United States Department of Agriculture

Forest Service

Agriculture Handbook 607

September 1984

Tropical Timbers of the World

Martin Chudnoff
Forest Products Technologist (retired)
Forest Products Laboratory
Madison, Wis.

edition produced by Publishing House Kessel, Eifelweg 37, 53424 Remagen (Germany)
Tel.: 0049-2228-493, Fax: 0049-12125123 82426, E-Mail: nkessel@web.de
www.forestrybooks.com
www.forstbuch.de
www.verlagkessel.de

Impressum
Verlag Kessel
Eifelweg 37
53424 Remagen-Oberwinter
Germany

Homepage:
www.VerlagKessel.de
www.forestrybooks.com
www.forstbuch.de

Tel.: 0049-2228-493
Fax: 0049-1212-512382426
E-Mail: nkessel@web.de
ISBN: 3-935638-82-5

Acknowledgment

Sincere thanks to Dr. Robert C. Koeppen of the U.S. Department of Agriculture, Forest Service, Forest Products and Engineering Research Staff, for review of the technical data and nomenclature in this work.

Requests for copies of illustrations contained in this handbook should be directed to the Forest Products Laboratory, USDA Forest Service, P.0. Box 5130, Madison, WI 53705.

Foreword

Few days go by at the Forest Products Laboratory without questions from around the world about properties and uses of tropical woods. Interspersed with the queries about such U.S. species as Douglas-fir and white oak are requests about arariba from Brazil, sipo from Ivory Coast, or kapur from Malaya.

Such questions come logically to the Forest Products Laboratory, because it is the official wood identification arm of the Federal government. In the more than 70 years the laboratory has been answering such questions, research concentration has been primarily on determining properties and uses for U.S. species. But as lumber imports from the tropics are increasing, so are questions about foreign woods. As international trade increases, people need more Information on exotic species, their properties, and what woods can be substituted for those no longer available.

To answer these questions, information has to be gleaned from publications by other scientists around the world. The average person who needs technical data does not have access to the hundreds of rare publications that contain the information. Even if such documentation were pulled together from a variety of sources, the seeker might discover the information was given in several languages and often based on nonuniform test methods, descriptions, or measurements. How can one compare and choose?

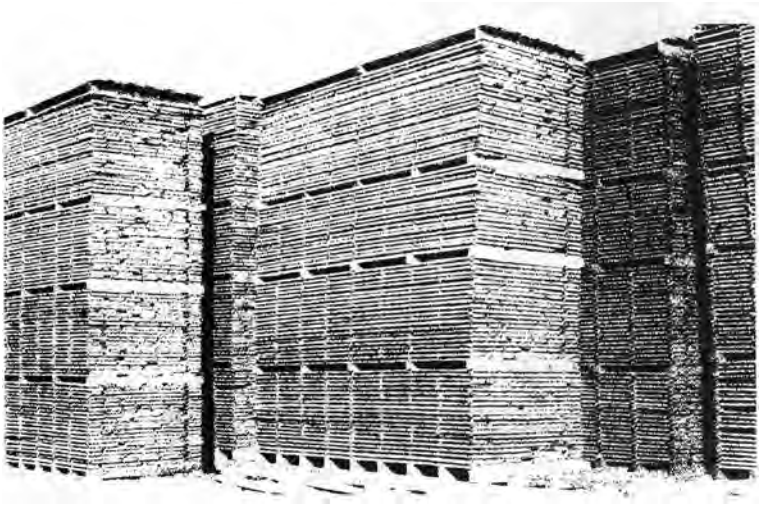
To fill this need, Martin Chudnoff has compiled information on the better known tropical species, put the data on a common basis, and assembled it in a brief, useful form. To accomplish this, he drew on his training as a forester and wood technologist and his many years of forest products research in tropical and subtropical areas of the world.

This volume is the product of his dedicated work.

Max A. Davidson
Forest Products Laboratory, retired

Contents

Introduction



M 150 272-17

Hartwood lumber being air-dried at a large industrial complex in South America. The lumber will be further dried in a kiln before it is processed for export markets.

Filling a Need

Over the past two decades U.S. lumber imports from the tropics have increased fourfold. Plywood trade, mostly from Asian sources, has soared fortyfold and now equals our domestic production. Log imports, though, have decreased drastically from about 100 million board feet (log scale) in the 1950‘s to 30 million currently. Much of the world timber trade now is in the form of processed material. A wide array of tropical wood species and species groupings are now available to U.S. processors. Many are already well known on the European markets. This surge in supplies from overseas includes softwoods, hardwoods, decorative species, and utility woods.

