PROPERTIES OF IMPORTED TROPICAL WOODS[1]

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INTRODUCTION

The descriptive text and tabular data compiled here have been drawn freely from a wide variety of sources, but special credit is due the publications of the British Forest Products Research Laboratory and those of the Yale University School of Forestry.

Species descriptions are arranged alphabetically by generic names. The generic name may be followed by a specific name when the latter is the sole or principal name used in the timber trade. When a number of species are involved and it is generally not practical to identify the precise species from the wood alone, the generic name is followed by the designation spp.

With well-established species only a single common name has been applied, even though it may have many local or vernacular names, particularly if the species has widespread distribution. Where two or three names are indicated, they usually refer to the name in use in the several areas of principal production. Common names which are inappropriately applied and are generally misleading have been avoided as much as possible. The use of generic common names such as birch and teak in connection with totally unrelated species is bad practice and only adds to already existing confusion of names in the wood-using industry.

The pair of capital letters after the species name serves as a quick reference to the broad area of origin as AF (Africa), AM (Latin America), and AS (Southeast Asia).

An index of common names with their botanical equivalents is included at the end of this report.

The average weight of the woods described is given in pounds per cubic foot and at a moisture content of 12 percent, unless otherwise indicated.

The term "texture" refers only to the diameter of the pores.

Kiln schedules for foreign woods are given in British Forest Products Research Laboratory Leaflet No. 42, "Kiln-Drying Schedules," revised 1959. The schedules differ somewhat from those in Chapter 8 of "Dry-Kiln Operator's Manual," Agriculture Handbook 188 (1961). Table 1 (at end of report) lists the British schedule recommendations for 4/4 to 6/4 lumber, the nearest U.S.

[1]Presented at the Conference on Tropical Hardwoods held at the State University College of Forestry, Syracuse University, August 18-21, 1969.

[2]The Laboratory is maintained at Madison, Wisconsin, in cooperation with the University of Wisconsin.

schedule from the Dry Kiln Operator's Manual for these same sizes, and a suggested U.S. schedule for 8/4 stock.[3]

Statements relative to durability refer only to heartwood and under conditions favorable to deterioration. Sapwood is always nondurable under exterior use conditions. Wood kept continuously dry is not subject to attack by fungi although the sapwood of certain species may be attacked by powder-post beetles.

The term "in-service," when mentioned, refers to the shrinkage and swelling or "movement" of wood that may occur under conditions of use. It refers to interior use in the major part of the United States and the values, when cited, apply to unfinished wood. Finishes do not prevent "movement" but retard to varying degree the rate at which moisture is lost or gained. The values given in table 2 represent total shrinkage from the green to the ovendry state and are based on the dimensions when green. Such values have limited application and do not indicate the degree of "movement" that may occur between different levels of relative humidity or the ratio of shrinkage that occurs during different stages of drying. It is unfortunate that so little "movement" data are available with respect to the species in everyday use.

The machining of wood perhaps presents more problems than any phase of conversion from the log to finished product.. Lumber that is straight grained and free of all defects is, of course, the ideal material to the machine operator. Problems begin to mount when a user is confronted with the necessity of machining species with which he is totally unfamiliar. With respect to tropical species he will be confronted with considerable variation in density, degree of interlocking and variable grain, silica content, and tension wood, all of which can be very troublesome in species of lower density. Interlocked grain is characteristic of the majority of tropical species and presents difficulty in the planing of quartered surfaces unless attention is paid to cutting angles and sharpness of knives. Tension wood may account for rough surfaces, which may be referred to as fibrous, fuzzy, or torn. It is also frequently responsible for the pinching effect on saws due to stress relief in the lumber during sawing and the resulting burning and dulling of the teeth This particular difficulty is sometimes attributed to the presence of silica, even when silica is not present. Silica, when present, may have a pronounced dulling effect on all cutting edges and this becomes more pronounced as the wood is dried to the usual in-service requirements.

Strength values are given in table 3 for green wood and in table 4 for seasoned wood. The values are based on the ASTM or 2-inch standard. The values published by the British Laboratory in their Bulletin No. 50 are based on the 2-centimeter standard and are not directly comparable with those based on the 2-inch standard. The British values cited in tables 3 and 4 have been converted to the 2-inch standard using the conversion factors recommended in their Bulletin No. 50.

ALBIZIA FALCATARIA — As Batai

This species, originally described from the Molucca Islands, is now commonly found in cultivation throughout the tropics of the world. The tree has been utilized in Malaysia for the afforestation of degraded and idle lands, and in Central America it is replacing the silk-oak (Grevillea) and native species used for shade trees in coffee plantations. This species has shown remarkable growth in several plantations on the islands of Kaual and Hawaii. Data presented here are based primarily on the timber obtained from these Hawaiian plantations. Synonyms of this species are A. moluccana and A. falcata.

Heartwood and sapwood not clearly distingulshable in all trees; wood light colored with a very pale brown, pinkish, or yellowish cast. Desch reports the Malayan-grown wood with grain deeply interlocked and spiral: the texture rather coarse and even. The Hawaiian-grown material was essentially straight-grained and, although interlocking was noted, it was rather shallow. The wood weighs about 24 pounds per cubic foot.

American basswood (Tilia americana), of the same average specific gravity as batai, exceeds

[3] John McMillen of the U.S. Forest Products Laboratory, Madison, Wis., provided this abstract of Leaflet No. 42 and the U.S. schedule suggestions. The British schedules may be purchased from the British Information Service, 845 Third Avenue, New York, N.Y. 10022.

the latter in static bending and compression Parallel to grain at the 12 percent moisture content level; batai is slightly superior with respect to side hardness and maximum shearing strength.

In Malaya, batai is said to dry fairly rapidly without serious degrade; the most common defect observed was bowing. Lumber of 5/4 thickness was air seasoned in 6 weeks and 4/4 material was well dried in 4 weeks. None of the material was reported to have developed any splits or checks.

The wood is said to be abrasive to saws, but because this species is not a silica accumulator, the dulling effect can be attributed to the pinching and resulting burning of the saw teeth as tension stresses are relieved in the lumber. Wood in this density class would require sharp knives to ensure the production of smooth surfaces in planing. The fine sawdust produced when machining the dry wood is said to be responsible for allergic responses in certain individuals. Responses noted have been sneezing and tearing.

The wood is not durable under exterior conditions. It has been treated by the open-tank procedure and absorptions of 5 pounds of creosote-diesel fuel mixture were obtained in Malayan tests.

Because this species has some degree of importance as an ornamental tree and in silvicultural practice, the lumber has been utilized on a relatively small scale and only for local purposes. Because of its rapid growth, it would appear to have promise as a plantation species for lumber and veneer purposes. For plantation purposes it would be highly desirable to select strains which are relatively straight grained, since there appears to be considerable variation in the species with respect to degree of interlocking grain. This species requires a more thorough evaluation of its inherent tension stresses.

The Australian Laboratory reports the following potential problems in veneer production based on four billets from the Solomon Islands: End popping on crosscutting of logs; high output of narrow veneer, woolliness of veneer surfaces when the knife edge is blunt or poorly prepared; buckling and splitting of veneer containing tension wood; shortage of face veneer through end splits: and bow distortion of plywood due to tension wood. One billet contained brittleheart and two billets contained a severe form of tension wood,

ALBIZIA LEBBEK AS

Kokko, Siris

Albizia lebbek. which is native to India, Burma, Pakistan, Malaya, and the Andaman Islands has frequently and very erroneously been referred to as “Indian walnut.” The names kokko and siris are well established, well known, distinctive of the species, and should be used consistently in the U.S. trade.

Several other Indian species of Albizia occur within the range of Albizia lebbek and are difficult to distinguish because they intergrade in color and are very similar in anatomical structure. It is very possible that the wood reaching U.S. markets may be the product of two or three species.

The sapwood is white or yellowish-white and wide; heartwood light to dark brown and frequently streaked with lighter and darker bands. The grain may be straight but is more frequently interlocked to irregular. The texture is very coarse but even. The wood weighs about 38 pounds per cubic foot.

The timber is stated to be a moderately refractory species with some tendency to end splitting and surface checking.

The heartwood is rated as moderately durable.

The presence of irregular and interlocked grain presents some difficulties in sawing and planing, but in planing the problem can be alleviated by the use of proper cutting angles. Because the wood is used in the United States mainly in the form of veneer. the lumber machining characteristics are of little consequence.

The wood is utilized principally as decorative veneer. When used for purposes where smoothness of surface is essential, the pore must, of necessity, be filled.

ALBIZIA spp. AF

Albizia

The genus Albizia is represented by a large number of species widely distributed throughout the tropics of the world. In Africa the genus is represented by about 30 species, but many of these are relatively Small trees of the savannah areas. The following three species are probably representative of the range of quality that maybe anticipated: Albizia adianthifolia, A. ferruginea, and A. zygia.

Albizia ferruginea.--Sapwood straw-colored, about 2 inches wide and distinct from the heartwood, which varies from a light brown to a dark chocolate brown. The texture is coarse. The grain is markedly interlocked. The wood is moderately hard and heavy, weighing about 44 pounds per cubic foot.

Albizia adianthifolia.--Heartwood alight golden yellow or light brown sometimes with a greenish-yellow cast. Sapwood about 2 inches wide and distinct from the heartwood. Texture coarse. Grain shallowly interlocked and the strip pattern broad and widely spaced. The wood averages about 35 pounds per cubic foot.

Albizia zygia.--Sapwood white or gray to yellowish-white and distinct from the heartwood, which is pale brown and often has a reddish cast. Texture coarse. Grain shallowly and broadly interlocked. Wood averages about 35 pounds per cubic foot. The following description applies principally to this species:

Limited seasoning data suggest that the lumber can be seasoned with little degrade, but seasons very slowly in the thicker dimensions. Shrinkage is low and movement is rated as small.

Variability in weight both within and between species is reflected in the mechanical properties and should be taken into account where the timber is used where strength is a primary consideration.

The heartwood of the various species is rated as moderately durable to very durable. Heartwood is generally resistant to preservative treatment.

The wood is reported to work fairly easily, but attention must be given to the machining of quartered surfaces because of interlocked grain.

Not utilized in the United States at the present time. The British Laboratory indicates that these species should be satisfactory for such purposes as joinery and general carpentry.

ALSTONIA BOONEI & CONGENSIS AF

Alstonia

The two African species of Alstonia are widely distributed throughout West and Central Africa.

The sapwood, which may be up to 7 inches in width, is not visually distinct from the nearly white heartwood. The grain is generally straight or with a broad and shallow interlock. Texture is moderately fine and even. A distinctive feature of the wood of these species is the presence of slit-like passages or latex traces that run radially through the wood. They vary in size, but are commonly about 1/2 inch high, generally occur at fairly regular intervals, and are abundant over localized areas of the lumber. A similar condition occurs in the Asiatic Dyera belonging to the same family as Alstonia. The wood averages about 25 pounds per cubic foot.

The lumber seasons rapidly and easily with slight tendency toward checking and splitting. Slight distortion is likely to occur in thin, flat-sawn lumber.

Alstonia is in the density range of cottonwood and its mechanical properties are similar.

The wood is rated as perishable, but is readily treatable with preservatives.

The wood works easily with hand and machine tools. but sharp cutting tools are essential to ensure smooth surfaces in wood of this low density.

Although Alstonia can be readily peeled, it is reported to be unsuited for plywood manufacture because of the latex traces. Utilization in the solid form is also restricted because of this inherent defect and consequently limits the use of the wood to that of a “short-cutting” species. Alstonia would be suited for core stock in both solid and veneer form

ANACARDIUM EXCELSUM AM

Espave

Espave ranges from Costa Rica through Panama into Ecuador, Colombia, andvenezuela. The genus is best known through the edible cashew nut (Anacardium occidentale).

The freshly exposed heartwood of espave is a light yellowish brown to light reddish brown, often with a greenish cast. These colors may appear in streaks of variable width Upon exposure to light the heartwood becomes a fairly uniform russet brown with a golden or reddish cast. The sapwood may be very thick, up to 10 inches. and is sharply demarcated from the heartwood. Both the sapwood and heartwood are quite lustrous and prominently marked by the coarse vessel lines. The grain is Interlocked and shows a coarse ribbon stripe on quartersawn surfaces. The wood averages about 30 pounds per cubic foot at 12 percent moisture content.

Espave is rated as moderately difficult to air-dry and exhibits a variable drying rate.

The heartwood is rated as durable.

Espave is surpassed in most mechanical prop-

erties by yellow-poplar (Liriodendron tulipifera) of nearly comparable density, The differences between the two are small but favorable to yellow-poplar, except in hardness where espave has a slight advantage.

Machining tests conducted at the Forest products Laboratory show espave as poor in planing and sanding: chipped grain and fuzzy surfaces were the most common machining defects. Tension wood appears to be very common in this species.

Although espave is readily available, it has never gained favor in the United States for any form of utilization. The avoidance of this species is probably attributable to the warping tendencies of flatsawn material due to wide interlocking grain and machining difficulties attendant to tension wood.

In its area of growth it is used as a general utility lumber.

ANISOPTERA spp. AS

Krabak, Mersawa, Palosapis

Genus of about 15 species distributed from the Philippine Islands and Malaysia to East Pakistan. Names applied to the timber vary with the source and three names are generally. encountered in the lumber trade: krabak (Thailand), mersawa (Malaysia), and palosapis (Philippines),

The Anisoptera species produce wood of light color, moderately coarse texture, and of plain appearance on flatsawn or rotary-cut surfaces: quartered surfaces exhibit a slight ribbon strip figure due to interlocking grain. Although about 15 species comprise the genus Anisoptera, there is relatively little variation between species in all respects. The heartwood when freshly sawn is pale yellow or yellowish-brown and darkens on exposure. Some timber may show a pinkish cast or pink streaks, but these eventually disappear on exposure. The sapwood, which is about 2 inches wide is poorly defined. The wood weighs about 39 pounds per cubic foot in the seasoned condition and about 59 pounds when green.

