly to 53.0-percent yield had strengths comparable to sulfate pulps cooked to 51.6-percent yield. Multiwall bag papers in nominal weights of 40, 50, and 60 pounds and linerboards in nominal weights of 26, 42, and 69 pounds were made using a 68.2-percent yield pulp. In addition, 50-pound nominal weight bag papers and 26-pound nominal weight linerboards were made using a 57.5- and a 53-percent yield pulp. Tear strength specifications for the 50- and 60-pound multiwall bag papers were met when half the furnish consisted of soda sulfur pulp. Tear strength requirement of the 40-pound bag paper, however, was not met with a furnish containing as low as 40 percent of the soda sulfur pulp. Edgewise compressive strength specifications were met by all three weights of linerboard with high percentages of the 68.2-percent yield soda sulfur pulp.

1961 **Laundrie, J.F.; Fahey, D.J.; Hyttinen, A.** Tissue paper containing eucalyptus cold soda pulp. Chemistry and Paper Research File 1544. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Cold soda pulps were made from *E. viminalis* and from a mixture of *E. tereticornis* and *E. rostrata* at sodium hydroxide consumption levels of 5 and 8 percent. These pulps were single-stage bleached with calcium chlorate to a brightness of about 70 percent and used to replace various amounts of the softwood groundwood and sulfite components in tissue paper furnishes. For comparison, a reference standard tissue was made using commercial pulps. The addition of cold soda pulps generally resulted in more absorptive tissues that were not, however, as soft as the reference standard. The *E. viminalis* pulp made with 8-percent sodium hydroxide gave a less absorptive and harsher tissue than that made with 5-percent sodium hydroxide. This difference was not apparent when the pulps made from the mixture were compared. Species had little effect on the strength properties of the tissue papers, although those made with the cold soda pulps prepared with 5-percent sodium hydroxide were usually lower in tear and tensile strength than those made with 8-percent sodium hydroxide.

1961 **Sanyer, N.; Keller, E.L.; Fahey, D.J.** Preparation and evaluation of insignis pine sulfite, bisulfite, and groundwood pulps for use in newsprint. Chemistry and Paper Research File 1538. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Insignis pine, grown in the Nacimiento and Almendro districts of Chile, was pulped by the calcium-base acid

sulfite, the sodium bisulfite, and the groundwood processes. Pulp quality was generally comparable with that of similar pulps prepared from typical North American softwoods. In spite of its 7.4-percent heartwood, the wood pulped to low yield without difficulty by the sulfite processes. The brightnesses of the chemical pulps showed a strong dependence on the degree of cooking. For a brightness of 60 percent, the pulp had to be cooked to a yield below 55 percent, but pulps of 55- to 60-percent yield could be readily brightened with 1-percent sodium hydrosulfite or hydrogen peroxide, and pulps of 65-percent yield responded well to the application of both brightening agents. Newsprint comparable to commercial newsprint was prepared.

1961 **Schafer, E.R.; Chidester, G.H.** Pulping and papermaking experiments on certain pines of Mexico and Central America. Report No. 2217. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: This report discusses (1) groundwood pulping and the making of newsprint paper from a mixture of nine species of pine from Mexico, (2) groundwood and sulfate pulping and making newsprint, wrapping, writing, and tissue papers from *P. oocarpa* from Honduras, and (3) groundwood and sulfate pulping experiments on *P. caribaea* from British Honduras (Belize).

1962 **Chilson, W.A.; Laundrie, J.F.; Fahey, D.J.** Linerboards from soda sulfur pulp from extracted Mexican pine chips. Chemistry and Paper Research File 1555. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Kraft and soda sulfur digestions were made using screened and unscreened chips from which the resins had been extracted. The strengths of the kraft and soda sulfur pulps were approximately the same when made from the same chips, but the unscreened chips required more chemicals than the screened chips for complete pulping. Linerboard made from 100 percent soda sulfur pulp had adequate strength in the 26-pound weight. For the 42-pound weight, a topliner of either 100 percent commercial Mexican pine kraft or 50-50 pine kraft and soda sulfur mixture applied to an all soda sulfur pulp base plus an increase in weight were necessary to meet the properties of a fourdrinier linerboard made in Mexico.

1965 **Sanyer, N.; Laundrie, J.F.; Byrd, V.L.** Kraft pulping, bleaching, and papermaking experiments with Venezualan wood. Chemistry and Paper Research File 1644. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: A comprehensive study was made to determine (1) the kraft pulping characteristics of a 39 species mixture of hardwoods, (2) the bleaching characteristics of the pulps, (3) the effect of drying on the strength and optical properties, and to prepare papers using maximum amounts of the hardwood pulps in linerboard, bag and multiwall sack paper, bond, offset, book paper, napkin, towel, and cup and milk carton stock.

1966 **Chilson, W.A.; Laundrie, J.F.** Linerboard, multiwall bag paper, and corrugating medium from a mixture of Mexican pines. Chemistry and Paper Research File 1660. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: Kraft pulps with various yields were made from a five-species mixture of Mexican pines grown in the state of Durango. Single- and double-ply linerboards were made from a kraft pulp at 48-percent yield that met specifications for linerboard made in the United States. Both linerboards had good surface characteristics. Multiwall bag paper, made from this same yield pulp, had strength properties slightly lower than the U.S. specification, but its porosity was substantially higher, a desirable feature of bag paper. Corrugating medium was successfully made from a 56-percent yield pulp containing all of the sawdust and fine chips produced during chipping. This medium had compressive resistance values in excess of standard U.S. mediums.

1968 **Laundrie, J.F.** Yield of kraft pulp from mixed Mexican pines. Chemistry and Paper Research File 1684. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Abstract: This was a very limited study of commercial mill chips to determine only yield and pulp strength at one level of delignification.

1977 Bormett, D.W.; Laundrie, J.F.; Fahey, D.J. Linerboard, corrugating medium, and corrugated containers from mixtures of Colombian woods. AID Report No. 14. Washington, DC: U.S. Department of State, Agency for International Development PASA No. TA(AG) 03−75.

Abstract: Corrugated fiberboard containers were made from nominal 42-pound starch surface-sized linerboard of 50 percent high-yield kraft pulp from Colombian woods and 50 percent western kraft softwood pulp, and 26-pound corrugating medium made from 100 percent high-yield kraft Colombian hardwood screenings. The containers did not have as high a compressive strength as containers used for controls. The combined board as well as the linerboards were slightly low in bursting strength. Corrugating medium made from neutral sulphite semichemical pulp fractured when fluted on the single facer at 20 ft/min and minimum tension. Screened pulp from high-yield digestions (Kappa 85) had about 30 percent less bursting strength and tearing resistance than fully cooked pulp (Kappa 24.7) and about 20 percent less tensile strength.