An extensive body of foreign literature describes the properties of tropical woods, but much of this literature is not readily available to interested users. In this country the Forest Products Laboratory has issued “Information Leaflets” or “Forest Wood Series” reports on some species of importance, but few are in print. The most recent comprehensive document, “properties of Imported Tropical Woods,” (*3*) contained a description of about 100 tropical genera.

Because of the ever-increasing demand for reference material, we have prepared this more extensive data source. Parts I–Tropical America, II–Africa, and III–Southeast Asia and Oceania contain concise descriptions of tree and timber characteristics for about 370 tropical species or generic groupings. The actual number of botanical entities, however, is many more. Almost all the information was compiled from world literature. This required an extensive search of abstracts and then an amassing of a rather formidable documentation. Focus has been on species already highly favored in international trade.

The worldwide literature was translated, interpreted, reduced, and synthesized. Only a small part of the information presented in this volume is based on research conducted by the USDA Forest Service.

Species are listed alphabetically by scientific name and are grouped according to regional origin–Tropical America, Africa, and Southeast Asia and Oceania. Each of these parts supplies condensed information about particular species or species grouping. Technical data and descriptive information presented here follow the format used by R. H. Farmer (*2*)

Part IV classifies the physical and mechanical property data from parts I, II, and III into groupings that permit comparisons even though methods of testing may have been quite different. A guide to several major use categories is also included. All data are presented in table form that allows rapid scanning or easy transfer to card sorts or input to a computer retrieval system. A summary reference sheet attached to the table can be used to decode physical and mechanical properties classified in table IV-I.

M 150 273-17

Modern logging equipment, including portable high lead rigging, is now in use throughout the tropics where tree size and species concentrations are economically favorable.

Five appendixes supply additional Information. Appendix A is a partial list of forest products references, almost all of which were used in this compilation. They are divided into those with worldwide coverage and those specific to Tropical America, Africa, and Southeast Asia.

Appendix B is a list of generic synonyms. If a particular species or species grouping cannot be found in the text, this list of name changes should be checked.

Appendix C may be helpful where more than one genus makes up a trade grouping. For example, the name *Neesia* may be known, but the data are filed under *Durio* and *Neesia*.

Appendix D furnishes Information on the derivation of comparable toughness values given in table IV–1.

Appendix E offers tables that can be used to assemble the dry kiln schedules suggested for the various timbers.

If only the trade name of a wood is known, the Index of trade names can be used to obtain cross references to scientific names and entry to the species descriptions. For a listing of the thousands of common names used in the producing countries, see the catalog prepared by Boutlje (*1*).

Scientific Names

Species information is arranged alphabetically by generic name within the three main tropical regions. Where more than one species is described within a genus, the material is presented alphabetically according to specific name or group trade name. Where two or more species in a genus make up a commercial grouping, the composite is designated by spp. (e.g., *Peltogyne* spp).

We have attempted to use currently accepted nomenclature, but well-known synonyms are also given (e.g., *Ochroma pyramidale* syn. *Ochroma lagopus* or *Nauclea diderrichii* syn. *Sarcocephalus diderrichii).* Some commercial timber groupings may include more than one genus (e.g., the wood marketed as Resak includes *Cotylelobium* spp. and *Vatica* spp.*).*

Many genera are native to more than one region (e.g., *Podocarpus, Pterocarpus, Terminalia),* but *Ceiba pentandra, Symphonia globulifera, Andira inermis* and *Rhizophora mangle* are the only species listed that are indigenous to two or more regions. However, many species from one region have been introduced into the other two, either as ornamentals or for the production of such products as timber, tannin, latex, gums, and resins. Para rubber tree, *Hevea brasiliensis, is* native to Brazil but is most extensively cultivated in Africa and Asia. Teak, *Tectona grandis, is* a favored plantation species in tropical America and West Africa but is native to Southeast Asia. The information on these and other exotics is arranged in their region of origin.

To further complete botanical affinities, family names are also given. Plants developing woody tissue are classified in about 250 families. Species and species groupings in this compilation can be placed in some 70 families. The largest number, by far, belongs to the Leguminosae, followed by Meliaceae, Lauraceae, and Moraceae. Nineteen species or species grouping of the 4 gymnosperm or softwood families of Araucariaceae, Cupressaceae, Pinaceae, and Podocarpaceae are also included.

Trade and Other Common Names

The scientific name is followed by one or more trade names. These come into use after years of marketing on national and international levels. Sometimes the trade name is merely a repetition of the generic name (e.g., afzelia, albizzia, alstonia). Often when there is a superficial similarity to a Temperate Zone timber, but no botanical affinity, names such as Queensland-maple and silky-oak are used. Honduras mahogany, is a trade name for *Swietenia macrophylla* because shipments, at first, were mostly centered in Honduras. Yet the name applies to timber now harvested from Mexico southward to eastern Bolivia. The name mahogany, with a geographical modifier, also refers to species of *Khaya* from Africa and to botanically unrelated species of *Shorea* from the Philippines.