Green lumber air seasons very slowly, and unless well ventilated during this period, is very susceptible to deterioration by stain and decay fungi.

The sapwood is susceptible to attack by powder-post beetles and the heartwood is not resistant to termites. With respect to fungus resistance, the heartwood is rated as moderately resistant and should not be used under conditions favoring decay. The heartwood does not absorb preservative, solutions readily.

The wood machines readily, but the dulling effect on the cutting edges of ordinary tools is severe and is very troublesome with saws. Carbide-tipped saw teeth are essential for the satisfactory cutting of seasoned lumber and knives of similar material are necessary for planing. The wood planes fairly well with sharp cutters, but a fibrous finish is produced by slightly dull blades. A cutting angle of 20° may be helpful with quartered surfaces which tend to tear in the zones of interlocked grain.

A characteristic feature of the Anisoptera species is the presence of silica, which occurs principally in the wood rays. The amount varies with the species, but all present some difficulty in sawing and working with machine tools, Available values for silica accumulation range from 0.24 to 1.37 percent of the ovendry weight of the wood.

It appears probable that the major volume of these timbers will be used in the form of plywood, because conversion in this form presents considerably less difficulty than lumber production.

ANTIARIS AFRICANA & WELWITSCHII AF

Chenchen

The two African species of Antiaris are fairly common trees occurring in the high forest zone of West, Central, and East Africa. Some botanists include the two African species under the Asiatic species A. toxicaria.

The wood is generally a light yellow or light yellow brown with no distinction between heartwood and sapwood. The texture is medium to rather coarse. Grain is interlocked. Wood averages about 27 pounds per cubic foot.

The lumber can be seasoned fairly rapidly, but has a pronounced tendency to distort; twist may be a serious degrade.

The mechanical properties of chenchen are similar to those of Alstonia. The wood is rated as perishable, but permeable to preservative treatment.

The wood is moderately difficult to work because of its low density and interlocking grain. The wood is reported to glue satisfactorily.

The inherent characteristics of Antiaris generally militate against its utilization, at least in the United States.

ARAUCARIA ANGUSTIFOLIA AM
"Parana pine"

Although this species is not classified as a hardwood, it is. included here for convenience and because it is one of the more important of the imported species.

The name "Parana pine" is applied to this species in the United States, but it is not a true pine in that it does not belong to the genus Pinus. Its ranges include several of the states of southeastern Brazil and adjacent Argentina and Paraguay. Commercial supplies originate only in Brazil.

The sapwood is yellowish and not always distinct from the heartwood, which is a very light brown and frequently shows bright streaks of red. The wood is straight-grained and of a more uniform and finer texture than the softwoods of the North Temperate zone. Growth rings are evident, but more or less inconspicuous as in U.S. white pines. The wood weighs about 34 pounds per cubic foot at 12 percent moisture content.

"Parana pine" appears to be more difficult to season than most softwoods and is variable in this respect. The darker colored wood is very prone to split, distort, and dry slowly. Inherent stresses in the wood are likely to cause distortion on machining.

Strengthwise, "Parana pine" is in the density range of loblolly and shortleaf pine and the mechanical properties of these three species are quite similar.

The heartwood is rated as nondurable with respect to natural durability and is rated as moderately resistant to preservative treatment.

The wood can be worked easily by hand and machine tools and has very little dulling effect on their cutting edges. It planes and molds to a clean, smooth finish and gives good results in most other operations. The wood takes stains and other finishes readily and can be glued satisfactorily. The wood is free from resin ducts, pitch pockets, and pitch streaks.

Some tendency toward splitting of kiln-dried "Parana pine" and warping of seasoned and ripped lumber is caused by the presence of compression wood, an abnormal type of wood structure with intrinsically large shrinkage along the grain. Boards containing compression wood should be excluded from exacting uses.

The principal uses include framing lumber, interior trim, sash and door stock, furniture, case goods, and veneer.

Adequate supplies of lumber are still available for export from Brazil although it is anticipated that the volume will decrease because of increasing local demands and because tremendous volumes were lost in recent years through very disastrous forest fires.

ASPIDOSPERMA spp. AM
Peroba rosa, red peroba

There are a number of species of the genus Aspidosperma in southeastern Brazil which are classified as belonging to the peroba group. The most important of this group from the commercial standpoint is A. peroba.

The heartwood color of this group is characteristically roseate, sometimes striped with red or purplish-red, and not sharply demarcated from the yellowish sapwood. On exposure the wood assumes a yellow-brown coloration. The texture is very fine and uniform; grain is straight to very irregular with a low luster. The wood is moderately heavy, weighing about 47 pounds per cubic foot at 12 percent moisture content and in this respect is about equal to white oak

The wood appears to season without much splitting, but some distortion is likely to develop in material with variable grain.

The woods of the peroba rosa group are generally heavier than native commercial hardwood species, but the strength properties are more nearly on par with woods in the density class of hard maple.

The heartwood is rated as durable with respect to fungus attack.

The wood works with moderate ease, although some difficulties may be anticipated with irregular grain. It takes finishes readily and can be glued satisfactorily.

The peroba rosa group is an important source of hardwood in southeastern Brazil where it is utilized for a multitude of purposes in both solid and veneer form. In areas of abundance, all the component parts of frame house construction may consist of this wood alone, and the furniture may be made of it. In the United States this should be

a good wood for "printing" purposes if not considered too heavy.

ASTBONIUM GRAVEOLENS & FRAXINIFOLIUM AM
Goncalo alves

Because of their extensive growth range these species are known locally by a variety of names. The major and early imports of this wood have been from Brazil, where the commercial name is goncalo alves. This name has also been adopted by the U.S. trade, These species range from southern Mexico, through Central America Into the Amazon Basin.

The heartwood is very variable with respect to color and ranges from various shades of brown to red with narrow to wide, irregular strips of dark brown or nearly black. The sapwood is grayish-white and sharply demarcated from the heartwood. The pigment figure in these species is quite striking and very characteristic. The texture is medium and uniform. Grain is variable from straight to interlocked and wavy, The wood is very heavy and averages about 63 pounds per cubic foot at 12 percent moisture content.

Although the wood is in the high density class, it is not difficult to work with machine tools. It turns readily, finishes very smoothly, and takes a high natural polish. The heartwood is highly resistant to moisture absorption and the pigmented areas, because of their high density, may present some difficulties in gluing.

The heartwood is rated as very durable with respect to fungus attack.

In air seasoning studies, goncalo alves is observed to' dry at a fast to moderate rate. It is rated as moderately difficult to season. Degrade observed is moderate crooking or bowing accompanied by a slight tendency to twist.

Checking is noted to be slight. Shrinkage is low, especially so in consideration of the high density of the wood.

The high density of the wood is accompanied by equally high strength values, which are considerably higher in most respects than those of any well known U.S. species. It is not expected, however, that goncalo alves will be imported for purposes where strength is an important criterion.

In the United States the greatest value of goncalo alves is in its use for specialty items such as archery bows, billiard cue butts, brush backs, cutlery handles. and for fine and attractive products of turnery or carving.

AUCOUMEA KLAINEANA AF
Okoume

Okoume is undoubtedly the most important of the African timbers with respect to production volume and utilization. Supplies originate. principally in French Equatorial Africa.

The sapwood is narrow and has a pale gray color. The heartwood is a salmon pink or light pinkish brown to a dark reddish brown. The texture is similar to that of mahogany. Okoume is without odor or taste and quite lustrous. Grain is straight to interlocked, wavy, and variable, The wood weighs about 29 Bounds per cubic foot.

The seasoned lumber is generally difficult to work with machines because of the variability in grain and the occurrence of silica. The logs are readily converted to veneer by the rotary and slicing procedures. Okoume is used in the United States only in the form of veneer for plywood, which obviates the difficulties that may be encountered in seasoning and machining in the solid form

Large volumes of okoume are utilized annually in Europe. In the United States it is used primarily as a general utility plywood as well as for decorative effect.

BERLINIA spp. AF
Berlinia

About a dozen species of Berlinia occur in West Africa and the Congo area. It is uncertain whether the various species differ significantly with respect to their timber quality or whether commercial shipments are predominantly one species or include a mixture of species. The British Laboratory indicates that there is some evidence that several species are confused and their timbers may be mixed, but the present state of knowledge does not permit distinction between them, The following description is based on timber presumed to be Berlinia grandiflora: The heartwood varies from pale red to a deep red brown with dark purple or brown streaks which are somewhat irregular in outline. The sapwood is white or gray, often with a pinkish tint, distinct from the heartwood, and may be up to 12 inches

in width. Texture is coarse and even. The grain is usually interlocked and sometimes very irregular, Dark-colored gum streaks are said to be a common feature of this wood. The wood weighs about 44 pounds per cubic foot.

The timber is reported to season rather slowly but well.

Berlinia has about the same average density as white oak and its mechanical properties are also very similar.

The wood is moderately difficult to work because of interlocking and irregular grain, but can be managed with proper attention being paid to all operations.

The heartwood is rated as moderately durable and as resistant to preservative treatment.

Berlinia is reported to be unsuitable for plywood manufacture and can be utilized for many purposes where white oak is used, except where bending is a prime consideration.

BRACHYSTEGIA spp. AF
Okwen

About five species of Brachystegia are known from West Africa and the Congo and specific data are available only for B. nigerica from southern Nigeria.

The heartwood is a light brown to medium dark brown with high luster. The light-colored sapwood is well defined and may be up to 6 inches in width. The texture is rather similar to or slightly coarser than that of mahogany. The gram is commonly interlocked and shows a pronounced stripe figure on quartered surfaces. The wood averages about 44 pounds per cubic foot.

The lumber is reported to season slowly but fairly well. Distortion is the main cause for degrade, although there appears to be little tendency to end splitting and surface checking. The movement of seasoned lumber is rated as medium.

The average density of okwen is the same as that of white oak and its mechanical properties are also very similar.

Okwen is reported to be rather difficult to work and it is difficult to obtain consistently smooth surfaces due to the steeply interlocking grain.

With respect to natural durability, okwen is rated as probably moderately durable and the heartwood is extremely resistant to impregnation.

Okwen does not appear to be well suited for utilitation in the solid form, which requires smooth surfaces, but should find application in the decorative veneer field. Okwen has a rather pleasing appearance resulting from its color, luster, and figure.

BROSIMUM spp. (Alicastrum group) AM
Capomo, ojoche, ramon

This group comprises a number of closely related species occurring from southern Mexico through Central America into the Amazon Basin of Peru. The best known species in Latin America is B. alicastrum, and it contributes its name to this group.

Both sapwood and heartwood are a uniform yellowish white, except around knots and other defects, where the wood is a distinct red. Starch is common throughout the radius and this consequently may be considered as a “sapwood” species. Texture is fine; grain is straight to shallowly interlocked. The wood weighs about 50 pounds per cubic foot.

Because of the abundance of starch, the wood is rated as nondurable with respect to attack by insects and decay.

No data are available with regard to seasoning and kiln-drying, although it is expected they would be somewhat similar to those of hard maple.

Strength data are very limited, but indicate that these species are appreciably stronger than other tropical species of equal density. Shrinkage data based on one tree of B. alicastrum show it to be equal to hard maple with respect to in-service conditions of swelling and shrinkage.

The high density coupled with silica accumulation make this wood difficult to machine with ordinary machine tools. Brosimum uleanum was observed being used on a relatively large scale in the manufacture of Sewing machine cabinets in Peru. In this instance the figured wood (wavy grain) was sliced for use in face veneer and the straight-grained wood was utilized for structural members. Seemingly little difficulty was experienced in utilization and the net effect was a very handsome cabinet.

Logs showing wavy grain should find ready acceptance in the fancy veneer trade if they are protected against degrade through stain and insect attack. Its high bending strength values suggest utilization as handles of impact tools.

BROSIMUM spp. (Utile group) AM
Sande, Cocal

Brosimum utile, which ranges from Costa Rica to Pacific Ecuador, lends its specific name to this group of Brosimum woods that are appreciably lighter in weight and coarser textured than the Brosimum woods comprising the alicastrum group. Several related species of this group occur in the Amazon Basin. Considerable volumes of standing timber occur in the forests of Pacific Ecuador and Colombia where the vernacular name is sande. This is also the name used in the U.S. trade. Practically all of the exportation of sande is from Pacific Ecuador and Colombia.

The sapwood and heartwood show no distinction, being a uniform yellowish white to yellowish brown or light brown, The pores are moderately coarse and evenly distributed. The grain is straight to widely and shallowly interlocked. The wood rays generally show prominently on quartered surfaces because of their darker colored contents. In many respects, sande has much the same appearance as white seraya (Parashorea plicata) from Sabah. The utile series consists of "sapwood" species, just as the alicastrum series of species does. The wood averages about 33 pounds per cubic foot.

The lumber seasons rapidly and easily with little or no degrade, except for material containing tension wood, which is always subject to warp degrade.

The wood is nondurable with respect to stain, decay, and insect attack and care must be exercised to prevent degrade from these agents.

Strength data for sande are too limited to permit comparison with woods of similar density such as banak, although it is suspected that they would be rather similar.

Normal wood of sande machines easily, takes stains, and finishes readily, and presents no gluing problems. Lumber containing tension wood has been prevalent in some shipments and is chiefly responsible for machining difficulties, such as raised or fuzzy grain, and the rapid dulling and burning of saws due to the pinching effect when stresses are released in the wood during sawing. These difficulties have led to the statement that the wood contains silica and that carbide-tipped saws are to be used for most economical conversion. Chemical analysis made on a representative number of samples of sande showed a maximum silica content of only 0.01 percent of the ovendry weight of the wood. This amount of silica can occur in any species and cannot be held responsible for machining difficulties. Tension wood may be a very important factor in the conversion of timbers in the density class of sande, but the deleterious effects can be eliminated or at least minimized by proper selection of the trees in the forest. In this density class, trees showing a definite lean or an obvious eccentric bole are best left in the forest.