1977 Laundrie, J.F. Exploratory kraft and NSSC pulping and production of a bleached market grade kraft pulp from Colombian hardwoods. AID Report No. 8. Washington, DC: U.S. Department of State, Agency for International Development PASA No. TA(AG) 03−75.

Abstract: Kraft pulps with quality equal to or better than those of North American hardwood kraft pulps were made using three mixtures of 17 Colombian hardwoods. The concept of using a high-yield kraft process to produce 25- to 30-percent screenings for use in corrugating medium and the screened pulp for linerboard was verified as being feasible. Semichemical kraft pulp, with a Kappa number equal to that of the kraft screenings, has handsheet properties comparable to those of the kraft screenings. Handsheet tests indicate that acceptable quality corrugating medium can be made from all three mixtures cooked by the neutral sulphite semichemical process. Improved handsheet quality can be obtained by the addition of sodium hydroxide to the neutral sulphite semichemical pulping liquor or by reducing pulp yield. Semichemical kraft and green liquor pulps at 73-percent yield are deficient in handsheet properties considered essential for the production of acceptable quality corrugating medium.

1977 Laundrie, J.F. Some potential processing problems with mixed tropical hardwoods. AID Report No 16. Washington, DC: U.S. Department of State, Agency for International Development PASA No. TA(AG) 03-75.

Abstract: Examples of processing problems include chipping, air classification, silica, and dulling of chipper knives.

1977 Laundrie, J.F.; Fahey, D.J.; Koning, J.W., Jr. Corrugating medium from mixed tropical hardwood semichemical pulps. AID Report No. 15. Washington, DC: U.S. Department of State, Agency for International Development PASA No. TA(AG) 03-75.

Abstract: Semichemical pulps made from mixtures of Colombian hardwoods by the neutral sulphite semichemical, kraft, green liquor, and soda carbonate processes were converted into nominal 26-pound corrugating medium on the FPL papermachine. Most mediums failed to corrugate at less than 20 ft/min with a minimum of sheet tension. Decreasing the neutral sulphite semichemical pulp yield from 74 to 65 percent, refining the pulp more to give better bonding, and lowering the papermachine headbox consistency to give a better formed sheet did not improve its ability to feed through the corrugator. This deficiency was improved by adding oleic acid to the papermachine furnish to act as a lubricant or by passing the medium over a polyethylene bar as it was being fed into the corrugator. Surface frictional tests, microscopic examinations, and chemical analysis failed to reveal causes for the poor performance through the corrugator.

1977 Wahlgren, H.E.; Laundrie, J.F. Properties of 50 individual Philippine hardwood barks and mixtures of 22 Ghanaian and 18 Colombian hardwood barks. AID Report No. 10. Washington, DC: U.S. Department of State, Agency for International Development PASA No. TA(AG) 03−75.

Abstract: Silica and ash contents of the barks were much higher than those found in the corresponding woods. Kraft pulp yields from bark were somewhat less than those found for barks from North American species. Heat value was very similar to those found in barks of North American species.

1978 Fahey, D.J.; Laundrie, J.F. Market pulp and white papers from mixed tropical hardwoods. In: Proceedings on improved utilization of

tropical forest; Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 355-370.

Abstract: Market-type, bleached kraft pulps with quality as good or better than commercial North American hardwood kraft market pulps were made from mixtures of tropical hardwoods grown in the Philippines, Ghana, and Colombia. The lowest density, lightest colored species selected from these wood resources produced good quality thermomechanical pulps suitable for use in newsprint, tissue, toweling, and tablet papers.

1978 **Forest Products laboratory.** Improved utilization of tropical forests. Proceedings of a conference; 1978 May 21–26; Madison, WI. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 569 p.

Abstract: Proceedings of a conference containing more than 30 pages on the resource and potential for making fiber products from tropical woods.

1978 **Koning, J.; Laundrie, J.F.; Fahey, D.J.; Borrnett, D.** Linerboard, corrugating medium, and corrugating containers from mixed hardwoods. In: Proceedings on improved utilization of tropical forest; Madison, WI. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 371-386.

Abstract: Corrugated fiberboard containers were successfully made from linerboard consisting of 50 percent Philippine or Colombian hardwood high-yield kraft pulp and 50 percent western U.S. kraft softwood pulp, together with corrugating medium from 100 percent Philippine or Colombian hardwood high-yield kraft screenings. Semichemical pulps made from mixtures of tropical hardwoods by the neutral sulfate, kraft, green liquor, and soda carbonate processes were converted into corrugating medium and evaluated for resistance to fracturing during fluting. Most mediums fractured when fluted at 20 ft/min with a minimum of sheet tension. Adding oleic acid to the papermachine furnish or passing the medium over polyethylene bars as it was being fed into the corrugator effectively overcame this performance deficiency.

1978 **Laundrie, J.F.** Kraft and NSSC pulping of mixed tropical hardwoods. In: Proceedings of conference on improved utilization of tropical forest: Madison, WI. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 332-354.

Abstract: Samples of tropical hardwoods with wide ranges of properties were obtained from the Philippines, Ghana, and Colombia. Three different mixtures were made with the woods from each country–one with uniform density distribution, the second favoring the higher densities, and the third with a preponderance of the medium-density woods. Three kinds of kraft digestions were made using all nine mixtures to produce fully cooked, semichemical, and high screening pulps. Neutral sulphite semichemical digestions were also made using all nine mixtures. Results indicate mixed tropical hardwoods, regardless of source, would be suitable for the production of kraft and neutral sulphite semichemical pulps with properties as good as similar pulps made from temperate-zone hardwoods.

Sawing and Drying

1920 **Brewster, D.R.** Experiment in kiln drying five species of Brazilian woods–cabreuva, ipe, jatahy, peroba, and pao marfim–1.29 to 1.49 inches thick. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 16 p.

Abstract: With temperatures from 103°F to 150°F and humidities from 89 to 9 percent, a flat pile of 1-1/4- to 1-1/2-in. boards, 8 in. wide and 3 ft high, was dried in a fan-ventilated kiln from an average moisture content of 42.5 to 6.3 percent in 36 days (34-days drying and 2-days conditioning) for jatahy, peroba, and pao marfim and 46 days (42-days drying and 4-days conditioning) for cabreuva and ipe. Drying time included an 18-day shutdown period because of equipment problems, as equivalent to 4 days of drying time with the schedule specified. Final moisture content of five samples varied from 4.7 to 8.8 percent with an average difference of 1.7 percent between center and outside and maximum difference of 3.8 percent.

Steaming or conditioning treatments were given four times using temperatures ranging from 140°F to 178°F and humidities from 44 to 100 percent.

Drying degrade ranged from 0 to 15 percent because of surface checking. Stresses due

to casehardening were negligible. Significant observations included rapid drying of jatahy, peroba, and pao marfim and slow drying of cabreuva and ipe, checking of ipe, large shrinkage of pao marfim, small shrinkage of jatahy, and lack of uniformity in temperature between the upper and lower portions of the drying chamber in the kiln.