A few other common names, mostly of local use only, are also given. Some woods may have dozens of such names, changing from country to country and from district to district within countries. All of the trade names, but only a few of the common names, are indexed in this volume.

Distribution

Information on growth ranges and site preferences is given. Gregarious species are also noted. Most of the species or species groups described here are found growing between the Tropic of Cancer and Tropic of Capricorn, some 50° of latitude. Included are a few species growing outside of the tropical belt (e.g., *Nothofagus* spp. and *Fitzroya cupressoides* native to Chile and Argentina and some eucalypts from Australia).

Most of the species described are available to world markets only in rather small volumes. To obtain larger supplies for a particular end use, it may be necessary to accumulate timbers having similar characteristics from several botanical groupings. Even those species growing in pure Stands over large areas may be limited in supply. For example, Parana-pine forests have been heavily cut over in Brazil, and the area is being restocked mainly with exotics. *Virola* spp., once abundant for plywood production in the Guianas, must now be imported from other regions to meet their veneer needs. Okoume, a highly favored plywood species on the European market, is no longer available from the First Zone (mostly coastal) of Gabon. Because of this transient characteristic of the resource, we have not attempted to indicate current or future availability of the species listed.

Distribution within the tropics is highly variable. Some species are found in coastal tidelands (red

mangrove, *Rhizophora mangle),* swamp forests (ramin, *Gonystylus bancanus* or banak, *Virola* spp.*),* on low coastal plains, and along riverbanks (cativo, *Prioria copaifera* or mora, *Mora excelsa).* Others are established on low-temperature, high-mountain sites (roble, *Quercus* spp. or Benquet pine, *Pinus insularis).* All of the above species occur in rather pure forest stands, but this is not typical of the tropical forest as a whole. Where there are no special atmospheric, geological, topographic, or edaphic conditions, individuals of the most common species found in lowland tropical forests are widely dispersed, seldom making up 10 percent of the volume, and often much less.

The Tree

Tree form and size are emphasized under this heading. Some specialty woods are milled from very small stems (e.g., African blackwood, *Dalbergia melanoxylon* and West Indian satinwood, *Zanthoxylum flavum).* Other timbers come from trees that soar to heights of 150 to 200 feet and have log diameters of 8 feet and more (e.g., okoume, *Aucoumea klaineana* or kapur, *Dryobalanops* spp.*).* Trunks of many species have buttresses that may reach heights of 15 to 25 feet (e.g., obeche, *Triplochiton scleroxylon* or mora, *Mora* spp.*).*

The Wood

General Characteristics: This section stresses the appearance of wood of individual species and species groupings. Heartwood colorations, unusual changes on exposure to light or air, and differentiation, if any, from sapwood are described. Woods with high luster or golden cast due to the way light is reflected are noted. If anatomical elements are large and irregular, the wood is described as having coarse and uneven texture. If these same features are small and evenly distributed, the texture is fine and uniform. Grain defines the arrangement or alinement of wood tissue-straight, spiral, or interlocked. Interlocked grain is most common in tropical timbers and is due to an alternating right- and left-hand spiraling of the grain. If quartersawn, this produces a ribbon or roey figure. Other grain irregularities, enhanced by various sawing or slicing techniques, can develop other kinds of figure (e.g., curly, feather, fiddleback, etc.). Distinctive scents and tastes are also noted. Silica percentages, if significant, are given. The literature suggests that there is little blunting of cutting tools unless silica accumulations are above 0.5 percent.

Almost all woods have constituents that are allergenic or toxic to someone, including our native white pine and paper birch. Most people, though, are unaffected by most woods. Dust generated in woodworking may irritate skin and mucous membranes and even cause nosebleeds and respiratory disorders. Timbers that are particularly toxic are noted. Woods with gummy, oily, or resinous exudates are also indicated.

Weight: Specific gravity or density may be related to important wood attributes such as mechanical strength, shrinkage, paper-forming properties, and cutting forces required in machining. Often in assessing the use potential of a species, specific gravity receives first attention.

Basic specific gravity is the ratio of wood density to the density of water at 4° C and is calculated from the ovendry weight and volume in the green condition. This may range from less than 0.1 for balsa, *Ochroma pyramidale* to about 1.1 for lignumvitae, *Guaiacum* spp. Density calculated from weight and volume when air dry, usually at a moisture content of 12 percent, is also given. This may range from about 10 to 80 pounds per cubic foot (pcf) for commercial species.