Sande should find utilization for many of the same purposes as banak, and with the current demand for molding species, it should assist in relieving the ever-increasing wood demand of this industry.

BURSERA SIMARUBA AM
Gumbo-limbo

Gumbo-limbo ranges from southern Florida, the West Indies, through Mexico and Central America into northern South America Because of the resemblance of the wood to that of paper birch, gumbo-limbo has been erroneously referred to as "West Indian birch" and "Mexican white birch." The application of the name birch to this wood is very misleading and adds to the already confused nomenclature of the tropical woods coming into the U.S. market.

The wood is uniformly white to yellowish white, a "sapwood" species as evidenced by the occurrence of starch along the entire radius. Texture is fine to medium. Grain is usually straight. The wood is soft and light, averaging about 24 pounds per cubic foot.

The lumber seasons very well with only slight checking or warping. It is very subject to degrade (through stain, decay, and insect attack) unless conversion is accomplished as quickly as possible after felling and the lumber is treated with antistain and anti-insect solutions immediately after sawing. Total shrinkage is very low and the shrinkage-swelling that may be anticipated during in-service conditions is about 1.1 percent radially and 1.5 percent tangentially. These low values place gumbo-limbo on a par with mahogany and Spanish-cedar.

Gumbo-limbo is easy to work with hand and machine tools in all operations. The wood takes

stains and finishes readily and presents no gluing difficulties. Veneer logs can be peeled on the rotary lathe without preliminary heating.

The wood is nondurable in use with respect to conditions favoring stain, decay, and insect attack. The seasoned wood is suitable for interior use only. Appropriate precautions must be taken to ensure production of bright and clean lumber or veneer.

Gumbo-limbo is in the density range of eastern white pine, but available strength data indicate that its strength properties are appreciably below those of eastern white pine.

The low density and good dimensional stability of gumbo-limbo suggest utilization in the pattern industry and for core stock

Difficulties encountered in the utilization of gumbo-limbo are the frequent crookedness of the logs, highly perishable nature of the wood, and occurrence of tension wood. The latter condition is generally responsible for machining and finishing difficulties as well as the excessive buckling of veneers. Proper selection of logs for conversion and their subsequent care would assist materially in the reduction of degrade in this species.

CALOPHYLLUM BBASILIENSE AM
Santa Maria, Maria

Some botanists attribute several species to the genus Calophyllum, and others regard the genus as consisting of a single species with several geographical forms in Latin America. From the standpoint of the wood, the genus may be considered to consist of a single species.

Santa Maria ranges from the West Indies to southern Mexico and southward through Central America into Northern South America

The heartwood is pinkish to brick red or rich reddish brown and marked by a fine and slightly darker striping of parenchyma tissue on flatsawn surfaces. The sapwood is lighter in color and generally distinct from the heartwood. Texture is medium and fairly uniform The grain is interlocked and shows a broad stripe pattern on quartered surfaces. Luster is medium The heartwood is rather similar in appearance to the red lauan of the Philippines. The wood averages about 38 pounds per cubic foot.

The wood is moderately difficult to season and flatsawn boards in the usual nominal thicknesses are very prone to twist. This can be avoided by quartersawing as is commonly done with the "Philippine mahoganies."

Shrinkage is generally low, and in movement between relative humidities of 65 percent and 30 percent it is lower than the hardwood species commonly used in the U.S. furniture trade.

The wood is moderately easy to work and good surfaces can be obtained when attention is paid to machining operations. In planing, the most critical operation for this species, it is desirable to use a cutting angle of 20° and machine speeds that will produce 20 or more knife cuts per inch. The best machining results are obtained at a moisture content of 6 to 7 percent.

Santa Maria is in the density of class of hard maple and its strength properties are generally similar, with the exception of hardness, in which property hard maple is superior to Santa Maria

The heartwood is generally rated as moderately durable to very durable in contact with the ground, but apparently has little resistance against termites and marine borers.

The inherent natural durability, color, and figure on the quarter suggest utilization as face veneer for plywood in boat construction.

CALYCOPHYLLUM spp. AM
Capirona, Degame

A genus of about five species found throughout most of Latin America. The species best known in the United States and particularly in the archery field is degame (Calyconhyllum candidissimum), which was imported in the past in some quantities from Cuba. "Glass" products have now almost completely replaced degame in archery bow stave production. Capirona (C. spruceanum) of the Amazon Basin is a much larger tree and occurs in considerably greater abundance than degame. The information presented here is based primarily on degame, but because of the almost identical nature of capirona, the data should be applicable to the latter species.

The heartwood of degame ranges from a light brown to gray, while that of capirona has a distinct yellowish cast. In either species there is no sharp demarcation of heartwood and sapwood. The texture is fine and uniform. The grain is usually straight or infrequently shows a shallow interlocking, which may produce a narrow and indistinct strip on quartered faces. The luster is

medium and the wood is without odor and taste. The wood weighs about 50 pounds per cubic foot.

It has been stated that degame tends to warp when dried in small sizes such as those used for archery bow staves. Air seasoning characteristics for 5/4 lumber are not available. Observations made on 9/4 plank material at Yale indicated slight surface and end checking during air seasoning.

Shrinkage is moderate and practically identical for both degame and capirona. Values obtained at Yale for two trees of degame from Venezuela were 4.8 percent radially and 8.6 percent tangentially. Values for four trees from Peru obtained at the Forest Products Laboratory were 4.7 percent radially and 8.5 percent tangentially. The in-service movement for capirona from Peru was 1.7 percent radially and 2.8 percent tangentially: these values are like those for hard maple. Natural durability is low when the wood is used under conditions favorable to stain, decay, and insect attack.

In strength, degame is above the average for woods of similar density. Tests made at Yale show degame superior to persimmon (Diospyros virginiana) in all respects but hardness. Limited tests on hardness of capirona from Peru gave higher values of side hardness than those of degame or persimmon.

Degame is moderately difficult to machine because of its density and hardness, although it produces no appreciable dulling effect on cutting tools. Machined surfaces are very smooth and only insignificant chipping has been noted on quartered surfaces in which interlocking grain was present.

Degame and capirona are little used in the United States at the present time, but the characteristics of the wood should make it particularly adaptable for shuttles, picker sticks, and other textile industry items in which resilience and strength are required. The fine texture and density would encourage its use in the manufacture of specialty items such as scales and would make an excellent "printing" wood. It should find application for many of the same purposes as hard maple and yellow birch.

CANARIUM SCHWEINFURTHII AF

Aiele

Although there are a number of species of Canarium in tropical Africa, only this species seems to be of economic importance in the region.

The heartwood is a light pinkish brown, somewhat resembling okoume in general appearance but heavier and coarser textured. The grain is interlocked and produces a stripe pattern on quartered surfaces. The wood weighs about 33 pounds per cubic foot,

The wood appears to season rather slowly but fairly well. Collapse may be troublesome and there is a tendency toward end splitting. The movement of the wood in service is rated as medium

Aiele is reported to work easily with machine and hand tools, but has a fairly severe blunting effect on cutting edges due to the occurrence of silica in the wood,

The wood has the same average density as mahogany, but its mechanical properties are generally lower in all respects with the exception of shear, in which it is superior.

The wood is rated as nondurable and the heartwood is extremely resistant to impregnation.

Aiele is not likely to find utilization in the United States in the solid or lumber form because of its silica content. In the form of plywood it could find use for both utility and decorative purposes.

CARAPA spp. AM

Andiroba, cedro macho, crabwood

A genus of five species, four of which are native to Latin America and one in Africa.

The American species are Carapa guianensis, ranging from the West Indies and Central America to western Ecuador and Colombia, into Venezuela, the Guianas, Amazonian Brazil and eastern Peru; C. nicaraguensis which overlaps the range of C. guianensis fromNicaragua to western Ecuador: C. surinamensis limited to Surinam and French Guiana; and C. macrocarpa known only from the State of Para, Brazil. The African species, C. procera, often attributed to America does not occur in the Western Hemisphere. The species of commercial importance are C. guianensis and C. nicaraguensis.

The heartwood of freshly cut C. guianensis varies from pinkish to dark red and becomes a uniform reddish brown upon exposure. In C. nicaraguensis the heartwood generally ranges

from a light brown to a golden brown. Luster is variable and neither taste nor odor is distinctive, The grain is commonly shallowly interlocked and shows a narrow stripe figure on quartered surfaces. The texture is similar to that of mahogany, The wood of C. guianensis averages about 38 pounds per cubic foot, and that of C. nicaraguensis about 29 pounds.

According to the British Laboratory, the wood of C. guianensis seasons well but rather slowly and has a tendency to split in the initial stages. Longitudinal distortion may be severe in lumber where pronounced tension wood is present,

Strength values for C. guianensis are generally similar to those of white oak except in compression perpendicular to grain. side hardness, and shear, where white oak has a definite superiority. Strength values for C. nicaraguensis are very limited, but suggest values which are proportionate with its lower average specific gravity.

C. guianensis machines well in all operations but fuzzing may be anticipated when streaks of tension wood occur in the lumber. Limited machining tests on C. nicaraguensis showed it to be well below average with respect to planing, shaping, and sanding, but these are not to be considered as conclusive because tension wood was prevalent in the material available for testing.

Decay resistance studies on C. guianensis gave it a rating of durable to very durable, while those for C. nicaraguensis rate it only as moderately durable.

The wood is well suited for the manufacture of furniture, millwork, and decorative plywood and should also find utilization in the boat building industry. It is, of course, obvious that tension wood be eliminated for most efficient utilization.

CARINIANA spp. AM

Albarco, bacu, jequitiba

A genus of about 10 species distributed from eastern Peru and northern Bolivia through Brazil into Venezuela and Colombia. The northernmost species, Cariniana pyriformis, is known as albarco in Colombia and bacu in Venezuela. C. legalis appears to be the species best known as jequitiba in eastern Brazil and C. domestica and C. estrellensis probably are also included under this name. Several of the Amazonian species pass under the name tauary.

The sapwood is gray to light brown and generally distinct from the brown to red-brown heartwood. The grain may be straight or more commonly with a shallow interlocking of the grain, which produces a mild appearing and narrow strip on quartered surfaces. The luster is medium; the wood is without odor or taste. Plank material of jequitiba tested at the British Laboratory gave a weight of about 36 pounds per cubic foot.

No seasoning information is available. For a wood of this density class the shrinkage is rather low and in this respect compares favorably with our native cedars of much lower density.

Strength data are limited and the tests made at the British Laboratory on plank material of jequitiba show it to be similar in all respects to white oak.

The heartwood is rated as probably durable with respect to decay.

The working properties of Cariniana vary considerably and apparently are dependent upon the species under consideration, The British Laboratory reports that jequitiba works easily with little blunting effect on cutting edges, and is comparable in this respect with. the better grades of straight-grained American mahogany. On the other hand, albarco, which was first introduced into the United States about the turn of the century as "Colombian mahogany," lost favor very rapidly because of its rapid dulling effect on cutting edges. All species of Cariniana are known to accumulate silica, and a microscopic examination of these species at the Forest Products Laboratory gave results that seem to account for differences in dulling effect, The wood of Cariniana pyriformis was observed to accumulate silica particles of appreciably larger size and in greater abundance than in any other of the six species examined. The silica content was not determined quantitatively by chemical analysis, but the fact that it is optically visible suggests that the amounts present are in excess of 0.05 percent.

Albarco could undoubtedly be handled in the solid form with appropriate cutting tools and should offer less difficulty in veneering. Jequitiba has already been shown to be readily worked with ordinary cutting tools.

In Brazil, jequitiba is used for many purposes which include construction and furniture manufacturing, and in place of mahogany in shipbuilding.

CEDRELA spp. AM

Cedro, Spanish-cedar

A genus of seven species distributed from Mexico to the West Indies and found in all of the Latin American countries with the exception of Chile. Prior to the exhaustive study of this genus published at the Field Museum of Natural History in 1960, the genus consisted of a nomenclatural mess of 37 species plus a number of varieties and forms. The most important and most widespread species are Cedrela odorata, C. angustifolia, and C. fissilis. The name Cedrela mexicana frequently encountered in the literature is a synonym of C. odorata.

Freshly cut heartwood is pinkish to reddish brown and upon exposure it becomes red or dark reddish brow-n, sometimes with a purplish cast. It is reported to be darkest in color when grown on the drier sites and this type of wood is said to be preferred by local craftsmen. The wood ranges from diffuse porous to decidedly ring-porous, the latter condition producing a distinct growth-ring pattern on flatsawn surfaces or rotary-cut veneer. The grain is generally straight, although interlocking to some degree may occur, The wood has a medium to high luster which appears to vary with the depth of color, being lowest in the lighter colored material. The heartwood has a characteristic “cedary” odor. The wood is coarser textured than that of mahogany.

On the basis of mechanical tests made at Yale, cedro with an average specific gravity of 0.40 (green volume and ovendry weight) would be similar to Central American mahogany in most properties except in hardness and compression perpendicular to grain, where mahogany is definitely superior. Most of the imported wood falls into the 0.34 to 0.38 range of specific gravity class and, as a consequence. its mechanical properties would be proportionately lower than those shown in the table. The wood weighs about 26 pounds per cubic foot.

Cedro is considered easy to season by either air drying or kiln drying methods. In the tropics it is common practice to end-rack the lumber in the sun and little, if any, seasoning degrade is encountered. Shrinkage is low and uniform; in-service movement of unfinished wood is about 1.2 percent radially and 1.5 percent tangentially.