1930 **Browne, F.L.** Some observations of Nicaraguan slash pine logs and lumber at the mill of the J. F. Prettyman and Son Co. at Summerville, SC. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 8 p.

Abstract: Overall assessment of sawn material is provided in comparison with native longleaf pine.

1947 **Torgeson, O.W.** Kiln drying of two Chilean woods, coigue *(Northofagus dombeyi)* and eucalyptus *(Eucalyptus globulus).* Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 17 p.

Abstract: Experiments indicated green sawn coigue and eucalyptus require high inital relative humidities and have low critical temperatures with respect to checking and collapse. After moisture content of about 20 to 25 percent (ovendry weight) is reached, the safest procedure is to air season and then kiln dry to desired moisture content.

1955 **McMillen, J.M.** Seasoning of Venezuelan boxwood *(Gossypiospemum praecox* (gris.) P. Wilson). Unpublished report (Vault copy). In cooperation with The Frederick Post Company, Owen, WI. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 28 p.

Abstract: The Fredrick Post Company had problems obtaining properly seasoned Venezuelan boxwood for making scale sticks. That is, dried material contained fine seasoning checks invisible to careful inspection, but it absorbed black dye when marking graduations on the rule sticks. The FPL conducted kiln-drying tests and compiled recommendations for preferred kiln-drying procedures, as presented in this report.

1961 **Malcolm, Fredrick B.** A report on an assignment to give technical assistance to sawmill operators in northern Mexico. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 25 p.

Abstract: Two 1-week sawmill seminars in northern Mexico between August 10 and September 1 , 1961, were conducted and a limited number of representatives from sawmills and wood products firms attended. The project was planned by ICA–USOM/Mexico and sponsored by Centro Industrial Productividad, Chihuahua, Mexico. Subjects presented at the seminars included logging problems, sawmill efficiency and maintenance, saw fitting, timber evaluation, sales, and related subjects. Problems observed at plants visited included logging road maintenance, degrade in logs and lumber, plant layout and material handling efficiency, and saw fitting.

1961 **McMillen, J.M.** 1961. Kiln schedules for Puerto Rican yagrumo hembra. Caribbean Forester. 22(3/4): 84–90.

Abstract: Yagrumo hembra *(Cecropia peltata)* was found to be easy to kiln dry as 1- and 2-in.-thick lumber. Recommended kiln schedules are given for 1-, 2-, 3-, and 4-in.-thick material. Drying times range from 5 days for 1-in. lumber to 21 days for 3- to 4-in.-thick material.

1962 **Maldonado, Edwin D.; Peck, Edward D.** Drying by solar radiation in Puerto Rico. Forest Products Journal. 12(10): 487-488.

Abstract: Research on solar drying at the FPL led to construction of the first solar dryer in the tropics in Puerto Rico in October 1961. The dryer, constructed of lumber with clear plastic double walls, has a capacity of 2,000 board feet and requires power only to operate circulating fans during daylight hours. The first two tests of this dryer were promising. With the first test, 5/4 Mexican mahogany *(Swietenia macrophylla)* was dried from 50- to 12-percent moisture content in 23 days compared to air drying to about 25-percent moisturet 25-percent moisture content in 23 days. For the second test, 4/4 Mexican mahogany was solar dried from 32- to 12-percent moisture content in 13 days and to 8.6 percent after 25 days of drying.

1973 **McMillen, J.M.** Brief mission on wood drying in Central America furniture industry. AID Report PlOK No. 596433. 1–2-30026. Washington, DC: U.S. Department of State,

Agency for International Development PASA No. LA(AJ) 35-73.

A report on a 29-day AID-sponsored mission to examine status of lumber drying at major furniture companies in Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua. Advice and additional measures needed to enable these firms to export furniture with freedom from moisture-related problems was given. Current facilities and practices were found somewhat inadequate, but interest in major improvement was high. Managerial and technical personnel appeared capable of bringing about the major jump in wood drying practice needed. This paper reviews research facilities available at two universities and an international development laboratory and comments on export development organizations and personnel.

1974 **McMillen, J.M.: Boone, R.S.** Kiln-drying selected Colombian woods. Forest Products Journal. 24(4): 31-36.

Abstract: An approach to kiln drying three Colombian woods–cuangare *(Diayanthera* spp.), sande *(Brosimum utile),* and sajo *(Campnosperma panamensis)*–is described, and results are given of exploratory research to improve efficiency and quality of the kiln drying. Procedures for drying the woods separately or together from the green condition or from a partly air-dried condition and shortened procedures for relieving drying stress are included. Of three schedules, severe, moderate, and mild in the degree to which they induce degrade, the moderate schedule was ultimately chosen as most satisfactory.

1977 **Tschernitz, John L.; Simpson, William T.** Solar kilns: feasibility of utilizing solar energy for drying lumber in developing countries. Prepared for AID, Washington, DC: U.S. Department of State, Agency for International Development PASA No. TA(AG)02–75.

Abstract: This study tested the feasibility of using solar energy to improve lumber drying by small- to medium-scale operators in developing countries. A literature review confirms the potential of solar drying and points out the success or failure of some design features, construction details, and applications of solar dryers. Feasibility estimates concluded that solar drying is practicable if a dryer meets production and cost requirements. Two dryer designs, a greenhouse type and an external-collector type, were proposed. Their production capacity was estimated by a material and energy balance analysis, and their construction costs were estimated.

1978 **McMillen, J.M.** Overseas protection of logs and lumber. Part I. Import/Export Wood Purchasing News. 4(5): 4.

Abstract: The need for protection of logs and lumber starts in the forest and continues until the wood is dried to 20-percent moisture content. Handling procedures for woods operations, log storage (under water, shaded or wet land, and dry land), and lumber storage for green material are suggested, including effective chemicals and coatings.

1978 **McMillen, J.M.** Overseas measures to improve initial seasoning and handling. Part II. Import/Export Wood Purchasing News. 4(6): 4.

Abstract: This paper describes seasoning at the source and protection during shipment. Wood is grouped into seasoning classes–easy drying, intermediate, and difficult-to-dry wood. It describes seasoning methods, air, forced air, and kiln, and their appropriateness for each group. Also, a discussion of protection during shipment including bundling, wrapping, and cartons or containerization of lumber or products is included.

1979 **Tschernitz, J.T.: Simpson, W.T.** Solar-heated, forced-air lumber dryer for tropical latitudes. Solar Energy. 22: 563–566.

Abstract: This paper reports on a study sponsored by the Agency for International Development, to test the feasibility of using solar energy to improve drying of lumber processed by small- and medium-scale operators in developing nations. The initial target country for the feasibility study is the Republic of the Philippines. The study showed that if solar dryers could be built for no more than approximately $5,000 and could process at least 1,000 board feet per week, they would be feasible in the Philippines. Using a material and energy balance analysis and construction cost estimates, two solar dryer designs that meet the performance and cost criteria have been proposed for construction and evaluation.

