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Tropical Timbers of the World

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The photo on the cover shows
Dryobalanops aromatica,
it comes from
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(Professor of Forest Ecophysiology,
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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?

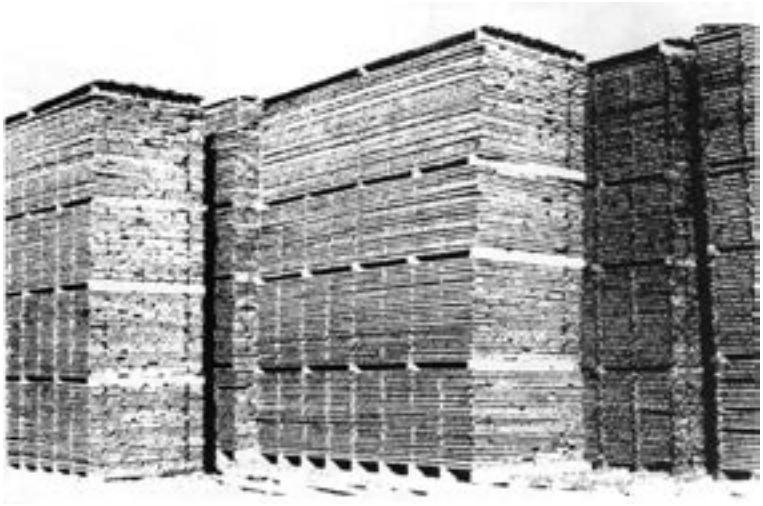
To fill this need, Martin Chudnoff has compiled information on the better known tropical species, put the data on a common basis, and assembled it in a brief, useful form. To accomplish this, he drew on his training as a forester and wood technologist and his many years of forest products research in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

Amburana cearensis
syn. *A. acreana*
Amburana
Ishpingo

Family: Leguminosae
Other Common Names: Amburana, Cerejeira, Cumaré, Cumarú (Brazil), Palo trébol, Roble del pais (Argentina), Ishpingo (Peru).
Distribution: Widely distributed in the dry regions of Brazil and northern Argentina. In Peru found in the tropical dry regions of the Húanuco Department on deep well-drained soils.

The Tree
Over 100 ft in height and 2 to 3 ft in diameter, sometimes to 5 ft; boles are cylindrical but with flutes to 3 ft.

The Wood
General Characteristics: Heartwood yellowish or light brown with a slight orange hue, darkening somewhat on exposure, not sharply demarcated from sapwood. Texture medium to coarse; luster medium to high; grain interlocked and irregular; with mild to distinct scent and taste of cumarin or vanilla; rather waxy appearance and feel.
Weight: Basic specific gravity (ovendry weight/green volume) averages about 0.55; 0.43 reported from Peru. Air-dry density range about 38 to 47 pcf.
Mechanical Properties: (First set of data based on the 2-in. standard, second set on the 2-cm standard.)

Moisture content	Bending strength	Modules of elasticity	Maximum crushing strength
	Psi	*1,000 psi*	*Psi*
14% *(2)*	10,715	1,363	6,100
Green *(30)*	9,880	1,343	4,670
15%	12,820	-	6,860

Dry Janka side hardness 790 lb; air-dry Amsler toughness 154 in.-lb (2-cm specimen).
Drying and Shrinkage: Reported to be easy to dry though sometimes with fine end-checking. No dry kiln schedule data available. Shrinkage green to ovendry: radial 2.3 to 3.0%; tangential 4.1 to 5.8%; volumetric 7.6 to 8.4%.
Working Properties: Easy to work with machine or hand tools, some difficulty in planing due to the interlocked grain. Reported to saw woolly when cut green.
Durability: Reported to have good resistance to attack by decay fungi and insects.
Preservation: No information available.
Uses: Construction, furniture, decorative veneers, and other applications requiring an attractive and dimensionally stable wood.

Additional Reading
(2), (30), (36), (56)

Anacardium excelsum
Espave

Family: Anacardiaceae
Other Common Names: Espavel (Nicaragua), Caracoli (Venezuela, Colombia), Cajú assú, Cajú da matta (Brazil), Marañón (Ecuador).
Distribution: Costa Rica south through Panama to Colombia, Venezuela, and Ecuador. Frequently found in coastal areas on well-drained soils. Almost pure stands reported in the Darién Province of Panama.

The Tree
Commonly attains diameters of 3 to 5 ft, total height frequently ranges from 75 to 150 ft. Forest-grown trees often have clear boles 30 to 60 ft. Some basal swelling but no welldeveloped buttress.