Cedro contains a gum-like substance with a volatile aromatic oil. The exudate is likely to stain materials in intimate contact with the wood and boards in similar contact may literally become glued together, Cedro dried by conventional methods is not recommended for such products as closed cases for clocks and other types of precision instruments, because the volatiles condense on the metal parts and materially reduce the efficiency of the mechanism The volatile content of the wood can be materially reduced by kiln drying the unsurfaced stock to a moisture content of 6 to 8 percent and then heating at 200° F. for 8 to 17 hours at a relative humidity of 60 percent. The oils and gums will exude to the rough surfaces, which can then be removed in subsequent planing.

Among importers of cedro it is the general consensus that wood from certain areas, principally Nicaragua, Costa Rica, and the Amazon region, shows more exudate than wood from other areas. Cedro from Mexico, British Honduras, and Guatemala infrequently shows such exudations and is therefore favored.

The heartwood of cedro shows considerable variation with respect to decay resistance. Wood in the lower density class which is usually lighter than average with respect to color may be rated from nondurable to moderately durable. Wood of average and better characteristics can generally be classified as resistant to very resistant. Wood of the latter type is also considered to be more resistant to dry-wood termite attack than mahogany, The sapwood is subject to attack by powder-post beetles.

Cedro is worked very easily with both hand and power tools, giving good results in all machining operations. Tension wood, when present, may result in grain tearing and fuzzing of surfaces in certain operations. The logs can be veneered without heating and the resulting veneer dried exceptionally well and has good gluing properties.

Cedro is used locally for all purposes where an easy working, light but strong, straight-grained, and durable wood is required. The wood has characteristics which recommend it for millwork, cabinets, patterns, musical instruments, boats, decorative veneer, and a multitude of other uses. Cedro and mahogany are the classic timbers of Latin America.

CEIBA PENTANDRA AF

Ceiba, fuma

Ceiba pentandra is found throughout the tropics

of the world, but the importation of this species into the U.S. has been only from Africa under the name fuma. Fuma has been used primarily for corestock, but has now been largely replaced by lupuna (Ceiba samauma), which is a firmer wood and more readily peeled than fuma. Both species occupy the same range in the Amazon Basin. Ceiba pentandra exhibits a considerable range of variability, particularly with respect to specific gravity and also with moisture content. Specimens of this species from Ecuador gave amazing moisture content values ranging from 632 to 1047 percent and a specific gravity average of 0.089 based on volume when green and weight when ovendry.

CEIBA SAMAUMA AM

Lupuna, samauma

Ceiba samauma which is native to the Amazon Basin is known as lupuna in the Peruvian Amazon and as samauma in its Brazilian range. The name lupuna has been generally adopted by the U.S. trade. When this species was first introduced into the United States it was believed to be a species of Chorisia, which is closely related to Ceiba. Specially collected botanical material consisting of leaves, flowers, and fruits from a number of trees have established the true identity of this wood as Ceiba samauma.

There is no sharp line of demarcation between sapwood and heartwood. The color varies between different trees, and ranges from a cream to a very pale reddish-brown Figure on flatsawn surfaces is produced by rather conspicuous pore lines and by the more or less evenly spaced parenchyma bands which demarcate the growth ring boundaries. Figure on quartered surfaces is produced by the somewhat conspicuous ray flecks and a ribbon strip resulting from shallowly interlocked grain. The texture is moderate to coarse. The black "veins" found in this wood are traumatic gum ducts that result from injury to the tree.

The strength properties of this species have not been investigated although a number of side hardness tests made at the Forest Products Laboratory gave an average value of 500 pounds at a moisture content of 14 percent. In this respect, lupuna would rank between cottonwood and yellow-poplar. Its strength properties should be proportionately higher than those for Ceiba pentandra, which has a lower average specific gravity. Lupuna averages about 23 pounds per cubic foot,

Although lupuna is comparatively low in density and uniform in texture, considerable care is required in seasoning to prevent excessive checking and splitting. Since some parts of thick green planks may range in moisture content up to 230 percent, preliminary air seasoning may be more practical than kiln drying from the green condition. The moisture content falls very rapidly during ordinary air drying and care must be used to keep the boards from checking, The wood has a 1-1/2 to 2-1/2 percent higher equilibrium moisture content than native U.S. species at any given relative humidity. The movement of lupuna for in-service conditions is about 0.9 percent radially and 1.4 percent tangentially. These values are low and on par with those encountered in Central American mahogany and primavera.

In machining tests made at the Forest Products Laboratory, lupuna performed as well as Central American mahogany in all respects.

The wood of lupuna, and that of all related species of this genus, is readily attacked by stain, decay, and insects and must be regarded as perishable and a "sapwood" species. The high starch content of the wood makes it subject to bacterial attack resulting in the production of butyric and caproic compounds which possess very offensive odors. The odor may not be apparent in seasoned wood or veneer during periods of low humidity, but it becomes more pronounced with increasing humidities such as may be encountered during the summer. The odors pass readily through overlaying veneer and finishes in installed plywood and. if the room area is relatively small and high humidity conditions prevail, the odor may become quite unbearable. The only cure is removal and replacement of the offending plywood. Whether the bacterial attack occurs only in certain trees or when an excessively long period of time has elapsed between felling and conversion is not known at this time. Seemingly these highly "aromatic" logs could be detected at the time of sawing or veneering.

The low density, good dimensional stability, and good machinability make lupuna ideally suited for both solid and veneer core and patterns. Lupuna should also find utilization in the molding industry.

CHLOROPHORA EXCELSA & REGIA AF

Iroko, kambala

Both species of Chlorophora from Africa are commonly known by the name iroko, but the timber originating in the Congo frequently passes under the name kambala. Chlorophora excelsa ranges from Ivory Coast southward to Angola and eastward across the continent into East Africa, Chlorophora regia has a more restricted range from Gambia to Ghana.

The heartwood varies from a pale yellowish-brown to dark chocolate brown with lighter markings associated with the vessel lines, which are most conspicuous on flatsawn surfaces. The texture is rather coarse and uniform, Grain is typically interlocked and shows a broad and widely spaced stripe pattern on quartered surfaces. The wood weighs about 40 pounds per cubic foot. Hard deposits, commonly referred to as "stone," may occur in these trees. They are largely calcium carbonate and are deposited in cavities probably developed. through some sort of injury to the tree.

The wood seasons well and fairly rapidly without much degrade. The movement of seasoned wood is rated as small.

The wood seasons well and fairly rapidly without much degrade. The movement of seasoned wood is rated as small.

The wood works with moderate ease in most machining operations and its dulling effect on cutting edges is about normal for a wood in its density class. The "stone" deposits, however, can be very damaging to cutting edges when they are not readily detectable and cannot be avoided by the machine operator.

Iroko is in the density range of white oak, but its mechanical properties are generally below those of white oak.

The heartwood is rated as very durable and as extremely resistant to preservative treatment.

Iroko is not utilized to any large extent in the United States, but should be well suited for many purposes where strength and inherent durability are prime requirements.

CHLOROXYLON SWIETENIA As

Satinwood, East Indian

East Indian Satinwood is a monotypic species native to central and southern India and Ceylon, The name satinwood has been applied to many species representing totally unrelated genera and is applied properly only to one other member of the family Rutaceae, and that is the West Indian Satinwood (Zanthoxylum flavum).

The wood is a light yellow or golden yellow in color without a distinct zone of demarcation between sapwood and heartwood. It has an exceptionally high luster on quartered surfaces, The grain is very narrowly interlocked and frequently is accompanied by an attractive mottle figure. Texture is fine and the wood is fragrant, The wood is heavy, weighing about 60 pounds per cubic foot. In side hardness this species is almost twice as hard as sugar maple (Acer saccharum).

The logs of this species are usually of small diameter and generally average between 1 and 1.5 feet in this dimension. The wood is utilized in the United States only in the form of quarter-sliced veneer, which brings out to best advantage the high luster and figure found in this species It is an expensive and highly decorative veneer species.

CORDIA spp. AM

Freijo, laurel, peterebi

The genus Cordia contains numerous species. but only a relatively small number are trees of commercial size. The three most important species are Cordia alliodora (laurel) with the most extensive range from the West Indies and Mexico southward to northern Bolivia and eastern Peru: C. goeldiana (freijo) of the Amazon basin; and C. trichotoma (peterebi) of southeastern Brazil, northern Argentina, and adjacent Paraguay.

The heartwood is light to medium brown, plain or frequently with a pigment figure outlining the growth ring pattern. Sapwood is generally distinct and of a yellowish or very light brown color. Grain is generally straight or shallowly interlocked. Texture is medium and uniform The lustrous wood rays produce a distinctive and rather attractive pattern on quartered surfaces. Luster in general is medium to high. The wood is variable in weight, but in the same density range as mahogany and cedro.

The wood air seasons at a moderate rate and degrade is generally limited to a moderate amount of warping. Surface checking and end splitting

are generally minimal. The wood saws and machines easily with good to excellent results in all operations. It is reported to glue readily and holds its place well when manufactured.

The Cordia woods are rated as moderately durable to durable when used in contact with the ground, and are rated slightly above mahogany with respect to resistance against dry wood termites. The darker colored wood is reputed to be more durable with respect to decay and have better termite resistance than the lighter colored material.

The strength properties of these Cordias are generally on a par with those of mahogany and cedro.

Because of their ease of working, good durability, low shrinkage, and attractiveness, the woods are used extensively within their areas of growth for furniture, cabinet work, general construction, boat construction, and many other uses. The characteristics of the wood should qualify it for use in the United States for many of the same purposes as mahogany and cedro.

CYBISTAX DONNELL-SMITHII AM
Primavera

The natural distribution of primavera is restricted to southwestern Mexico, the Pacific coast of Guatemala and El Salvador, and north-central Honduras. Plantations have been established within the natural range and are now producing commercial quantities of logs for lumber and veneer.

The wood of primavera is whitish to straw-yellow. The difference in color between sapwood and heartwood is very slight and cannot be detected in dried lumber or veneer, The luster is very high. Texture is like that of mahogany. The grain is almost invariably irregular, but the figure produced on flatsawn surfaces is not distinctive. Quartered surfaces exhibit a wide variety of figure which is comparable to that of mahogany and the satinwoods. The wood weighs about 30 pounds per cubic foot.

Primavera kiln dries easily and rapidly with little or no degrade due to warping and checking. There appears to he no difference in the drying characteristics of the sapwood and heartwood. The shrinkage is low and uniform and movement values are on a par with those of mahogany.

Although primavera has considerable grain variation, the wood machines remarkably well in all operations. In machining, primavera is practically the equal of straight-grained mahogany. The wood has excellent veneering qualities.

The heartwood is rated as durable to very durable with respect to fungus attack.

The strength properties of primavera are adequate for all purposes for which the wood is used. It is lighter in weight than mahogany and its strength properties are proportionately lower.

Primavera has been used in the furniture and cabinet industry of both Europe and the United States for many years. The dimensional stability, ease of working, and pleasing appearance recommend primavera for solid furniture, paneling, interior trim, and other decorative uses.

DALBERGIA LATIFOLIA AS
Indian rosewood

Native to most provinces of India except in the Northwest.

The heartwood is a dark purplish-brown with denser blackish streaks terminating the growth zones and giving rise to an attractive figure on flatsawn surfaces. The average weight is about 53 pounds per cubic foot. The texture is uniform and moderately coarse; grain is narrowly interlocked and produces an inconspicuous stripe figure on quartered surfaces which is somewhat accentuated by the presence of zones of darker color. The wood of this species is quite similar in appearance to that of the Brazilian and Honduras rosewood.

The timber is stated- to air dry fairly rapidly with no appreciable degrade. The characteristic defects of this species are slight surface checking and end checking and the lengthening of any shakes that may be present. The central core of the log very commonly contains numerous shakes. This species may be classified as a moderately refractory one, requiring a fair amount of protection against too rapid drying. The timber is said to kiln dry well, but rather slowly, and the color is said to improve during drying.

Indian rosewood is a heavy timber with high strength properties and is particularly hard for its weight after being thoroughly seasoned.

The wood is moderately hard to work with hand tools and offers a fair resistance in machine operations. Lumber containing calcareous de-

posits tends to blunt tools rapidly. A good surface is Obtained In most operations under normal working conditions and smooth surfaces are produced in planing, particularly if a cutting angle of 25° is used. The wood turns well and has high screw-holding properties. Filling of the pores is desirable if a very smooth surface is required for certain purposes.

Indian rosewood is essentially a decorative wood for high-class furniture and cabinet work. In the United States it is used primarily in the form of veneer.

DALBERGIA MELANOXYLON AF
African blackwood

African blackwood has a rather extensive range in Africa and occurs in the savannah regions from Senegal and northern Nigeria eastward to Sudan and Abyssinia and southward into Transvaal. The trees are small and usually of poor form so that the amount of usable wood from a given bolt is usually small.

The heartwood is a deep brown to purple-black, the colors commonly alternating in narrow bands. The sapwood is yellowish and thin, up to 1/2-inch thick.

Texture is moderately coarse. Grain is straight and luster is low, The wood is very hard and heavy, weighing about 70 pounds per cubic foot at 6 percent moisture content.

The wood can be air dried satisfactorily, but this must be done slowly to prevent degrade through checking. African blackwood has been successfully treated with polyethylene glycol-1000 when in the green condition to improve dimensional stability and to reduce or practically eliminate degrade from checking. After treatment, seasoning presents no difficulties.

In the United States, African blackwood is used primarily in the manufacture of woodwind instruments. For this utilization, the wood is machined with metal-working equipment.

DALBERGIA NIGRA AM
Brazilian rosewood, jacaranda

Brazilian rosewood has been an article of commerce for several centuries, but amazingly, there are no technical data available for this species. It would appear that its early acceptance by the makers of classic furniture mitigated against the need for a thorough academic study of the wood properties. At any rate, Brazilian rosewood or jacaranda, as it is known in Brazil, still maintains its long established reputation as one of the most esteemed woods of the world.