Mechanical Properties: It must be emphasized that the mechanical properties presented here by species are taken from the world literature. Sampling and testing procedures have varied considerably. Values are given so that comparisons between species can be made as well as selection for targeted end uses. However, the data reported may not be acceptable to regulatory bodies as a basis for assigning design properties. Such interests are beyond the scope and intent of this document.

Sources from which the strength data were obtained are listed in the Literature Cited sections at the end of each geographical part.

Data are given for strength tests in the green and dry condition. These include bending strength (modulus of rupture), stiffness in bending (modulus of elasticity), compression parallel to the grain (maximum crushing strength), Janka side hardness, and toughness (based on either the Amsler or the FPL-Madison type machines).

Most test results reported here are based on the ASTM D 143 procedures using either 2-inch or 1-inch specimens, British Standard No. 373 using 2-centimeter material, or Norme Francaise B51-007, B51-008, and other standards in this series, also a 2-centimeter standard. In the French data, modulus of rupture was calculated using beam depth to the 10/6 power instead of the square of the depth used to obtain U.S. and British bending strength values. The data based on French standards were adjusted to be comparable in this presentation. There are other differences in testing methods. At the Instituto de Pesquisas Tecnologicas, São Paulo, bending strength is based on beams 2 by 2 by 30 centimeters, center-loaded over a 24-centimeter span. Modulus of elasticity, though, is calculated from test beams 6 by 6 by 100 centimeters, center-loaded over an 84-centimeter span.

Drying and Shrinkage: Note is made of the response of individual woods to air-drying and kiln-drying and whether or not there is degrade due to checking, warp or collapse.

Percent shrinkage values (volumetric, radial, tangential) from the green to ovendry condition or green to air-dry condition are given. Movement ratings indicate dimensional stability in service and are based on the sum of percent radial and percent tangential dimension changes corresponding to a change in exposure from 90 to 60 percent relative humidity. Ratings used are:

Small	Under 3.0 percent
Medium	3.0 to 4.5 percent
Large	Over 4.5 percent

Appendix E presents a series of tables that can be assembled into kiln schedules where these are suggested for particular species or species groupings. If no kiln schedules are found in the literature, none are recommended.

M 150 273-6

Highly perishable cuangare (*Dialyanthera* spp.) and banak (*Virola* spp.) logs harvested from coastal lowlands in southwest Colombia are ready for pond storage

Working Properties: Much of the information given on working properties of individual species is highly subjective. Described are ease of working with hand and machine tools, tendencies to torn or chipped grain, smoothness of finish cut, dulling of cutters, and ease of veneering. Nailing, screwing, or gluing characteristics may be included as well as steambending properties if well suited for this purpose. If working the wood is reputed to cause skin or mucous membrane irritations, this is mentioned again.
Durability: Resistance of the wood to attack by decay fungi, insects, and marine borers is described. Ratings are based on laboratory assays, field stake tests, or performance under actual use conditions.

M 150 273-11

If natural durability is good and turnover is frequent, logs can be held in "dry" storage until processed.

Heartwood decay resistance classifications are based on ground contact and are:

Classification (2)	Approximate service life
	Years
Very durable	More than 25
Durable	15-25
Moderately durable	10-15
Nondurable	5-10
Perishable	Less than 5

Sapwood of all species will rate perishable. If not in ground contact and kept dry, all woods could be free of rot and have an extended service life. Consideration must also be given to vulnerability to attack by Lyctus beetles, subterranean and dry-wood termites, and other insects. If data are available, resistance to such attack is reported here. Weathering characteristics and performance under particular kinds of chemical exposure may also be noted.
Preservation: Treatability of sapwood and heartwood using either open tank or pressurevacuum processes is described. Ratings may range from permeable, where 15 to 20 pcf and more of preservative solutions are absorbed with complete or deep chemical penetration to extremely resistant if absorption is only 2 to 3 pcf or less and lateral penetration is superficial. There is no standard treatability test. Ratings may be based on laboratory trials using a wide range of specimen sizes, with or without end coatings, or actual commercial treating plant experience.
Uses: Suitability of a wood for particular applications may be based on indigenous uses in underdeveloped regions or perhaps long experience in export trade but with little or no experience

on U.S. markets. As an example, Jongkong, *Dactylocladus stenostachys*, is treated with oil and used for shingles in Sarawak. This wood may not be marketable elsewhere for the same purpose. Demand exists overseas for woods particularly suitable for produce boxes, which are rarely used in the U.S. economy. Nevertheless, the lists of uses indicate the properties and working characteristics of the wood and may suggest applications still not realized. Often trees formerly classified as uneconomic or weed species are now in high demand an world markets. Use categories, then, should not be considered restrictive.