1984 **Simpson, W.T.; Tschernitz, J.L.** Solar dry kiln for tropical latitudes. Forest Products Journal. 34(5): 25-34.

Abstract: Developing countries that export forest products often lack the capital to build high-cost dry kilns. Many of these countries are in the tropics where solar radiation and ambient temperatures are high. The low-cost solar dry kiln described in this paper was designed and tested because solar dry kilns can be built and operated at low cost and have possible application in these countries.

The design was for a 2.4-m^3 capacity solar dry kiln, having an insulated drying compartment attached to a horizontal external solar collector. This design allows collector sizing to match the energy demands in the dryer.

The kiln was designed to be as low-cost as possible, but still be able to provide fully automatic control of scheduled drying. One dry kiln was built in Madison, Wisconsin, in 1977 and was tested and improved during succeeding summers. Northern red oak and hard maple, 2.9-cm thick, were dried from green to 8 percent moisture content in 54 and 26 days, respectively. Kiln temperatures reached as high as 24.6°C above ambient temperatures. Vent control was adequate to provide the relative humidity control necessary for scheduled drying.

Another kiln, built at a furniture factory in Sri Lanka, demonstrated that the design can perform successfully in a tropical location.

1985 **Tschernitz, John L.; Simpson, William T.** FPL design for lumber dry kiln using solar/wood energy in tropical latitudes. FPL–GTR-44. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 17 p.

Abstract: The low-cost solar/wood energy lumber dry kiln described in this report was designed and tested by the Forest Products Laboratory (FPL) for such countries where solar dry kilns can be built and operated at low cost.

The FPL design is for a 6,000-fbm capacity kiln having an insulated drying compartment, an external horizontal solar collector, and a furnace room containing a wood burner. Capacities larger or smaller than 6,000 fbm are also possible. This design allows collector and wood burner sizing to match the energy demands of the dryer. The design also incorporated low-cost controls that allow unattended drying when operated as a solar-only dryer. Manual firing is necessary when the wood-burning system is supplying the energy.

1986 **Tschernitz, J.L.; Simpson, W.T.** Design for lumber dry kiln using solar/wood energy in tropical latitudes. Drying Technology. 4(4): 651-670.

Abstract: Developing countries with a timber resource that can be manufactured into finished products either for local use or export often lack the capital to build high-cost dry kilns. The low-cost solar/wood energy lumber dry kiln described in this report was designed and tested for such countries where solar dry kilns can be built and operated at low cost.

1988 **Boone, R. Sidney; Korlik, Charles J.; Bois, Paul J.; Wengert, Eugene M.** Dry kiln schedules for commercial woods–temperate and tropical. FPL–GTR–57.Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 158 p.

Abstract: This report provides dry kiln schedules for more than 500 temperate and tropical woods, with special schedules for wooden squares, handle stocks, and gun stock blanks. Primarily for use by dry kiln operators and others interested in dry-kilning wood, the report consolidates and updates drying schedules from many sources, making them easy to find and convenient to use.

1989 **Simpson, William T.; Baah, Charlie K.** Grouping tropical wood species for kiln drying. Res. Note FPL–RN-0256. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 14 p.

Abstract: The most efficient method to kiln dry tropical hardwood species is in groups because of the large number of them and their diffuse occurrence in the forest. However, this large number of species presents a wide variety of drying properties, which makes it difficult to dry mixtures of species. This report develops a mathematical model for grouping species by similar drying times. The goal is to kiln dry so all species will emerge from the same kiln at the same time within set limits of moisture content and with minimum drying defects. The model, which utilizes experimental drying rate data collected in previously reported research, incorporates specific gravity and initial moisture content as

criteria for grouping species based on estimated drying time. The model has not been tested in actual kiln drying studies but established the necessary framework to design such a study.

1989 **Simpson, William T.; Tschernitz, John L.** Performance of a solar/wood energy kiln in tropical latitudes. Forest Products Journal. 39(1): 23-30.

Abstract: This paper reports observations on the energy efficiency of the kiln, its durability, and its overall ability to dry lumber.

Veneer and Plywood

1919 **Colgan, R.A.** Sawing, veneer cutting, and gluing of Brazilian woods. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 20 p.

Abstract: Nine Brazilian species of wood were evaluated (cabreuva, cedro, embuya, ipe, jacaranda, jatahy, jequetiba, marfim, and peroba). Veneers were sliced from flitches in thickness of 1/80, 1/30, 1/16, and 1/8 in. The following glues were used for tests: blood albumin, casein, animal, and vegetable. Sawing tests were made for drying and mechanical strength tests and to determine approximate sawing resistance. The saw used had a circumferential velocity between 1.5 and 2 miles per minute. Results of this research indicated these Brazilian woods could be satisfactorily made into furniture, and that they could be machined, glued, and given a pleasing natural finish.

1945 **Teesdale, L.V.** Factors influencing veneer and plywood production in Puerto Rico. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 5 p.

Abstract: On the basis of available information, the advantages of low-cost labor do not appear to be sufficient to offset the numerous disadvantages of a Puerto Rico location for veneer and plywood production. Sufficient questions justify a careful and more thorough investigation of all factors before any action is taken.

Wood Preservation

1919 **Griffin, Gertrude J.** Microscopic examinations for presence of decay in South American woods collected by H. M. Curran. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 8 p.

Abstract: This report covers examinations for decay on air-dry specimens of South American woods received at the FPL, Madison, WI, during 1919. These specimens were subsequently tested in impact and static bending.

1947 **Scheffer, Theodore C.; Duncan, Catherine G.** The decay resistance of certain Central American and Ecuadorian woods. Approved for publication August 1947. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 22 p.

Abstract: Forty-one species were tested for decay resistance. A few of the species were tested in Central America, but most were tested in Wisconsin and Mississippi. About one-fourth to one-third of the species were found very durable and an equal number as durable. The remainder were classified as relatively nondurable to moderately durable. Local reputations for durability were in general agreement with test evidence.

1948 **Kruger, K.W.; Bixby, J.O.** Results of tropical exposure tests of container-grade plywood panels and cleated-plywood boxes. Unpublished report. In cooperation with U.S. Army Air Force. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 57 p.

Abstract: Results from exposure of container-grade plywood panels and cleated-plywood boxes to tropical weathering on Barro Colorado Island in the Panama Canal Zone are given. Study results indicated container-grade plywood deteriorates more rapidly when exposed directly to tropical sun and rain than when exposed in shaded jungle. Jungle exposure, however, was more conducive to fungus growth and wood decay. Of the four wood species investigated, Douglas-fir was the most durable. Sweetgum, cottonwood, and yellow birch were about equal in durability. Adding preservatives to glues and treatment of plywood panels increased their resistance to deterioration.