Brazilian rosewood occurs in the eastern forests of the State of Bahia to Rio de Janeiro. Having been exploited for such a long period of time it is, at present, nowhere abundant.

The wood of commerce is very variable with respect to color, ranging through shades of brown, red, and violet and is irregularly and conspicuously streaked with black. Many kinds are distinguished locally on the basis of prevailing color. The texture is coarse and is commonly overlooked because attention is generally drawn to the color. Grain is generally straight. Heartwood has an oily or waxy appearance and feel. The odor is fragrant and distinctive. The wood is hard and heavy, thoroughly air dry wood is just barely floatable in water.

The strength properties have not been determined, but for the purposes for which Brazilian rosewood is utilized they are more than adequate. In hardness, for example, it exceeds by far any of the native hardwood species used in the furniture and veneer field.

The wood machines and veneers well. It can be glued satisfactorily, providing the necessary precautions are taken to ensure good glue bonds as with other woods in this density class.

Brazilian rosewood has an excellent reputation for durability with respect to fungus and insect attack, including termites, although the wood is not used for purposes where these would present a problem

Brazilian rosewood is used primarily in the form of veneer for decorative plywood. Limited quantities are used in the solid form for specialty items such as cutlery handles, brush backs, billiard cue butts, and fancy articles of turnery.

Due to existing shortages of Brazilian rosewood, present day shipments may include wood of somewhat similar color but of finer texture, which belongs to the closely related genus Machaerium. Wood of the latter genus is known in Brazil by the common name of caviuna

DALBERGIA RETUSA AM
Cocobolo

Dalbergia retusa, and very probably two additional species in Central America and southern Mexico, supply the cocobolo of commerce. This species is closely related to Brazilian rosewood and is technically similar to it. Cocobolo differs primarily with respect to color and odor, Cocobolo heartwood predominates in the reds, yellows, and orange with dark pigment streaks; the wood has a rather sharp "cinnamon-like" odor, Cocobolo is used for the same purposes as Brazilian rosewood.

The fine dust arising in machining operations may produce an allergic response in susceptible individuals, which is generally a form of dermatitis resembling ivy poisoning. It has been stated that workmen whose perspiration gives an acid reaction are resistant, while an alkaline reaction indicates susceptibility. A good sawdust-collecting system is essential in the machining of cocobolo.

DIALYANTHERA spp. AM
Cusngare, "virola"

"Virola" is the common name currently being applied to the wood of two or more species of Dialyanthera originating in Pacific forests of Colombia and Ecuador, The local name for the wood is cuangare and would be preferred for common usage because the common name "virola" is frequently confused with the botanical genus Virola. The two genera are closely related botanically and belong to the same family, the Myristicaceae. The manufactured wood has also been called nutmeg in the trade journals.

The wood is a pale, pinkish-brown with a medium to high luster. There is no demarcation between heartwood and sapwood. Starch is abundant throughout the wood and thus it may be classified as a perishable wood or a "sapwood species." The wood is generally straight-grained. easy to work, holds nails well, and finishes smoothly. In its gross appearance, cuangare most nearly resembles the closely related banak of the botanical genus Virola. Cuangare averages about 25 pounds per cubic foot.

Strength data are not available for cuangare, but on the basis of anatomical similarity and the fact that its average density appears to be generally lower than that of banak, its properties would be proportionately lower than those of banak

Cuangare air seasons and kiln dries readily, Lumber containing streaks of dark color has been referred to as "brownheart" and these zones have been found to have moisture contents up to 80 percent even though the normal lumber was at a moisture content of about 17 percent. Kiln-dried "brownheart" material will be appreciably above the moisture content desired for fabrication purposes, and when used for corestock it is known to collapse and produce wavy surfaced panels. Kiln-drying studies of previously air-dried lumber indicated that, by using a mild schedule and by assuming an artificially high kiln sample moisture content for pieces with wet zones, such stock can be kiln dried to a uniform moisture content without collapse, excessive shrinkage, or honeycomb.

The best results were obtained using a modified Forest Products Laboratory hardwood kiln schedule T5-C3. The elapsed time was 6-3/4 days, including equalizing and conditioning. Subsequent hot-pressing trials with some of the stock produced wavy panels, and it is recommended that material containing "brownheart" should not be used for hot-press panel core stock.

Cuangare is currently being used in the United States for corestock (normal wood), moldings, interior doors, and paneling.

DICORYNIA GUIANENSIS AM
Angelique, basra locus

Angelique or basra locus has long been incorrectly identified with the botanical name Dicorynia paraensis, but it differs from the latter with respect to floral characteristics and its restricted range of growth Dicorynia guianensis is limited to French Guiana where it is known as angelique and Surinam where the common name is basra locus. It is available in considerable volume from both countries.

Because of the variability in color between different trees, three forms or types are recognized by producers. Heartwood that is russet colored when freshly cut and becomes superficially dull brown, commonly with a purplish cast on drying, is referred to as "gris." Heartwood that has a more distinct reddish cast and

frequently shows wide bands of purplish color is called “rouge.” Grayish-white wood. which apparently comes from trees that are late in forming typical heartwood, is called “blanc.” The “blanc” type contains abundant starch deposits and in this respect possesses the characteristics associated with sapwood.

The grain is generally straight to slightly interlocked. The texture is medium. Flatsawn surfaces usually show a pattern produced by the wood parenchyma bands, which appear violet against the background color of the wood Quartered lumber shows a more or less distinctive strip figure associated with interlocked grain.

With respect to strength the wood is superior to teak and white oak, when either green or air dry, in all properties except tension perpendicular to grain, in which it is surpassed by both. The wood averages slightly heavier than teak or white oak.

Machinability varies with the different forms and this is reportedly due to differences in density and silica content. Sawing is the least difficult when the wood is in the green condition, although considerable dulling of the saw does occur. After the wood is thoroughly air dried or kiln dried, it can be worked effectively only with carbide-tipped tools. A planer cutting angle of 15° is said to be suitable for working this species. The wood finishes smoothly and is moderately easy to glue. Silica analysis made on the Surinam wood gave a range of values from 0.20 to 1.70 percent silica based on the ovendry weight of the wood. A value of 2.92 percent silica has been reported.

The wood may collapse badly when kiln dried from the green condition, but if it is well air dried it can be kiln dried readily. It is subject to checking and splitting during air seasoning and careful piling methods should be used. The total shrinkage from the green to ovendry condition is slightly less than that of white oak.

The heartwood is rated as very resistant to decay and resistant to marine borer attack. Local reputation indicates that the wood has considerable resistance to termite attack and that the ‘rouge’ form is superior to the others.

When exposed to weathering without a protective coating, the wood develops characteristic hairline checks that cover practically all of the surfaces, This checking does not appear to become extensive with time and is not disqualifying for most structural uses. The heartwood is quite resistant to moisture absorption and in this respect is comparable to white oak.

Its strength and durability combined make angelique or basra locus especially suitable for heavy construction, harbor installations, bridges, heavy planking for pier and platform decking, and railroad bridge ties. The wood is particularly suitable for ship decking, planking, boat frames, and underwater members. The wood is used in the United States primarily in the form of timbers for heavy duty and durable marine construction. Small quantities have been used for flooring

DIOSPYROS spp. AF
Ebony, African

The genus Diospyros is represented in Africa by about 40 species but only a few produce enough of the dark-colored heartwood to be of economic importance. The ebony of commerce originating in West Africa is believed to be D. crassiflora and D. piscatoria. Both species are trees of relatively small dimensions.

As with most ebony woods, the color varies from nonuniform to a uniform black The best of the jet-black wood is said to be D. crassiflora. The wood is very fine textured, very hard and heavy, averaging about 63 pounds per cubic foot.

In small dimensions the wood is reported to season rapidly and easily, but has a tendency toward splitting or distortion.

Because of the hardness of the wood, it is best worked with metal working equipment. Ebony is a specialty item wood and is used primarily for small parts of musical instruments, carvings, and items of turnery.

DIOSPYROS spp. AS
Ebony, East Indian

The species comprising this group are Indian ebony (Diospyros melanoxylon), Ceylon ebony (D. ebenum), and Andaman ebony (D. marmorate).

The genus Diospyros consists of about 200 species distributed through the tropics of the world. Several reach the temperate zone, one of which is the well-known persimmon (Diospyros virginiana) of the United States which is used

for golf club heads and shuttles. Within the genus the wood ranges through shades of grayish-white, yellowish-white, reddish-gray, brownish-gray, purplish-gray, variegated black to Jet black, and infrequently has greenish zones. The trees producing the ebony of commerce are usually small--1 to 2 feet in diameter--and may have a relatively small core of usable wood. The number of species producing the ebony of commerce is relatively small in comparison to the size of the genus.

Ceylon ebony is an extremely heavy, fine, and even-textured black wood. Irregular light-brown streaks are commonly present but these are a much less conspicuous feature than in most other East Indian species. The striping is characteristic in the Andaman and Macassar ebonies. The average weight of Ceylon ebony is about 73 pounds per cubic foot.

The black portions of D. ebenus are reputed to be very difficult to season as the wood develops long, fine, deep cracks, especially if cut to relatively large dimensions. It is best to convert the logs to the smallest convenient size and store under protective cover from the sun. The best results in air seasoning D. melanoxylon are said to have been obtained by girdling the trees and allowing them to stand for 2 years before felling, followed by 6 months of seasoning in plank form The dark heartwood is liable to develop end splits and surface checks and should be well protected against rapid drying.

The ebonies are extremely hard to work with both hand and machine tools and have a considerable dulling effect on tool cutting edges. The wood is brittle and cuts harshly, producing a fine sawdust. A very smooth finish can be obtained in most operations. In planing, the material must be held firmly in the machine to prevent chattering on the cutters.

The ebonies are utilized primarily in the turnery field for many purposes, but particularly in the manufacture of parts for stringed instruments. In the cabinet trade the wood is used primarily for inlay work.

DIPTEROCARPUS spp. AS

Apitong, gurjun, keruing, yang

This genus consists of about 80 species of trees widely distributed through Southeast Asia from the Philippines to India. Timbers produced by species of Dipterocarpus are marketed collectively as yang in Thailand, apitong in the Philippine Islands, gurjun in Indian and Burma, and keruing in Malaysia and Indonesia. Because the number of species producing yang and apitong is appreciably less than the number producing keruing, the timber from Thailand and the Philippines is considered to be less variable in its properties than that from Malaysia.

Sapwood is gray or buff with a pinkish or purplish cast, 2 to 3 inches in width, and sharply defined when dry. Heartwood varies from light to dark red brown or brown to dark brown with a reddish or purplish cast. Grain is usually straight or only shallowly interlocked. Texture is moderately coarse but even. Resin canals (axial) occur in all species and when abundant may exude resin over the surface of sawn lumber, particularly if the lumber is exposed to the sun or excessive heat, The various species weigh between 40 and 57 pounds per cubic foot when seasoned and the freshly sawn timber generally weighs between 60 and 70 pounds per cubic foot. Strength is, of course, variable with species and density; average apitong, for example, is appreciably stronger than white oak in bending, stiffness, and compression parallel to grain, but somewhat weaker in shear and hardness.

Kiln drying is rather slow with a marked tendency toward development of cupping. In thicknesses greater than 2 inches, the wood is very slow to dry and it is sometimes difficult to achieve uniform drying. Resin exudation is often troublesome, especially if high temperatures are used, and existing surface checks will open up. Slight collapse may occur.

All species contain silica in amounts Varying with the species, but in general, the silica content is less than 0.5 percent of the ovendry weight of the wood. In the green condition the wood can be sawn and machined without serious difficulty, but the tool dulling effect increases as the wood dries. In some species the dulling effect may be severe when the wood has been air dried, and the use of tungsten-carbide tipped tools, especially saws is advisable. The wood machines to a clean, slightly fibrous surface. Quartersawn surfaces may pick up in planing unless the cutting angle is reduced to 20° Resin adhering to tools and working surfaces is sometimes troublesome.

Durability varies with species. Some of the lower density species are regarded as nondurable but most are at least moderately durable. Insect

damage is generally confined to the sapwood in the case of ambrosia and Lyctus, but the heartwood is very susceptible to termite attack.

The wood is rated as moderately resistant to penetration by preservative solutions, but the vessels are very readily impregnated. For exterior use the wood should be preservatively treated,

The uses for the timber are numerous and varied. Large volumes go Into mine guides where it is unexcelled because of its availability in long, clear lengths and its open pored nature, which permits retention of lubricants for long periods of time. Another very important utilization is for heavy-duty flooring, particularly in box cars and trucks where its uniform texture is a distinct advantage over species showing a marked contrast within the growth ring. Other uses include keels, bumpers, and stems for boat building; dock planking and fenders; pallets; acid pickle boxes; agitators for chemical solutions; and platforms around chemical vats.

DISTEMONANTHUS BENTHAMIANUS AF

Ayan, movingui

This genus represented by a single species is widely distributed through the rain forest zone of West Africa.

The heartwood varies from a yellow to a yellow-brown, the heavier material generally being darker in color, The sapwood is straw-colored, narrow, and usually distinct from the heartwood. Texture is similar to mahogany. Grain is interlocked to wavy and variable; luster is high. The wood contains a yellow extractive which is visible in the pores as a yellow deposit. It is also an accumulator of silica and shows considerable variation in this respect; the denser wood generally possessing the greater accumulation. The wood weighs about 42 pounds Per cubic foot.

The lumber is reported to be readily seasoned with little degrade. The movement of seasoned wood is rated as small.

Movingui has the same average density as white oak and its mechanical properties are also very similar in all respects.

The heartwood is rated as being moderately durable and resistant to preservative treatment.