M 150 272-11

Sash gang saws are used in Surinam for log breakdown. About 30 species are classified as available in quantity from the region, yet only 3 species make up 90 percent of the lumber exports.

M 150 273-8

In Guyana band mills are preferred for log breakdown and resaw.

If a tree is noted for the yield of products other than wood (gums, latex, fiber, tannins, nuts and fruits, etc.), this is also indicated.

Additional Reading

The species descriptions are based on a compilation of world literature. Presentations are rather concise to fit the format used. Material for a few species is based on only one or two sources; more often dozens were used. Usually three or four references are cited and listed at the end of each regional section.

Several thousand documents, many of them long out of print, were consulted to develop this data base. For those with an interest to read further, a few comprehensive references are given in appendix A.

Literature Cited–Introduction

1. Boutlje, J. B. 1980. Encyclopedia of world timbers: Names and technical literature. Swedish For. Prod. Res. Lab. STFI–meddelande Serie Anr 611. Stockholm.
2. Farmer, R. H. (Editor). 1972. Handbook of hardwoods. H. M. Stationery Office, London.
3. Kukachka, B. F. 1970. Properties of imported tropical woods. USDA Forest Service Res. Pap. FPL-125. Forest Product Laboratory, Madison, Wis.

Part I–Tropical American Species[1]

M 150 272-12

Planalto forest south of Santarém in the Rio Curuá-Una region, Brazil. About 60 percent of the volume is in species considerably denser than U.S. commercial woods (basic specific gravity over 0.70).

[1] Numbered references listed under Mechanical Properties and Additional Reading for each species appear in Literature Cited–Tropical American Species, beginning on p. 172.

Tree and Wood Characteristics

Alexa imperatricis
Haiari

Family: Leguminosae
Other Common Names: Haiariballi (Guyana).
Distribution: Found in the Venezuelan Guiana, Guyana, Surinam, and the Brazilian Amazon region. Often dominant on the light-colored sands of the northwest and upper Mozaruni district and the Pakaraima Mountains in Guyana.

The Tree

Unbuttressed, well formed, with small oval crowns. Grows to 36 in. in diameter and 100 ft high on favorable sites, but are usually 20 to 24 in. in diameter and less than 100 ft high. The bole is cylindrical and often 70 ft long.

The Wood

General Characteristics: Heartwood brownish yellow but occasionally somewhat darker; not sharply differentiated from the light yellow to grayish-yellow sapwood, 3 to 4 in. wide. Luster is medium to low; generally straight grained; rather coarse textured; odorless and tasteless when dry.
Weight: Basic specific gravity (ovendry weight/green volume) reported to be 0.46 to 0.55 in Guyana; 0.41 in the Venezuelan Guiana. Air-dry density about 32 pcf.
Mechanical Properties: (1-in. standard)

Moisture content	Bending strength	Modules of elasticity	Maximum crushing strength
	Psi	*1,000 psi*	*Psi*
12% *(24)*	10,590	1,580	5,620

Janka side hardness is 690 lb and the Forest Products Laboratory toughness is 118 in.-lb (5/8-in. specimen).
Drying and Shrinkage: Lumber has a marked tendency to collapse during seasoning. Close piling for air-drying and the use of high humidities and low temperatures during the early stages of kiln-drying are suggested. Veneers are slow to dry. Jet-drying of 1/16-in. veneer at 285° F resulted in buckling, collapse, and splitting. Kiln schedule T2-C2 is suggested for 4/4 stock and T2-C1 for 8/4. Shrinkage green to ovendry: radial 4.0%; tangential 8.5%; volumetric 11.7%. Movement of seasoned wood is classified as large.
Working Properties: Haiari is reported to work easily and finish satisfactorily. Nail withdrawal resistance is higher than would be expected from its density. Rotary cutting trials of 1/16-in. veneer gave smooth surfaces and uniform thickness; rough cutting occurred in 1/8-in. veneer. Reported to have rather unfavorable gluing properties when made into plywood.
Durability: Reported to be highly resistant to decay, but freshly cut logs are very susceptible to damage by pin-hole borers.
Preservation: Both sapwood and heartwood very easy to treat. Absorptions over *9 pcf* with uniform penetration obtainable by hot and cold bath as well as pressure-vacuum systems.
Uses: Haiari is suitable for interior construction, boxes, crating, general construction, plywood, and other uses requiring an easily worked wood of moderate strength.

Additional Reading

(24), (46), (60)