1948 **MacLean, James D.** Report on the study of factors that have a bearing in selection of site for a wood preserving plant in Chile. Unpublished report (vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 30 p.

Abstract: This report discusses relative merits of different locations in Chile that might be considered as a site for a pressure wood preserving plant to treat railroad ties and similar timbers. Valdivia was identified as a good location for a treating plant. This report also provides recommendations for handling of timbers for seasoning and treating.

1949 **Blew, J. Oscar, Jr.** Memorandum on observations concerning the possibility of establishing a wood preserving operation in Puerto Rico. Unpublished report. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 24 p.

Abstract: This report concludes there is good opportunity in Puerto Rico for a treating operation processing fence posts, crossties, poles, pilings, lumber, and other wood materials intended for construction. Need for information on treatability of local woods is emphasized as necessary to determine practicability of treating local species.

1959 **Maclean, J.D.** Report on the study of preservative treatment of Chilean woods. Technical Aids Branch. Washington, DC: Office of Industrial Resources, International Cooperation Administration. 12 p.

Abstract: Recommendations of procedures are given for treating several Chilean wood species, and suggestions are listed for testing effectiveness of treating other species.

1962 **Baechler, R.H.; Gjovik, lee R.; Reinke, Ronald R.** The analysis of Puerto Rican posts treated by double diffusion. Limited distribution report. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 6 p.

Abstract: This paper reports chemical analyses of green sample posts treated in Puerto Rico by double diffusion using two methods, with complete tank immersion and by standing posts upright in barrels. Treating posts upright in barrels gave poor results. Posts treated by complete tank immersion were varied between species, with five species showing complete penetration and seven species showed penetrations of 1/8 in. or less. Service life for posts not obtaining full penetration would depend on the amount of penetration and the natural durability of untreated wood.

1969 **Chudnoff, M.; Wawriw, R.** Effectiveness of groundline treatments of creosoted pine poles under tropical exposure: interim report. Turrialba. 19(1): 117–125.

Abstract: Study was initiated to evaluate supplementary treatments of utility poles in a high-rainfall, high-decay-hazard tropical environment. Fluoride-creosote, pentachlorophenol gel, and fluoride-arsenic compounds were applied to southern yellow pine poles initially treated with creosote. The distribution of sodium fluoride after 1 , 3, 5, and 10 years of service is to be determined. As a first year report, the pentachlorophenol gel formulation gave higher than threshold absorption only in an outer 1-in. shell. Based on agar-wood block threshold values, all assayed zones of fluoride-cresote and fluoride-arsenic treatments have acceptable toxic levels. On soil-block threshold measures, the fluoride-creosote surface application has good retention only in the outer 1-in. zone, while fluoride-arsenic injection results in high sodium fluoride levels in the 2-, 3-, and 4-in. zones with only marginal levels in the outer 1 in.

1969 **Zinkel, D.F.; Ward, J.C.; Kukachka, B.F.** Odor problems from some plywoods. Forest Products Journal. 19(12): 60.

Abstract: Objectional odors were reported in plywood made with some South American woods when subjected to hot, humid atmospheres. Odors were found to be a result of presence of volatile fatty acids such as butyric, valeric, and caproic and elevated amounts of propionic and acetic acids. The acids are a product of anaerobic bacterial fermentation in which certain carbohydrates in the wood, such as starch, are broken down. Related studies with some North American hardwoods show that fermentation can occur in the standing tree.

1970 **Chudnoff, M.; Wawriw, R.** Effectiveness of groundline treatments of creosoted pine poles under tropical exposure; second interim report. Turrialba. 20(3): 367-368.

Abstract: These third-year test results support earlier findings that suggest that after

2 years of exposure, surface-applied formulations contain above-threshold quantities of toxicants mainly in an outer 1/2-in. zone.

1970 **Highley, T.: Scheffer, T.** Natural decay resistance of 30 Peruvian woods. Res. Pap. FPL 143. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 4 p.

Abstract: Using outdoor stake and soil block tests, 30 Peruvian woods were evaluated for resistance to fungal decay by three fungi. Tables list relative resistance and physical properties of the woods.

1970 **Highley, T.: Scheffer, T.** Need for modifying soil-block method for testing resistance of white rot? Material und Organismen. 5(4): 281–292.

Abstract: Using sweetgum and various tropical hardwoods, intensity of white rot by *Polyporus versicolor* was greatly increased by substituting filter paper for the wood feeder block and by amending the soil with malt in the standard ASTM soil block test for natural decay resistance. These modifications did not increase the rate of brown rot by Poria *monticola.*

1973 **Chudnoff, M.: Gjovik, L.R.: Wawriw, R.** Effectiveness of groundline treatments of creosoted pine poles under tropical exposure. Southern yellow pine with various treatment for use as utility poles in tropical conditions–after 5 years. Forest Products Journal. 23(9): 80-84.

Abstract: Three proprietary groundline wood preservative formulations were applied to weathered southern yellow pine pole stubs initially treated with creosote. Under test were fluoride-creosote, fluoride-arsenic, and pentachlorophenol gel compounds. The study was made to evaluate supplementary treatments of utility poles in a high rainfall, high decay-hazard tropical environment.' The amount and distribution of sodium fluoride or pentachlorophenol after 1 , 3, and 5 years was determined. Developing decay patterns in treated and untreated control stubs were also described. Based on soil-block threshold determination of 0.15 to 0.25 lb/ft^3 for sodium fluoride, all zones in an outer 3 inches treated with a fluoride-arsenic injection and exposed for 5 years were deficient. Pole stubs treated with a surface application of fluoride-creosote had above-treshold retention only in an outer 1/2-in. zone. Similarly, pentachlorophenol applied in a gel formulation had above-treshold (0.10 to 0.20 lb/ft^3) retention only in the outer 1/2-in. zone. After 8 years of storage and 5 years of ground contact, creosoted southern yellow pine control poles initially pressure treated to 14 lb/ft^3 (gage) had oil residues of only 4 to 5 lb/ft^3 (assay) in an outer 3-in. zone. These control stubs were severely attacked by decay fungi. The three proprietary groundline treatment formulations were highly effective in preventing decay.

1976 **Johnson, Bruce R.; Gonzalez T., Guillermo E.** Experimental preservative treatment of three tropical hardwoods by double-diffusion processes. Forest Products Journal. 26(1): 39-46.

Abstract: Numerous modifications of double-diffusion treatment were evaluated with three tropical American hardwoods, cativo, gallinazo, and lechoso. Duration of soak had the most pronounced effect on retention, but time needed was shown to depend on sample condition and preparation, solution concentration, and retention level desired. With all three species, nearly all the variously modified treatments produced chemical retentions considered adequate to protect wood against severe decay and insect attack. It seems probable with additional experimentation that schedules for double-diffusion process could be found that would yield effective treatments of numerous other tropical species.