Because of the variability with respect to silica accumulation, the wood varies considerably with respect to its dulling effect on cutting tools. In addition to silica, the occurrence of interlocked grain may present additional machining difficulties unless suitable precautions are taken. The wood can be glued satisfactorily.

The similarity of movingui to white oak suggests its use for many of the same purposes. The wood should not be used under conditions where it may come in contact with wet fabrics, because the yellow extractive in the wood acts as a direct dye on such materials.

DRACONTOMELON spp. AS

Dao

A genus of six species native to Southeast Asia of which four are of commercial importance: dao (Dracacontomelon dao), ulandog (D. sylvestre), and lamio (D. edule) of the Philippines and sengkuang or laup (D. mangiferum) occurring throughout Malaysia and New Guinea

The heartwood varies from light brown, grayish or greenish-yellow to reddish-brown. It is often streaked with varying amounts of deep brown or almost black. The sapwood is generally pinkish or grayish and up to 4 inches in thickness. From the Philippines it is reported that in some trees the sapwood may comprise from 30 to 45 percent of the volume of the log. Grain is straight to interlocked and irregular. Texture is moderately fine to coarse. Weight of dao is about 38 pounds per cubic foot and mangiferum, 32 pounds.

The wood veneers readily and is used primarily in the United States for decorative veneer purposes.

DRYOBALANOPS spp. AS

Kapur, keladan

The genus Dryobalanops comprises some nine species distributed over part of Malaya, Sumatra, and Borneo, including North Borneo and Sarawak. The timber exported from North Borneo and Sarawak is believed to be mainly D. lanceolata, though small quantities of other species may be included in commercial shipments. Malayan exports consist of two species, D. aromatica and D. blongifolia. In Malaya the local name kapur is restricted to D. aromatica, and D. oblongifolia is known as keladan. For the export trade. however,

the two species are combined under the name kapur.

The heartwood is light-reddish brown, clearly demarcated from the pale colored sapwood. The wood is fairly coarse textured but uniform. The freshly cut wood has a characteristic camphor-like odor which fades in time. In general appearance the wood resembles that of apitong and keruing, but on the whole it is straighter grained and not quite so 'coarse in texture. The resin ducts which are in fine, whitish, concentric lines contain a solid material which does not normally exude over the surfaces of the wood. The Malayan timber averages about 48 pounds per cubic foot and the Bornea (D. lanceolata) is slightly lighter, averaging about 44 pounds per cubic foot.

The timber is said to season fairly well, with a slight tendency to split and check, but it is definitely less troublesome in this respect than keruing.

Strength properties values available for D. lanceolata show it to be on a par with apitong or keruing of similar specific gravity.

The heartwood is rated as very durable and extremely resistant to preservative treatment.

The wood works with moderate ease in most hand and machine operations. It is somewhat easier to work than average quality keruing and, in general, has slightly less dulling effect on the cutting edges of tools. This is variable, however. and saw teeth are sometimes dulled rapidly. A good surface is obtainable from the various machining operations, but there is a tendency toward "raised grain" if dull cutters are used. It takes nails and screws satisfactorily. A silica content of 0.91 percent is reported for D. lanceolata, 0.39 percent for D. aromatica, and 0.12 percent for D. oblongifolia.

The wood provides good and very. durable construction timbers and is suitable for all the purposes for which apitong and keruing are used for in the United States.

DYERA COSTULATA AS
Jelutong

Jelutong is an important species in Malaya where it is best known for its latex production rather than its timber.

The wood is white or straw-colored and there is no differentiation between heartwood and sapwood. The texture is moderately fine and even. The grain is straight, and luster is low. The wood weighs about 29 pounds per cubic foot.

A natural defect of this species, as in many other timbers of this family, is the occurrence of large latex traces or passages which radiate outward in the stem at the branch whorls. The channel openings appear lens-shaped on flatsawn surfaces, generally are about 1/2 inch in height along the grain, and are distributed in irregularly spaced rows along the length of the lumber. The rows are generally 2 to 3 feet apart, depending upon the spacing of the branch whorls. The passages contain unlignified parenchymatous tissue in which are embedded numerous small latex canals; the canals exude latex when the timber is green, but later dry and shrivel. In seasoned timber the latex passages contain dried ribbons of tissue which have become detached from the wood.

The wood is reported to be very easy to season with little tendency to split or warp, but staining may cause trouble.

The wood is easy to work in all operations, finishes well, and can be glued satisfactorily.

The wood is rated as nondurable. but readily permeable to preservatives.

Jelutong would make an excellent core stock if it were economically feasible to fill the latex channels. Because of its low density and ease of working, it is well suited for sculpture and pattern. Jelutong is essentially a "short-cutting" species, because the wood between the channels is remarkably free of other defects.

ENDIANDRA PALMEBSTONII AS
Orientalwood

Orientalwood is native to the heavy rainfall area in the coastal tablelands of northern Queensland, Australia. It is said to be one of the most common trees in that region.

The heartwood shows a general resemblance to plain European walnut (Juglans regia) and shows almost as great a variety of coloration; it varies from light or pinkish-brown to dark brown, often with pinkish, grayish-green or blackish streaks. The grain is interlocked in varying degrees and frequently rather wavy, giving a broken stripe or mottle pattern on quartered surfaces. The various patterns have been described as straight stripe, irregular stripe, mottle with straight stripe, fiddle-back, and

finger roll. The medium and even texture is similar to that of European walnut, but the wood is more lustrous and slightly heavier, weighing about 42 pounds per cubic foot. The wood accumulates silica in the wood rays.

The timber is said to kiln dry fairly rapidly in the thinner sizes without any tendency toward surface or internal checking. but with some tendency toward warp. Thicker materials are reported to be likely to split unless quartersawn.

The wood offers a moderate resistance to cutting by hand and machine tools when they are sharp, but has a severe dulling effect on the cutting edges of the tools, particularly saws. The use of special saws, having teeth tipped with tungsten carbide, is recommended where continuous production is anticipated. The occurrence of silica in the wood has less influence on veneer knives, and for that reason the wood used in the United States is practically always in veneer form. The flitches are commonly sliced on the quarter to take advantage of the stripe and mottle figure produced in this species.

ENTANDROPHRAGMA ANGOLENSE AF
Tiama, edinam

A large tree of the semievergreen forest ranging from French Guinea to Angola and eastward through the Congo to the Sudan and Uganda.

The heartwood is generally a dull reddish-brown and distinct from the sapwood, which may be up to 4 inches thick. Texture is similar to mahogany and khaya. Grain is interlocked. The wood weighs about 34 pounds per cubic foot. This species is the plainest appearing of the several Entandrophragma species.

The wood seasons fairly rapidly and with a marked tendency to distort. The in-service movement is classified as small.

Tiama averages slightly more in weight than American mahogany, but its mechanical properties are lower than those of mahogany with respect to bending and compression parallel to grain. Tiama is superior with respect to side hardness and shear.

The heartwood is rated as moderately durable and as extremely resistant to preservative treatment.

Tiama works rather easily with machine and hand tools, but interlocked grain may give some difficulty unless proper cutting angles are maintained. The wood finishes and stains well and provides satisfactory glue bonds,

Tiama provides both plain and decorative veneer and is used extensively in this form. Other uses include furniture and cabinet making and, to a certain extent, boat construction.

ENTANDROPHRAGMA CANDOLLEI AF
Kosipo, Omu

A large forest tree ranging through West Africa to Angola and the Congo region.

The heartwood is a dull brown or purplish-brown and distinct from the lighter colored sapwood which may be 2 to 3 inches wide. The texture of kosipo is coarser than that of the other Entandrophragma species and the parenchyma bands are conspicuous on planed surfaces. The grain is interlocked. The wood weighs about 39 pounds per cubic foot.

The wood is reported to season slowly and with a marked tendency to distort. The movement of seasoned wood in service is rated as medium.

Kosipo offers more difficulties in machining than the other members of the genus and this may be attributable to the combination of silica, abundance of parenchyma, and interlocked grain. Grain-raising and grain-tearing are common defects in machining and veneering.

Apparently this species is little used because of the availability of related species with better properties.

ENTANDROPHRAGMA CYLINDRICUM AF
Sapele

A large African rain forest tree ranging from Sierra Leone to Angola and eastward through the Congo to Uganda.

The heartwood ranges in color from that of mahogany to a dark reddish- or purplish-brown The lighter colored and distinct sapwood may be up to 4 inches thick. Texture is finer than that of mahogany. Grain is interlocked and produces a narrow and uniform stripe pattern on quartered surfaces. The wood averages about 39 pounds per cubic foot.

The wood seasons fairly rapidly and with a marked tendency to distort.

Sapele has the same average density as white

oak, and its mechanical properties are in general higher than those of white oak.

The wood works fairly easily with machine tools, although interlocked grain offers difficulties in planing and molding. Sapele finishes and glues well.

The heartwood is rated as moderately durable and as resistant to preservative treatment.

Sapele is used extensively, primarily in the form of veneer for decorative plywood

ENTANDROPHRAGMA UTILE AF
Sipo utile

Utile occupies the same African range as the other related species, principally West and Central.

The heartwood is a uniform reddish- or purplish-brown and is distinct from the light brown sapwood. Texture is slightly coarser than that of sapele. Grain is interlocked and shows a broader and less uniform stripe pattern on quartered surfaces than sapele. The wood averages about 41 pounds per cubic foot.

The wood seasons at a moderate rate and shows a marked tendency toward distortion. The movement of seasoned lumber in service is rated as medium.

The mechanical properties of utile are generally similar to those of sapele and white oak.

The heartwood is rated as durable and as extremely resistant to preservative treatment.

Because of similarity of density and grain characteristics, the working characteristics are similar to those of sapele.

Utile is used for decorative veneer, somewhat interchangeably with sapele.

ENTEROLOBIUM CYCLOCARPUM AM
Guanacaste

Guanacaste has an extensive range from southern Mexico through Central America into northern South America, including Jamaica and Cuba.

The sapwood is white and sharply demarcated from the heartwood which occurs in shades of brown, occasionally with darker colored pigment streaks. The grain is commonly interlocked and shows a narrow to wide ribbon stripe on quartered surfaces. The texture is coarse, the vessel lines generally showing quite prominently on longitudinal surfaces, Luster is high. The wood weighs about 24 pounds per cubic foot.

Seasoning data are not available, but local reputation indicates that the wood air dried rapidly with little or no degrade. The only shrinkage values available are based on one tree tested from Guatemala. The total shrinkage from green to ovendry condition was 1.7 percent radially and 4.0 tangentially. The movement between relative humidities of 65 and 30 percent was 0.4 percent radially and 0.8 percent tangentially.

The normal wood is easy to work with hand and machine tools and has good dimensional stability in use. Tension wood zones may be common in some logs and these are generally responsible for considerable fuzzing and grain-tearing during machining. Wood from the central core of the tree frequently contains compression failures and makes such logs unsuited for peeling.

The heartwood has a good local reputation for decay and insect resistance and is used for many construction and general utility purposes as a substitute for the more expensive cedro (Cedrela). Available strength values suggest similarity to gumbo limbo.

The fine dust arising from machining the dry wood causes irritation of the mucous membranes of most individuals, but this can be eliminated by a good sawdust collection system.

The low density and dimensional stability of guanacaste suggest possible utilization in the United States for corestock and patterns.

EUCALYPTUS DIVERSICOLOR AS
Karri

A very large tree limited to Western Australia, occurring in the southwestern portion of the state.

Karri resembles jarrah (Eucalyptus marginata) in structure and general appearance. It is usually paler in color, and, on the average, slightly heavier (57 pounds per cubic foot).

The timber is said to have a pronounced tendency to check during seasoning, and under adverse conditions, the cracks become very deep in thick pieces. Although much more severe on the tangential face, checking often appears on quartersawn material. In spite of the fact that the grain is generally much straighter than that of jarrah, considerable trouble from warping is experienced at times with thin stock Collapse is a little more prevalent than in jarrah. In kiln

drying from the green condition, very low temperatures and high humidities are advisable and periodic steaming treatments are recommended. Partial air drying before kiln drying is advised, but care must be taken to prevent checking during the preliminary air seasoning. It is said that in kiln drying green material to 15 percent moisture content the shrinkage is 10 percent tangentially and 5 percent radially.

The heartwood is rated as moderately durable and extremely resistant to preservative treatment.

Karri is a heavy hardwood possessing mechanical properties of a correspondingly high order.

The wood is fairly hard to work in machines and difficult to cut with hand tools. It is generally more resistant to cutting than jarrah and has slightly more dulling effect on tool edges. A fairly clean finish is obtained in most operations, but the wavy interlocked grain causes picking up in planing, particularly with a quartersawn material, and a cutting angle of 15° should be used.

It is inferior to jarrah for underground use and waterworks, but where lateral strength is required, such as in bridges, floors, rafters, and beams. it is an excellent timber. Karri is popular in the heavy construction field because of its strength and availability in large sizes and long lengths that are free of defects.

EUCALYPTUS MARGINATA AS
Jarrah

Jarrah is native to the coastal belt of southwestern Australia and one of the principal timbers of the sawmill industry.

The heartwood is a uniform pinkish to dark red, often a rich, dark red mahogany hue, turning to a deep brownish red with age and exposure to light. The sapwood is pale in color and usually very narrow in old trees. The texture is even and moderately coarse. The grain, though usually straight, is frequently interlocked or wavy. The wood weighs about 44 pounds per cubic foot. The common defects of jarrah include gum veins or pockets which, in extreme instances, separate the log into concentric shells.

In the kiln drying of jarrah, warping is said to be the principal cause of degrade. With narrow boards, such as flooring, checking is not serious either in air or kiln drying, but with wide and thick flatsawn stock care must be exercised. Partial air drying before kiln drying is recommended; low temperatures and high humidities are advised when kiln drying from the green condition, especially in thicker dimensions.