The Wood
General Characteristics: Heartwood on exposure becomes a fairly uniform russet brown with a golden or reddish cast; sapwood is 6 to 10 in. thick, grayish white with more or less pinkish tinge, sharply demarcated from heartwood. Wood has a fairly high luster and is attractively marked by prominent vessel lines; medium to coarse textured and typically has an interlocked grain with a pronounced stripe. Distinctive odor and taste are lacking.
Weight: Basic specific gravity (ovendry weight/green volume) 0.41; air-dry density 30 pcf.
Mechanical Properties: (2-in. standard)

Moisture content	Bending strength	Modules of elasticity	Maximum crushing strength
	Psi	*1,000 psi*	*Psi*
Green *(74)*	5,320	1,060	2,460
12%	7,960	1,280	4,530

Janka side hardness 400 lb green and 470 lb for air-dry wood. Forest Products Laboratory toughness is 57 in.-lb average for green and air-dry material (5/8-in. specimen).
Drying and Shrinkage: Espavé is described as moderately difficult to air-dry. It has a somewhat variable drying rate, and pieces that dry quickly tend to warp and check. Kiln schedule T6-D2 is suggested for 4/4 stock and schedule T3-D1 for 8/4. Shrinkage green to ovendry: radial 2.8%; tangential 5.2%; volumetric 8.4%.
Working Properties: Espavé is rated poor in planing and sanding properties, good in shaping and mortising, and fair in turning and boring. Chipped grain and fuzzy surfaces are the most common machining defects. A silica content of only 0.09% is reported.
Durability: Laboratory tests indicate the heartwood is durable upon exposure to both white-rot and brown-rot fungi. Other evaluations have indicated the wood is vulnerable to attack by fungi and insects. The wood has been classified as resistant to dry-wood termite attack.
Preservation: Though heartwood penetration is irregular, absorptions of 8 pcf have been obtained using pressure-vacuum treatments in Venezuela. Wood from Panama is considered very difficult to preserve though complete penetration was observed in the sapwood.
Uses: General construction both interior and exterior (heartwood) has been suggested. Furniture, veneer and plywood, boxes and crates, and pulp and paper products have also been recommended.

Additional Reding
(44), (56), (71), (74)

Anadenanthera macrocarpa
syn. *Piptadenia macrocarpa*
Curupay

Family: Leguminosae
Other Common Names: Angico preto (Brazil), Cebil, Cebil colorado (Argentina), Curupay-atá (Paraguay).
Distribution: Has a wide distribution in Argentina and is also found in the subtropical and dry forests of Brazil and Paraguay.

The Tree

A medium-sized tree reaching a height of 80 ft with trunk diameters 2 to 3 ft; boles are straight and clear and will yield logs up to 24 ft in length.

The Wood

General Characteristics: Heartwood pale brown, darkening on exposure to reddish brown with darker colored, almost black, streaks; sapwood yellow brown or light pink. Texture fine and uniform; grain usually irregular and interlocked; without distinctive odor or taste.
Weight: Basic specific gravity (ovendry weight/green volume) 0.86; air-dry density 66 pcf.
Mechanical Properties: (2-cm standard)

Moisture content	Bending strength	Modules of elasticity	Maximum crushing strength
	Psi	*1,000 psi*	*Psi*
Green *(30)*	22,200	2,370	10,100
15%	26,900	-	12,600
12% *(42)*	29,290	2,595	14,100

Janka side hardness 3,840 lb. Amsler toughness 680 in.-lb at 15% moisture content (2-cm specimen).
Drying and Shrinkage: Dries slowly with little warp but does tend to check and split in kilndrying, particularly in thicker dimensions. Kiln schedule T8-B3 is suggested for 4/4 stock and T5-B1 for 8/4. Shrinkage green to ovendry: radial 4.6%; tangential 7.6%; volumetric 12.0%. Movement in service is rated as medium.
Working Properties: The timber is difficult to work on account of its hardness, severe blunting effect on cutting edges. In planning a cutting angle of 10 to 15 degrees is suggested to prevent tearing of irregular grain.
Durability: Heartwood is rated as very durable.
Preservation: Extremely resistant to preservative treatments.
Uses: Used for heavy exterior construction and marine work, flooring, railroad crossties, tool handles, turnery. The bark is extracted for its tannin.

Additional Reading
(22), (30), (42), (69)

Andira inermis
Angelin Partridge Wood

Family: Leguminosae
Other Common Names: Moca (Puerto Rico, Cuba), Cuilimbuco, Maquilla (Mexico), Barbosquillo, Arenillo (Panama), Rode kabbes (Surinam), Acapúrana (Brazil).
Distribution: Occurs throughout the West Indies and from southern Mexico through Central America to northern South America and Brazil. In most locations the tree will grow under varying rainfall and soil conditions.