1976 **Jutte, Susanna M.; Sachs, Irving B.** SEM observations of teredo attack on tropical hardwoods in brackish water. In: Scanning Electron Microscopy (Part VII), Workshop on Plant Science Applications of the SEM: 1976 April; Chicago, IL: IIT Research Institute: 555-562.

Abstract: Scanning electron microscopy (SEM) was used to determine if various tropical wood species were resistant or nonresistant to teredo attack, and if marine soft-rot fungi and silica deposits were present in softened wood. Resistant species were found with only slight attack by teredos; however, many of the specimens were worn and softened after many years in the sea, probably by pounding waves, swelling, slow hydrolysis, and action of organisms such as bacteria and fungi.

1978 **Chudnoff, M.; Eslyn, W.; Wawriw, R.** Effectiveness of groundline treatments of creosoted pine poles under tropical exposure. Southern yellow pine with various treatment for use as utility poles in tropical conditions–after 10 years. Forest Products Journal. 28(4): 28-32.

Abstract: Three proprietary groundline wood preservative formulations were applied to weathered southern pine pole stubs initially treated with creosote. Under test were pentagel, fluoride-creosote, and fluoride-arsenic formulations. The amount and distribution of pentachlorophenol or sodium fluoride after 1, 3, and 5 years of exposure was determined, as were decay patterns after 5 and 10 years of service. Residual toxicity after the 10-year exposure period was also determined using soil-block bioassays. After 8 years of storage and 10 years of ground contact, creosote control stubs were severely attacked by decay fungi. All three groundline applications deterred decay. The most effective was the fluoridearsenic injection treatment.

1981 **Eslyn, Wallace E.; Bultman, John D.; Jurd, Leonard.** Wood decay inhibition by tropical hardwood extractives and related compounds. Physiology and Biochemistry. 71(5): 521–524.

Abstract: Pine blocks were impregnated with extractives obtusaquinone, obtusastyrene, or lapachol, or with the synthetic compound 2–benzyl-4, 64–t–butylphenol. The blocks were sterilized by steam or by exposure to ethylene oxide and then subjected to decay by *Gloeophyllum trabeum, Poria placenta,* or *Coriolus versicolor.* Obtusastyrene and obtusaquinone were most effective against the brown-rot fungi, controlling them at concentrations of 3 and 3.5 percent, respectively. Weight losses by *C. versicolor* were reduced from 23 percent (steamed blocks) to 4 percent by a 4 percent concentration of obtusastyrene and to 6 percent by a similar concentration of obtusaquinone. Lapachol was effective at its highest concentration (4 percent) only against *P. placenta.* Benzylphenol, at a similar concentration, reduced all decay-associated weight losses to 8 percent or below. Ethylene oxide sterilization resulted in decreased decay by *G. trabeum* and *P. placenta* on treated wood. In control (nontreated) wood, however, no significant differences in decay susceptibility were detected among blocks sterilized by different methods.

1986 **De Groot, Rodney C.** Durability of utility poles in Panama. FPL–RP-478. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 12 p.

Abstract: Creosote-treated southern pine and Douglas-fir utility poles, produced in the United States and installed in Panama, were inspected for termites and for decay at the groundline. Findings indicate that current U.S. industrial and Federal specifications for creosote treatment of southern pine poles provide adequate protection in most tropical environments, but some variation in performance was observed between poles set in different ecological biomes. In tropical regions, such as Panama, where termites pose a serious hazard, specifications for creosote treatment of Douglas-fir poles should be supplemented with requirements for treatment of soil around the pole with an approved termiticide.

1986 **De Groot, Rodney C.; Stoukoff, Michael.** Efficacy of alternative preservatives used in dip treatments for wood boxes. FPL–RP-481. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 21 p.

Abstract: Nailed pine boxes, wire-bound gum boxes, and wire-bound plywood boxes were dip treated with alternative wood preservatives and exposed above ground in a jungle and in an open field in Panama, and in a partially shaded field in southern Mississippi. This report describes results after 36 months of exposure at the two locations in Panama, and after 47 months of exposure in Mississippi. Results from the open field in Panama were intermediate between those from the jungle site and those from the site in Mississippi.

1986 **Gjovik, L.R.; Gutzmer, D.I.** Comparison of wood preservatives in stake tests. 1985 Progress Report. FPL–RN-02. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 100 p.

1989 **Gjovik, L.R.; Gutzmer, D.I.** Comparison of wood preservatives in stake tests. 1987 Progress Report. FPL–RN-02. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 98 p.

This report covers test stake results primarily from southern pine sapwood 2 by 4 by 18 in. in size, treated by pressure and nonpressure processes, and installed by the Forest

Products Laboratory and cooperators in our decay and termite exposure sites at various times since 1938 at Saucier, MS, Madison, WI, Bogalusa, LA, Lake Charles, LA, Jacksonville, FL, and the Canal Zone, Panama. Also included in the tests at Saucier, MS, are smaller pine stakes and those of treated and untreated plywood, particleboard, modified woods, laminated paper plastic, pine infected with Trichoderma mold, plus other selected wood species such as oak, Douglas-fir, and Engelmann spruce.

Hardboard and Particleboard

1979 **Myers, Gary C.** Hardboards from mixed tropical hardwoods. Forest Products Journal. 29(5): 44-48.

Abstract: Study was initiated to establish the suitability of using mixed tropical hardwoods in manufacture of medium- and high-density hardboards. Logs from secondary hardwood species were collected in Colombia, Ghana, and the Philippine Islands and shipped to the USDA FS, Forest Products Laboratory, Madison, WI, where chip mixtures were prepared. All chip mixtures readily fiberized in a pressurized refiner, producing excellent fiber. All classes of hardboards had excellent dimensional stability with small linear and thickness movement. The surfaces of all hardboards were excellent and would be suitable for finishing operations.

1979 **Youngs, R.L.; Laundrie, J.F.** Reconstituted products: A use for mixed tropical hardwoods. Journal of Forestry. 77(3): 178-179, 198.

Abstract: In cooperation with the Agency for International Development, research was conducted on the manufacture of reconstituted products from mixed tropical hardwoods, including kraft pulps, newsprint, papers, tissue, toweling, hardboards, particleboards, linerboard, and corrugating medium. Suitable products were produced showing the potential for use of mixed species.

1983 **Myers, G.C.** Properties of hardboards from tropical hardwoods and aspen chips with simulated exposure. Forest Products Journal. 33(2): 39-42.

Abstract: This limited study illustrates the feasibility of long-term storage of Philippine hardwood chips for dry-formed hardboard manufacture. Only 9 percent weight has occurred after 9 months of storage under conditions that resulted in a 22 percent loss with aspen chips. Highdensity hardboards made from the aged Philippine hardwood chips had greater bending strength, internal bond, and thickness swelling than did boards made with fresh chips. Tensile strength and linear movement were not as great.

Utilization–General

1918 **Gerry, Eloise.** Compilation and summary of information on South American forests and woods of commerce. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 55 p.