It is reported that in kiln drying green material to a moisture content of 15 percent, the tangential shrinkage is about 8 percent and the radial shrinkage about 5 percent.

Jarrah is a heavy, hard timber possessing correspondingly high strength properties. It is resistant to attack by termites and rated as very durable with respect to fungus attack. The heartwood is rated as extremely resistant to preservative treatment.

As with karri, jarrah is fairly hard to work in machines and difficult to cut with hand tools.

Jarrah is used for decking and underframing of piers, jetties, and bridges, and also for piling and fenders in dock and harbor installations. As a flooring timber it has a high resistance, but is inclined to splinter under heavy traffic.

EUXYLOPHORA PARAENSIS AM
Pau amarello

Pau amarello is the only member of this genus and apparently is limited in its distribution to the eastern and southern portions of the State of Para, Brazil,

The heartwood is a bright, clear, yellow which deepens on exposure and is not sharply defined from the yellowish-white sapwood. Luster is high. Texture is rather similar to that of birch. The wood is without odor or taste. The wood weighs about 48 pounds per cubic foot. The grain is straight to shallowly interlocked or sometimes irregular.

No data are available with regard to seasoning and machinability. but it is presumed that these qualities must be fairly good, judging from the esteem this species enjoys in Para. The reported shrinkage values indicate very uniform dimensional changes in the transverse direction.

Pau amarello is somewhat heavier than yellow birch or hard maple, but its strength properties are on a par with the hard maple.

In Brazil, and particularly in Para, pau amarello is used primarily for furniture and flooring. For flooring it is generally manufactured in the form of parquet and mixed with darker colored

wood to produce attractive and rather striking designs.

There appears to be little opportunity for utilization in the United States because the local demand for the wood is considerable and is generally equal to the supply.

FITZROYA CUPRESSOIDES AM
Alerce

Like "Parana pine," alerce is a softwood. The genus Fitzroya is represented in southern Chile and adjacent Argentina by the single species F. cupressoides. Alerce belongs to the Cupressacae family, which includes the well-known softwoods referred to as cedar in the United States.

The heartwood is reddish-brown and sharply defined from the narrow and very light-colored sapwood. The wood is similar in most respects to California redwood. The growth rings are usually narrow and the grain is straight. The wood averages about 26 pounds per cubic foot.

Alerce is reputed to season readily and with little or no degrade. The wood machines easily. Alerce has a very good local reputation for natural durability.

Limited strength data available for alerce suggest that its properties are generally somewhat lower than those of redwood.

Alerce is suitable for use for the same purposes as redwood.

GONYSTYLUS spp. AS
Ramin

The genus Gonystylus consists of about 25 species ranging from the Philippines through Indonesia to Malaya. In many areas the trees are quite common in the fresh water swamps. The type species of the genus and perhaps the most important in the export trade is Gonystylus bancanus, which ranges from the Malay Peninsula to Sumatra and Borneo.

Ramin may be regarded as a general utility hardwood which averages slightly heavier than hard maple and yellow birch and exceeds these species in practically all strength properties. Normally there is no visual difference between the sapwood and heartwood, both are white to pale straw in color. The texture is moderate, fine, and uniform. The grain is straight or slightly interlocked. When the lumber has been carefully handled and is free of defects and stain, it has a bright clean appearance with no outstanding decorative features. Under certain conditions logs may acquire an unpleasant smell which does not as a rule persist after the lumber has been thoroughly seasoned but may become noticeable again if the wood is rewetted. There have been reports that workers handling logs or wany lumber may develop a skin irritation which is believed due to the penetration of the skin by sharp-pointed fibers in the remains of the inner hark which are left on the log after debarking. Washing the hands with plain soap and water is apparently an effective remedy.

Shrinkage of ramin from the green condition to a moisture content of 12 percent is reported to be about 5 percent tangentially and 2.5 percent radially. In changing from a moisture content of 18 percent to a moisture content of 12 percent the tangential shrinkage is reported as 2.9 percent and radially as 1.3 percent.

With respect to natural durability ramin is rated as perishable, but is permeable with regard to preservative treatment.

The wood seasons readily with little distortion but with a tendency for end splitting and surface checking to occur. Many importers, custom dryers, and users are generally not aware of the special seasoning and handling requirements of this species and some heavy losses have been experienced.

Potential users and processors of ramin should avail themselves of USDA Forest Service Research Note FPL-0172, "The Seasoning and Handling of Ramin." for specific details which should be helpful in eliminating most of the difficulties encountered in this species. Single copies are available from the Forest Products Laboratory.

In general, the wood works cleanly with machine and hand tools and has only a moderate blunting effect on cutting edges. The wood takes stains and finishes readily and can be glued satisfactorily. As with most straight-grained wood in this density class, the wood has a marked tendency to split when nailed.

Ramin can be used for a wide variety of purposes just as hard maple and yellow birch are, but the major volume being utilized in the United States at the present time is in the molding industry.

GOSSWEILERODENDRON BALSAMIFERUM AF
Agba, tola

Agba is one of the largest trees of the African forest and is distributed from Nigeria to Angola and in the western area of the Congo.

The heartwood is a uniform light brown and the thick sapwood is distinctly paler in color. The texture is finer than that of mahogany. Luster is low. Grain is straight to shallowly interlocked. The wood weighs about 32 pounds per cubic foot. The wood contains a sticky resin which may be troublesome in green lumber, but as a rule well-seasoned lumber is not noticeably resinous, although it seems that under certain conditions some exudation may occur. The wood tends to retain a slightly resinous odor.

The wood can be seasoned fairly rapidly with little tendency toward splitting and distortion. Some gum exudation is likely to occur, but this should not be excessive. The in-service movement of seasoned wood is rated as small.

Agba has the same average density as American mahogany but its mechanical properties are lower in practically all properties except shear.

The heartwood is rated as durable and resistant to preservative treatment.

The wood machines well, finishes readily, and can be satisfactorily glued.

Agba is suitable for use in both veneer and solid lumber for many purposes requiring a relatively light-colored, easy working, and dimensionally stable wood. It serves well for corestock, decorative purposes, moldings, and other utility purposes.

GUAIACUM SANCTUM AM
Lignum vitae

Lignum vitae is another of the Latin American species which has been extensively used practically from the time of discovery of the New World. The wood was introduced to the medical profession of Europe about 1508 as a specific for many of the most serious ailments of mankind. Its reputation was so firmly established that for two centuries its therapeutic value remained unquestioned. Both wood and resin are medicinally obsolete except in certain proprietary decoctions.

Guaiacum officinale, native to the West Indies. northern Venezuela, northern Colombia, and Panama, was for a great many years the only species used on a large scale. With the near exhaustion of commercial-size timbers of G. officinale, the principal species of commerce is now G. sanctum. The latter species occupies the same range as G. officinale, but is more extensive and includes the Pacific side of Central America as well as southern Mexico and southern Florida.

The heartwood is distinctly green or olive-green and becomes very dark or even black upon long exposure. The sapwood is white or yellowish-white and generally shows distinct green vessel lines. The texture is very fine. The grain is strongly interlocked, and shows a narrow and closely spaced ribbon stripe pattern on quartered surfaces. Lignum vitae is perhaps the heaviest commercial wood and averages about 75 to 80 pounds per cubic foot in the thoroughly airdry condition. The heartwood has a mildly fragrant odor and a pronounced waxy or oily feel.

The usual strength values have never been obtained for lignum vitae and this probably stems from the fact that it is utilized mechanically for its extreme hardness, durability, and self-lubricating properties. The hardness modulus of lignum vitae is about four times that of hard maple, and this extreme hardness permits utilization as a self-lubricating bearing material under relatively heavy loads.

Shrinkage values are also not available, but because the wood is used primarily for underwater bearings, it must be utilized in its green or saturated condition and shrinkage values are of no consequence.

The most important and exacting use of lignum vitae is for bearings or bushing blocks lining the stern tubes of propeller shafts of steamships and submarines. The blocks are machined to conform to the curvature of the propeller shaft on one end-grain surface. and on the other side to conform to the curvature of the propeller tube.

Numerous attempts have been made to substitute other hard, heavy woods for use as underwater bearings but none contain the high guaiac resin content which makes lignum vitae self-lubricating and unique for this very exacting utilization. The genus Bulnesia, which is a closely related genus belonging to the same plant family as lignum vitae, is very similar in many respects but also lacks the high guaiac resin content which is so essential for this particular use.

GUAREA CEDRATA & THOMPSONII AF
Bosse, guarea

The two commercially important species of African guarea occur throughout West Africa and the Congo region.

The two Guareas show slight difference in technical properties, but for most purposes for which these species are used the differences are unimportant. It is general practice to market them under a single trade name.

Guarea cedrata heartwood is a pinkish-brown, similar to mahogany, but with a finer texture. It has a pleasant cedar-like odor which disappears with time. Luster is high. Grain is interlocked. Guarea thompsonii is similar to G. cedrata, but is slightly heavier and the grain tends to be straighter. The wood averages about 39 pounds per cubic foot. Guarea cedrata weighs about 36 pounds per cubic foot.

Both species appear to season fairly rapidly and with very little tendency to warp and split. Exudation of resin may cause some degrade in the seasoned appearance of the wood. Movement of the seasoned wood in service is reported to be small for both species.

Both Guarea species have a slightly higher average density than American mahogany and their strength properties are proportionately higher.

The heartwood is rated as durable and extremely resistant to preservative treatment.

Both species work fairly easily and smooth surfaces can be obtained in most operations. Guarea cedrata is likely to have a more pronounced dulling effect on cutting tools because of its silica content than G. thompsonii, in which silica is lacking. The silica content of G. cedrata is very low and the maximum value reported is 0.12 percent of the ovendry weight of the wood.

Both species are utilized in veneer for decorative purposes and also in the solid form for furniture, interior trim, and boat construction. Because the seasoned timber may retain volatile resins, it should not be used for instrument cases--a situation similar to that of Spanish-cedar (Cedrela).

GUIBOURTIA ABNOLDIANA & EHIE AF
Benge, ehie

Although benge (Guibourtia arnoldiana) and ehie (G. ehie) belong to the same botanical genus as bubinga, they differ rather markedly with respect to their color. The heartwood of benge is a yellow-brown to medium brown with gray to almost black striping. Ehie heartwood tends to be a more golden brown and is striped as in benge. Ehie appears to be the more attractive of the two species.

The technical aspects of these species have not been investigated, but both are moderately hard and heavy. Benge is fine textured and in this respect similar to birch; the texture of ehie is somewhat coarser. Both are straight grained or have slightly interlocked grain.

These woods are as yet little known in the United States, but would provide both veneer and lumber for decorative purposes and furniture manufacture.

GUIBOURTIA spp. AF
Bubinga, kevazingo

The woods of Guibourtia demeusei, G. pellegriniana, and G. tessmannii are similar in general character and are known as bubinga in the Cameroons and kevazingo in Gabon and French Equatorial Africa. The usual name applied in the United States is bubinga. The distribution of these species overlaps. but G. tessmannii is reported to be most common in the Cameroons and is the principal source of the local bubinga, while G. pellegriniana is most common in Gabon and the source of kevazingo. Guibourtia demeusei is widely distributed from southeastern Nigeria through the Cameroons, Gabon, and the Congo region.

Bubinga, when freshly cut, is red to reddish-brown with purple veining, but after exposure it becomes a yellow to medium brown with a pronounced pinkish or reddish cast. The veining then becomes less conspicuous and the wood bears a superficial resemblance to some types of rosewood. The grain is generally interlocked.

Although moderately hard and heavy, the wood is reported to saw without difficulty and finish well. It is used mostly in the form of veneer for decorative paneling, and in the solid form for articles of turnery.

HURA CREPITANS AM

Jabillo, possumwood

Jabillo, the usual Spanish common name for this species, ranges from the West Indies and southern Mexico through Central America southward to northern Bolivia and Eastern Peru, Included in this range is that of Hura polyandra which is the more common species in Mexico and northern Central America. The latter species can be differentiated only when in flower, and in all other respects the two species are similar.

The wood is yellowish-white to yellowish-brown with no sharp distinction between sapwood and heartwood. In Surinam the lumber trade distinguishes a "dark" and "white" variety of the wood. The "dark" variety is said to be of better quality than the 'white" type, which is reputed to saw wooly, pick up in planing, and to be prone to warping and checking. The 'dark" variety is also said to make up only a small percentage of the total stand volume. Luster is high. Texture is medium to coarse, the vessel lines usually prominent. Grain is interlocked. The wood averages about 26 pounds per cubic foot.

The wood is moderately difficult to season: it tends to dry rapidly which prevents the formation of blue stain, but also causes a variable amount of warp and checking. Shrinkage and movement are low. The wood is relatively stable in use and undergoes only moderate dimensional movement in response to atmospheric changes. The strength properties of jabillo are slightly superior to those of yellow-poplar, with the exception of stiffness.

Normal wood machines easily and little or no difficulty is encountered. The presence of tension wood zones results in fuzzy and torn grain surfaces in planing, particularly on quartered surfaces. The wood finishes well and glues readily. It can be readily peeled and sliced for veneer, but tension wood zones tend to produce excessive fuzziness and buckling of the veneer in drying.

The wood is very variable with respect to decay resistance and very susceptible to termite attack. Freshly cut logs are susceptible to blue stain and spraying with preservatives and prompt conversion are indicated. The unpainted wood has good weathering characteristics.

Normal wood should provide a very good corestock because of its low density and good dimensional stability. Locally it is used for boxes, crates, cheap carpentry, and interior trim.

HYMENAEA COURBARIL AM

Courbaril, guapinol

The genus Hymenaea consists of about 30 species occurring in the West Indies and from southern Mexico, through Central America, into the Amazon Basin of South America. The best known and most important species is H. courbaril, which occurs throughout the range of the genus. The majority of the species are known only from the Amazonian area. The following description applies only to H. courbaril.