The Tree
Evergreen, unbuttressed, moderate-sized trees; diameters of 20 to 28 in., heights of 90 to 120 ft, and clear boles 60 to 70 ft long are not uncommon.

The Wood
General Characteristics: The narrow sapwood is pale brown to grayish yellow and usually clearly demarcated from the yellowish-brown to dark reddish-brown heartwood. Bands of light colored parenchyma tissue give this wood a distinctive figure. Luster rather low; without distinctive odor or taste when dry; texture very coarse; grain only moderately irregular.
Weight: Basic specific gravity (ovendry weight/green volume) 0.64, air-dry density 45 to 60 pcf.
Mechanical Properties: (2-in. standard)

Moisture content	Bending strength	Modules of elasticity	Maximum crushing strength
	Psi	*1,000 psi*	*Psi*
12% *(44)*	20,870	2,640	-
12% *(24)*	17,680	2,442	9,130

Drying and Shrinkage: The wood air-seasons at a moderate rate with little degrade. Sapwood, during early stages of drying, is susceptible to discoloration by sap-stain fungi. Movement of seasoned wood is rather low. Shrinkage green to ovendry: radial 4.6%; tangential 9.8%; volumetric 12.5%.
Working Properties: Angelin saws and works fairly well except that it is difficult to plane to a smooth surface because of the alternating bands of hard and soft (parenchyma) tissue. The wood works well in the lathe, holds nails and screws well, and glues satisfactorily. Polishes and varnishes well after filling.
Durability: Heartwood is resistant to attack by decay fungi and insects, but is only moderately resistant to dry-wood termites. Sapwood is highly vulnerable to power-post beetle attack.
Preservation: Heartwood difficult to treat by both hot and cold bath and pressure-vacuum systems. Absorptions are considerably less than 6 pcf with poor penetration. Permeability of sapwood is also low.
Uses: The wood is used locally for heavy construction, crossties, house framing, and exterior siding. Other suggested uses are turnery, furniture and cabinet work, parquet flooring, and decorative veneer.

Additional Reading
(24), (44), (46), (72)

Aniba spp.
Louro

Family: Lauraceae
Other Common Names: Many species of the Lauraceae may be grouped here, but most are poorly defined botanically. Comino real (Colombia), Silverballi (Guayana), Moena amarilla (Peru), Coto (Bolivia), Louro rosa, Pau rosa (Brazil).
Distribution: Found throughout the Guianas and the Amazon region but also in the Pacific coastal areas of Colombia.

The Tree
Often attains a height of 100 ft with diameters up to 30 in.; clear bole lengths of 55 to 75 ft are obtained.

The Wood
General Characteristics: The woods are typically yellowish with a greenish hue when fresh, becoming brown or olive on exposure. Narrow sapwood light yellowish. Luster medium to high; grain straight to interlocked; texture fine to medium; spicy odor, taste may or may not be distinctive.
Weight: Woods range from rather light to moderately heavy. Basic specific gravity (ovendry weight/green volume) often between 0.55 and 0.65. Air-dry density 40 to 50 pcf.
Mechanical Properties: (2-in. standard)

Moisture content	Bending strength	Modules of elasticity	Maximum crushing strength
	Psi	*1,000 psi*	*Psi*
Green *(74)*	13,250	2,170	6,560
12%	19,030	2,570	10,010

Janka side hardness 1,160 lb green and 1,470 lb dry. Forest Products Laboratory toughness 176 in.-1b, average for green and air-dry material (5/8-in. specimen).
Drying and Shrinkage: Moderately difficult to air-season, dries at a moderate rate, warp and checking are slight. No kiln schedules available. Shrinkage green to ovendry: radial 4.7%; tangential 7.0%; volumetric 12.1 %.
Working Properties: Easy to work with hand and machine tools and dresses to a smooth surface to give a satiny sheen.
Durability: The timber has an excellent reputation for resistance to decay. Laboratory tests also indicate heartwood very durable to both white-rot and brown-rot fungi.
Preservation: No Information available but heartwood is known for its high resistance to moisture absorption and is comparable to teak in this respect.
Uses: Esteemed for high grade furniture, turnery, inlay work. Also favored for boat building, durable construction, and millwork. The wood of *Aniba rosaeodora is* distilled for its fragrant oil used in the perfume industry.