Abstract: This report summarizes available information and data on the distribution of forests and important commercial species of South America. It suggests that by testing about 200 species of wood, a good idea could be obtained of the mechanical properties of South American woods. The report further states how such technical knowledge is now lacking or inadequate.

1927 **Koehler, Arthur.** The need of research on tropical woods before marketing them. Unpublished report. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 10 p.

Abstract: Need for research on tropical woods is emphasized for the purpose of identifying their most suitable product markets. Great variability of tropical woods with respect to weight, hardness, durability, and other characteristics are illustrated in terms of the usefulness of such information for good utilization.

1929 **Markwardt, L.J.** South American hardwoods as related to the timber requirements of the United States: A proposed study of South American species. Unpublished report (vault copy). Madison, WI: US. Department of Agriculture, Forest Service, Forest Products Laboratory. 20 p.

Abstract: This report is in response to concerns for growing shortages of hardwoods in the United States suitable for current industrial needs. The report proposes that the suitability of different South American species for various uses should be determined by laboratory

correlations of properties with uses, but that it would not be practical to attempt for the number and variety of South American hardwoods in a brief study. The report outlines a 10-year program of research that might be carried out to accomplish given objectives, with possibilities for an abbreviated program to run for 5 years.

1947 **Koehler, Arthur.** The waiting forest resources of the American tropics. Unpublished report. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 6 p.

Abstract: To supply the United States with badly needed hardwoods and to find markets for timber in Latin American countries, intensive studies should be made of availability and characteristics. Research in utilization of tropical woods should have two objectives: (1) to determine their more important characteristics allowing comparisons with better-known native species and (2) to overcome, if possible, objectionable features of certain species.

1951 **Gerry, Eloise; Flick, Frances J.** Puerto Rican woods and their utilization: A bibliography. FPL Report No. R1793. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 15 p.

Abstract: This bibliography attempts to list background references contributing to a better understanding of available Puerto Rican woods and their uses. A time span from 1900 to 1950 is covered.

1952 **Bell, C.C.** Forest utilization in Puerto Rico. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 51 p.

Abstract: This report summarizes utilization problems of Puerto Rico and provides recommended actions to alleviate the problems identified.

1971 **Freas, A.D.** Properties and utilization of tropical woods. In: Proceedings of IUFRO Section 41; 1970 November 26–27; Hamburg, Lohbrugge. Hamburg: Kommissionsverlag Buchhandlung Max. Wiedebusch. 74 p.

Abstract: Describes supply from Amazon Basin, West Africa, Southeast Asia, including volumes and exports. Utilization excluding secondary species is discussed. Conversion capabilities and properties of the wood are noted.

1976 **Chudnoff, Martin.** Any-tree harvest for industrial processing in humid tropics. Import/Export Wood Purchasing News. 2(4): 6.

Abstract: The complex tropical forests and harvest by skimming suggest a need for other than conventional approaches to utilization. Any-tree harvest, as suggested by this paper, however, must be followed by high-yield plantations that can meet all the raw wood requirements of the industrial complex established for the first harvest.

1980 **Chudnoff, M.; Youngs, R.L.** Evaluation of concepts for improved utilization of tropical timber resources. UNASYLVA. 32(128): 27–28.

Abstract: Describes problems in tropical regions stemming from numbers of species and tree size. Properties may have been determined but lack of abundance of species is a problem. Pooling of species may be necessary and tied to end uses. Marketing of any–tree/wholetree may be necessary to use lesser known species.

1981 **Youngs, R.L.** Forest products research: Needs and prospects (thinking locally/acting globally). In: Proceedings of the 17th IUFRO Congress; 1981 September; Kyoto, Japan. Div. 5: 47–57.

Abstract: Describes research and technology transfer needs including processing, protection, wood anatomy, economics, and energy.

1984 **Hornick, J.; Zerbe, J.; Whitmore, J.L.** Jari's successes. Journal of Forestry. 82(11): 663–667.

Abstract: The authors discuss the Jari project which is an experiment to make plantation forestry profitable on a large scale in the Amazon River Basin of Brazil.

1984 **Marra, G.; Tuomi, R.; Erickson, J.; Koeppen, R.; Wahlgren, H.; Johnson, D.** Program direction for forest products utilization research in the Forest Service. In: Proceedings of Forest Service conference; 1984 January 30; Washington, DC. 56 p.

Abstract: Describes Forest Service, U.S. Department of Agriculture, goals and efforts in forest products research and includes Latin

American and other tropical-wood utilization research,

Miscellaneous

1919 **Forest Products Laboratory.** Review of "Rules and specifications for the classification and grading of lumber, ties, and piling for the Panama Canal" with comments, suggestions, and recommendations. Unpublished report (vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 22 p.

Abstract: This memorandum provides a paragraph-by-paragraph series of comments, suggested changes, and additions for proposed grading rules.

1942 **Paul, Benson H.** Outline of procedure for collection and field testing of Latin American woods. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 9 p.

Abstract: Specific procedures are given for collecting and recording wood specimens.

1943 **Teesdale, L.V.; Myer, J.E.** Inspection of wood aircraft at Salinas, Ecuador, April 4. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 7 p.

Abstract: The excellent condition of the wood and glue joints in the Curtis and Fairchild airplanes indicate climatic conditions in Ecuador have little detrimental effect upon wooden parts of airplanes of good design, workmanship, and proper maintenance.

1945 **Teesdale, L.V.** In Ecuador wood boats are built the hard way. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 14 p.

Abstract: During the U.S. mission investigating the forest resources of Ecuador in 1943, boats being built by primitive methods were observed, and this paper reports on those observations. Species of woods most commonly used for boat construction are listed with a table of estimated service life for different member parts of a ship.

1945 **Teesdale, L.V.** Shipbuilding facilities and practices in Ecuador. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 26 p.

Abstract: This paper reports on facilities for shipbuilding and local shipbuilding practices observed in Ecuador in 1943. In general, the design and details of construction differ from ships built in U.S. shipyards. For example, by using natural crooks, frames are made with a minimum of metal fastenings. Selection of species for resistance to marine borers for stem, stern, and rudder posts provides natural durability. Also, because species available are heavier and stronger than southern yellow pine or Douglas-fir, structural members can be reduced to save weight and materials.

1945 **Teesdale, L.V.** Timber of Ecuador best suited for wooden ships; interim report. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 15 p.

Abstract: The qualities of timber from Ecuador for use in highways, shipbuilding, and other construction related to the war effort are reported. It concludes that (1) Ecuador has an abundance of timber suited for building wooden ships; (2) timber sizes are suited for construction of ships up to 700 registered ton capacity; (3) available species are strong, durable, and resistant to attack by borers; (4) wood properties allow large members to be used without seasoning. (Planking and decking can be used after a few months of air seasoning.); (5) existing sawmill capacity is almost exclusively employed in production of balsa for the war effort; and (6) extraction difficulties tend to limit the sizes of logs that can be taken from the woods to the water.