Additional Reading
(56), (71), (74)

Apeiba spp.
Duru

Family: Tiliaceae
Other Common Names: Peine de mico (Mexico), Burillo (Nicaragua), Corcho (Colombia), Cortezo (Panama), Alastioelan, Borredaballi (Surinam), Maqui-sapa (Peru), Cortica, Gargauba (Brazil).
Distribution: The genus has a wide range in tropical America with the center of distribution in northern South America; found in the West Indies, southern Mexico, Central America, and southward to Brazil and Peru.

The Tree
Small to medium-sized trees *(A. tibourbou)* or large canopy emergents to 120 ft (*A. aspera).*

The Wood
General Characteristics: Sapwood and heartwood pale brown to oatmeal color no distinction between them; texture medium to coarse; grain straight; not highly lustrous; no distinctive odor or taste. Wood has Bands of soft cottony material that may be sporadic in occurrence.
Weight: Basic specific gravity (ovendry weight/green volume) is very variable due to the irregular bands of soft tissue-0.12 to 0.27; air-dry density 9 to 21 pcf.
Mechanical Properties: (2-in. standard)

Moisture content	Bending strength	Modules of elasticity	Maximum crushing strength
	Psi	*1,000 psi*	*Psi*
12% *(44)*	4,000	670	-
12% *(21)*	5,950	380	3,040

Janka side hardness about 250 lb for dry material.
Drying and Shrinkage: The wood is reported to be very easy to season with no drying defects. No kiln schedules available. Shrinkage green to ovendry: radial 2.1 %; tangential 6.3%; volumetric 7.8%.
Working Properties: The wood is easy to work in all operations but due to the bands of *soft* tissue, dressed surfaces are rough. Silica content is reported to be 0.03%.
Durability: The wood is vulnerable to attack by decay fungi.
Preservation: Reported to be easy to impregnate.
Uses: The wood is used to make rafts along the eastern coast of Brazil. Suggested as an insulating material in Colombia.

Additional Reading
(21), (24), (44)

Araucaria angustifolia
Paraná Pine

Family: Araucariaceae
Other Common Names: Pinheiro do Paraná, Pinho brasileiro (Brazil), Pinheiro do Brasil, Pino blanco (Paraguay), Curiy, Pino Paraná (Argentina).
Distribution: Botanical distribution covers parts of Paraguay and Argentina and the Brazilian plateau region of Rio Grande do Sul, Santa Catharina, and Paraná. Commercial exploitation has been centered in the State of Paraná.

The Tree
The mature trees are from 80 to 120 ft tall, with long clear boles. Diameters up to 60 in. are reported. Crown is flat with upturned limbs.

The Wood
General Characteristics: Sapwood is yellowish; the heartwood of various shades of brown, often with bright red streaks. Mostly straight grained and of uniform texture without prominent alternating bands of early- and latewood. The wood has no distinctive odor.
Weight: Basic specific gravity (ovendry weight/green volume) averages about 0.45. Air-dry density commonly 30 to 40 pcf, averaging 34.
Mechanical Properties: (2-in. standard)

Moisture content	Bending strength	Modules of elasticity	Maximum crushing strength
	Psi	*1,000 psi*	*Psi*
Green *(42)*	7540	1,260	4,180
12%	14,210	1,510	7,980
Green *(30)*	8,650	1,550	3,810
15 %	12,400	-	5,990

Janka side hardness reported to be 560 lb green and 780 lb at 12% moisture content. Amsler toughness 130 in.-lb at 15% moisture content (2-cm specimen).
Drying and Shrinkage: Paraná pine is reported to be more difficuit to season than most softwoods, darker colored material is prone to distortion and splitting and dries more slowly. Piles should be weighted to minimize warp. Kiln schedule T3-D2 is suggested for 4/4 stock and T3-D1 for 8/4 stock. Movement of seasoned wood is rated as medium. Shrinkage green to ovendry: radial 3.8%; tangential 7.3%; volumetric 11.6%.
Working Properties: The wood can be worked easily by hand and machine tools and dresses to a smooth finish. If compression wood is present, there can be considerable distortion when boards are planed, ripped, or resawed. Glues satisfactorily and holds paint well.
Durability: Heartwood is classified as nondurable.
Preservation: Heartwood is moderately resistant; the sapwood is permeable. Reported to absorb water-repellent preservatives readily during 3-minute dipping treatments for milwork. There were practically no differences in the amounts absorbed by light-colored sapwood or dark-colored heartwood.
Uses: Principal uses include framing lumber, interior trim, sash and door stock, furniture, case goods, and veneer. In Brazil the timber is made into plywood and is also considered suitable for pulp and paper products.

Additional Reading
(30), (42), (53), (69)