1945 **Teesdale, Laurence V.; Girard, James W.** Wood utilization in Puerto Rico. Publication No. TP–21 (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 46 p.

Abstract: The Puerto Rico Development Company requested assistance from the U.S. Department of Agriculture, Forest Service, to identify factors that might encourage and facilitate local production of furniture and specialty items for domestic consumption and export. Conclusions indicated it would be doubtful if lumber products could be imported, manufactured, and reexported to economic advantage. However, it was suggested

that existing woodworking industries should be able to take up some part of the volumes of manufactured wood products imported. Seasoning problems in Puerto Rico are discussed and suggestions are provided in an appendix.

1952 **Bell, C.C.** Forest utilization in Puerto Rico. Unpublished report (vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 51 p.

Abstract: Over 440 years of exploitation and population pressure have reduced forest stands to the point where they are inadequate to supply local need or even protect water supplies. From the standpoint of utilization, there is a need for increased use of small, poor-quality and poor-formed material; a need for increased production of timber in sawlog sizes and of high value; and a need for acceleration of tests and research to add to the meager amount of information available on Puerto Rico's 600 tree species.

1962 **Kukachka, B.F.; Saeman, J.F.** Report on investigations in South America related to a projected aid program in the field of forest products utilization. Unpublished report (Vault copy). Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 74 p.

Abstract: This report resulted from efforts by the Forest Products Laboratory in support of the objectives of the Alliance for Progress program for Latin America, the Agency for International Development (AID) to conduct a field survey in Venezuela, Brazil, Chile, and Peru. Information was developed regarding: (1) identification of wood species sufficiently important to warrant further study; (2) determination as to what extent forest products research can be undertaken in Latin American laboratories; and (3) assessment of capabilities and training requirements with respect to prospective research requirements. The report includes a record of conferences, a listing of people and places visited, and provides a key to major reference materials at the FPL that have a bearing on problems under investigation.

1975 **Burdsall, H.H., Jr.; Miller, O.K.. Jr.** A reevaluation of *Panellus* and *Dictyopanus* (Agaricales). Beiheft Zur Nova Hedwigia. 51 : 79-91.

Abstract: Describes fungi of the genera *Panellus* and *Dictyopanus* found around the world. Keys are given for identification of species within the genera and descriptions of cultural studies. Tropical species are included in the discussions.

1983 **Nakasone, K.K.** Cultural and morphological studies on *Cystostereum australe* (Corticiaceae), a new species from southeastern U.S.A. and Costa Rica. Mycotaxon. 17 (Apr.–June): 269–274.

Abstract: Cystostereum australe, a new species from the southeastern United States and Costa Rica, is reported. It is closely related to *Cystostereum murraii,* a common and widely distributed wood decay fungus. The basidiocarp and cultural characaterististics of the new species are described, illustrated, and compared with *C. murrai.* The two species can be differentiated by basidiospore morphology and cultural characters.

1984 **Burdsall, H.H., Jr.** The genus *Candelabrochaete* (Corticiaceae) in North America and a note on *Peniophora mexicana.* Mycotaxon. 19 (Jan.–Mar.): 389-395.

Abstract: Studies of wood-rotting Basidiomycetes for the purpose of clarifying taxonimic limits and biological similarities or differences among the taxa led to investigation of the genus *Phanerochaete* Karst., a genus containing numerous white-rot species. During the study, the similarity of *Ph. septocystidia* (Burt) Eriksson and Ryvarden, *Ph. insolita* Burds. and Nakas., and *Pheniophora mexicana* Bart to the genus *candelabrochaete* Boidin was noted. Candelabrochaete was then examined to establish generic differences from *Phanerochaete* and to determine *Candelabrochaete's* specific components. Such knowledge will enable more reliable determination of fungi in these genera, which are used in the study of forest pathology, wood products decay, and wood biodeterioration or bioalteration. As a result of this study, a key to and descriptions of the North American species of *Candelabrochaete* and a discussion of *Pe. mexicana* are presented.

1985 **Burdsall, H.H., Jr.** A contribution to the taxonomy of the genus *Phanerochaete* (Corticiaceae, Aphyllophorales). J. Cramer Publisher, In den Springaeckern 2, 3300 Braunschweig, Germany Mycologia Memoir No. 10. 165 p.

Abstract. Describes fungi of the genus *Phanerochaete* as found worldwide, with some species from the tropics.

1986 **Chudnoff, Martin.** Tropical timbers of the world. Agric. Handb. 607. Washington, DC: U.S. Department of Agriculture. 466 p.

Abstract: This handbook contains descriptions of 370 species or generic groupings of tropical trees and their timbers grouped by regional origin: Tropical America, Africa, and Southeast Asia and Oceania. Standardized descriptions emphasize physical and mechanical properties, processing characteristics, and uses. Data have been compiled, evaluated, and synthesized from the world literature. Extensive tables of technical data are coded to permit easy comparison of species properties and to aid in the selection of woods most suitable for particular end uses.

1987 **Laundrie, James F.; Montrey, Henry M.** Forest products technology affects tropical forest requirements. In: Figueroa–Colon, Julio C., ed. Management of the forests of tropical America: prospects and technologies: Proceedings of a conference; 1986 September 22–27; San Juan, PR. Rio Piedras, PR: U.S. Department of Agriculture, Forest Service, Institute of Tropical Forestry: 437-448.

Abstract: Five new technologies, developed or studied by the USDA Forest Service, Forest Products Laboratory, were selected and used to illustrate how they might affect the utilization of the present tropical forest resource and place new requirements on future tropical forest resources. The five new technologies were (1) utilization of mixed tropical hardwoods for various reconstituted products; (2) the press-dry papermaking process using high-yield unrefined hardwood pulps; (3) the saw-dry-rip process for producing structural lumber from hardwoods: (4) efficient and low-cost solar-wood energy kilns for drying lumber; and (5) the truss-framed building system for lower cost housing.

1988 **Food and Agriculture Organization of the United Nations.** Forest Products: World outlook projections. 1988 FAO Forestry Paper 84. 350p.

Abstract: This paper presents a country by country world view of the future demand for forest products and for timber–a useful tool in making country-level forestry development plans. The Forestry Department of the Food and Agriculture Organization (FAO) of the United Nations prepared this report with assistance from the Forest Products Laboratory.

This report projects consumption and production from 1987 to 2000 of several forest products reported in the FA0 Yearbook of Forest Products. Products include sawnwood, wood-based panels, fiber input to paper; roundwood input to all modern sector products, and roundwood consumed for fuel. Individual sections group the information by country and by product, covering 160 countries. The FA0 based these projections on data collected from 1961 to 1985 and econometric relationships that link consumption and production to economic variables such as gross domestic product, gross fixed capital investment, and population.

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