The sapwood is gray-white and usually quite wide The heartwood is sharply differentiated and varies through shades of brown to an occasional purplish cast. The texture is medium. Grain is interlocked, and luster is fairly high. The heartwood is without distinctive odor or taste. The wood weighs about 50 pounds per cubic foot.

Courbaril is rated as moderately difficult to air season. Although courbaril is a heavier wood than hickory or white oak, its shrinkage values are lower than those of the latter species. The in-service movement that may be expected from courbaril is less than that encountered in native United States furniture species.

The strength properties of courbaril are quite high but very similar to those of shagbark hickory, a species of lower specific gravity.

In decay resistance, courbaril is rated as very durable to durable.

Courbaril is considered to be moderately difficult to work because of its high density, but it can be finished smoothly and it turns and glues well. It compares favorably with white oak in steam-bending behavior.

Courbaril has been little utilized in the United States, but should find application for a number of uses. Its high shock resistance recommends it for certain types of sporting equipment, or as a substitute for ash in handle stock. It promises to be a suitable substitute for white oak in steam-bent boat parts. It makes an attractive veneer and should also find application in the solid form for furniture. The thick sapwood would provide an excellent source of blond wood.

INTSIA spp. AS

Ipil, merbau

The genus Intsia consists of six or seven

species distributed through the Philippines, Indonesia, Indo-China, Malaya, many of the Pacific Islands, and Malagasay. Two widespread species contribute mainly to commercial supplies: Intsia bijuga and I. palembanica.

The individual species of Intsia are not identifiable due to the range of variability shown by the individual species in color, texture, and weight. The timber, wherever available locally, is regarded with high esteem because of its many desirable properties.

The sapwood is sharply defined, white to pale yellow and up to 3 inches in width. The heartwood varies from a light brown to red-brown or dark brown. The grain is narrowly interlocked and occasionally wavy; texture is moderately coarse to coarse and even. Luster is usually low, and the wood may have a somewhat oily or waxy feel. The occurrence of yellow deposits in the vessels is characteristic of this genus and serves to separate it from similar-appearing woods. The heartwood ranges in weight from about 46 to 60 pounds per cubic foot, and averages about 50 pounds.

The available strength data show Intsia to be on a par with our native hickory species, although it averages somewhat heavier.

Intsia bijuga is reported to be readily kiln dried from the green condition with little degrade, except for occasional moderate twist in some boards.

The only reported kiln drying schedule is given below and is designed for 4/4 material.

Moisture content change points (percent)	Dry bulb temperature (°F.)	Wet-bulb depression (°F.)
Green	130	15
30	140	20
20 to final	160	30

This schedule is said to be tentative. With this schedule, 4/4 flatsawn stock requires 6 days to dry to 12 percent moisture content, 4/4 quartersawn stock requires 8 days, and material airdried to 25 to 30 percent moisture content requires about 4 days. Stacks should be weighed, and a short steaming treatment of about 4 hours should follow drying.

For wood of rather high density the shrinkage is very low: values reported for I. bijuga are 4.4 percent tangential and 2.7 percent radial from the green condition to ovendry. The values reported for I, palembanica are practically identical.

The green timber offers moderate difficulty in sawing and may be accompanied by pinching and sawdust packing. With airdry material, sawing is fairly difficult due to the density of the wood. With straight-grained material the machined surfaces are quite good, but interlocked grain may cause some difficulties on quartersawn surfaces, Boring and turning properties are reasonably good.

Intsia is one of the most sought-after of local timbers, being second only to chengal (Balanocarpus heimii) in popular favor in Malaya. Among the special merits of the timber are its low shrinkage, freedom from degrade in seasoning, freedom from defects, and its natural durability in certain circumstances. Locally the timber is used for outdoor structural work and ties, but its pleasing appearance when finished and low shrinkage promotes it to the class of good quality ornamental timbers suitable for paneling, flooring, and furniture.

JUGLANS spp. AM

Nogal, tropical walnut

Under the designation tropical walnut are included two species, Juglans neotropica of Peru and J. olanchana of northern Central America. These species are mentioned here because of the widespread interest in walnut from sources where lumber costs are decidedly lower than in the United States, and because so little technical information is available.

The wood of the tropical species is generally darker than that of typical American blackwalnut and the texture (pore size) is somewhat coarser. From the limited number of specimens available for examination it would also appear to be somewhat lighter in weight. Logs frequently show streaks of lighter color in the heartwood and this characteristic has caused some concern about the potential utility of the tropical wood. Another feature that is mentioned whenever tropical walnut is under discussion is the extreme slowness with which the wood dries. It has been stated that lumber to 5/4 thickness can be dried at the same rate as black walnut, but thicker stock takes an appreciably longer period of time and in the thicker stock the wood is prone to collapse and honeycomb.

Tropical walnut peels and slices readily, but

the veneer is also said to dry more slowly than normal. Tension wood and compression failures have been observed in a number of specimens and these invariably came from the central core of the tree.

It appears that these species require a rather intensive study, particularly with respect to seasoning and machining, in order to ascertain their true potential.

KHAYA spp. AM

Khaya, "African mahogany"

The "African mahogany" of the United States lumber trade is the product of two West African species, Khaya ivorensis and K. anthotheca. Khaya ivorensis occurs in the rain forests from the Ivory Coast to the Cameroons and Gabon; Khaya anthotheca occurs in the same general area but inhabits the regions of lower rainfall than K. ivorensis and its range extends eastward to Ugonda. Occasionally brought into the United States is K. grandifoliola, a tree of the intermediate zone forests where rainfall is low. This wood is appreciably heavier than that of the other species.

The heartwood varies from a light pinkish-brown to a deep reddish-brown shade, not always sharply defined from the yellowish-brown sapwood. The texture is similar to or only slightly coarser than that of American mahogany. Although some of the timber is straight grained. it is usually interlocked and produces a stripe figure on quartered surfaces. The wood weighs about 32 pounds per cubic foot.

The wood seasons fairly rapidly and with little degrade, When strongly developed tension wood is present, serious distortion or collapse may occur during seasoning. The in-service movement of seasoned wood is classified as small.

"African mahogany" is in the same density range as American mahogany, but is somewhat lower in bending strength and in compression parallel to the grain. 'African mahogany' is somewhat superior with respect to side hardness and shear.

The heartwood is rated as moderately durable and as extremely resistant to preservative treatment.

The wood machines fairly easily, although the usual difficulties may be expected when planing quartered lumber. As with many other species, the presence of tension wood zones creates difficulties in obtaining smooth surfaces. The wood has good finishing characteristics and can be readily glued.

"African mahogany" is used extensively in both veneer and lumber form and for many of the same purposes as American mahogany, except for pattern stock.

KOOMPASSIA MALACCENSIS AS

Kempas

The genus Koompassia consists of two species occurring in the Malay Peninsula and Indonesia. K. malaccensis is the most widespread species and K. excelsa, known as tualang, is limited to the northern portion of the Malay Peninsula.

Kempas is a hard, heavy wood of rather distinctive appearance. The heartwood is brick-red when freshly cut and darkens on exposure to an orange-red with numerous yellow-brown streaks due to the soft tissue associated with the pores. The sapwood is white or pale yellow, clearly defined-and about 2 inches wide in large trees. The average weight is about 54 pounds per cubic foot. The wood is rather coarse-textured with a bright, natural luster. The grain is typically interlocked

A fairly common defect is the presence of streaks or veins of hard, stone-like tissue that may be 1/4 inch wide radially, several inches in tangential width, and may extend for several feet along the grain. Well-developed defects of this kind are sources of mechanical weakness in construction timber and may give rise to serious splitting during seasoning. The wood has a slightly acidic character and may tend to promote the corrosion of metals.

Kempas is reported to season fairly well, but the zones of abnormal tissue which are not an uncommon feature may give rise to serious splitting during seasoning. A factor of some importance is the low ratio of radial to tangential shrinkage, which probably accounts for the absence of serious splits and excessive degrade in seasoning, notwithstanding a tendency to rapid drying.

Kempas heartwood is rated not at all durable in contact with the ground under Malayan conditions because it is readily attacked by termites. It is also said to be "not particularly resistant" to wood-rotting fungi. Kempas is reported to

absorb preservatives radially and penetration is good. Absorptions of 7 pounds of creosote in seasoned timber have been obtained with comparatively mild treatments. As with many other species, appreciable variation in absorption and penetration may occur. The presence of abnormal tissue is a distinct disadvantage, as it appears to inhibit penetration while accounting for relatively heavy absorption.

The timber offers a fairly high resistance to cutting in most machining operations. Its working properties are said to be somewhat similar to the heavier species of Dipterocarpus.

Kempas is essentially a heavy construction timber, and when exterior utilization is anticipated the wood must be treated with preservatives. This species is not likely to gain favor in the United States trade because of the common occurrence of abnormal tissue which may present numerous problems in conversion.

LOPHIRA ALATA AF
Azobe, ekki

A large tree of the heavy rain forest occurring in West Africa from Sierra Leone to Nigeria and the Cameroons.

The heartwood is a dark red or deep chocolate brown showing a mottled appearance due to the rather conspicuous white deposits in the vessels. The much paler sapwood is about 2 inches thick, and sharply defined. Parenchyma bands produce a distinctive "partridge" pattern on flatsawn surfaces. Texture is coarse. Grain is broadly interlocked The wood is very hard and heavy, averaging between 59 and 69 pounds per cubic foot.

Azobe is an extremely refractory species with respect to seasoning. Moisture loss is extremely slow and severe splitting and distortion are likely to occur in thin stock. This species is commonly utilized in the form of heavy timbers where kiln drying is not economically feasible.

Azobe is a very heavy wood and its strength properties are in the very high range.

The heartwood is rated as very durable and extremely resistant to preservative treatment.

Because of its high density, azobe is very difficult to saw and machine. Generally the wood is sawn only, because it is commonly used in rather large sizes.

The high strength and natural durability make azobe particularly well suited for all forms of, heavy duty construction.

LOVOA TRICHILIOIDES AF
Lovoa, tigerwood

Lovoa trichilioides, the most important of this small African genus, is distributed from Sierra Leone through West Africa into the Congo and Angola. Information relative to this species is also found in the literature under the synonymous name Lovoa klaineana.

The he art wood is a yellow-brown and occasionally marked by dark streaks which consist of traumatic gum ducts. The sapwood is gray or buff colored, up to 3 inches wide and sharply defined. Texture is similar to that of mahogany or slightly finer. Grain is narrowly and closely interlocked, producing a characteristic and lustrous ribbon stripe on quartered surfaces. The wood weighs about 34 pounds per cubic foot.

The wood is reported to season fairly rapidly without much degrade. It is easy to work with machine tools, finishes well, and provides satisfactory glue joints.

The heartwood is rated as moderately durable but extremely resistant to preservative treatment.

Lovoa is within the density range of mahogany and its strength properties are generally similar in all respects.

Lovoa is used in the United States primarily in the form of veneer for decorative purposes.

MANSONIA ALTISSIMA AF
Bete, Mansonia

Mansonia is represented in west tropical Africa by the single species altissima, which occurs in Ivory Coast, Ghana, and southern Nigeria.

The heartwood varies from a light to dark gray-brown, frequently with a purplish cast. The wood often shows alternating lighter and darker bands. The texture is fine and uniform

Grain is generally straight: luster is low. The wood weighs about 37 pounds per cubic foot.

The wood seasons fairly rapidly and well with very little distortion The movement of seasoned wood in service is rated as medium

Mansonia works well in all machining operations and produces good surfaces under standard con-

ditions. The fine dust arising from certain machining operations is reported to be irritating to certain individuals.

The heartwood is rated as very durable and extremely resistant to preservative treatment.

The wood bears a resemblance to some grades of European walnut and has been used as an alternate for this species in some instances. It is little used in the United States in either solid or veneer form.

MITRAGYNA CILIATA AF
Abura

Abura ranges from Ivory Coast through West Africa and southward to the Congo and Angola.

The heartwood is a uniform light yellowish-brown or pinkish-brown. The sapwood is generally not differentiated from the heartwood. Texture is fine and rather similar to that of birch. Luster is low. Grain is usually straight or may be irregularly interlocked. The wood weighs about 35 pounds per cubic foot.

The lumber seasons rapidly and well with little or no degrade. The in-service movement is classified as small.

The strength properties of abura are generally similar to those of American mahogany.

The wood is rated as nondurable and as moderately resistant to preservative treatment.

Abura works fairly well in all machining operations, but dulling of teeth in sawing seasoned lumber may be appreciable. Silica content up to 0.24 percent has been reported for this species. The wood takes stains and finishes readily and can be glued without difficulty.

Abura is rarely encountered in the United States lumber trade, probably due to the sawing difficulty and because it is not considered an attractive wood.

MORA spp. AM
Mora, Morabukea, Nato

The genus Mora consists of about nine species ranging from the West Indies through northern South America into the Amazon Basin. The principal species in northern South America are Mora excelsa (Mora) and M. gonggrijpii (Morabukea), which are described below. Another species of some importance in this general area is M. paraensis of the Amazon Delta and M. megistosperma (Nato) which occurs in the Pacific forests of Panama, Colombia, and Ecuador. Mora excelsa ranges from the Guianas to Trinidad and the Orinoco River Delta, while M. gonggrijpii is limited to Surinam and Guyana.

The wood of mora and morabukea Is almost identical in appearance, structure, weight, and strength properties. The sapwood is yellowish-gray, and may be up to 6 inches in thickness. The heartwood is sharply defined from the sapwood and varies from a yellow-brown through red brown to dark brown. Luster is medium. Texture is variable from medium to coarse. The grain is interlocked. showing a narrow to broad stripe on quartered surfaces and is also sometimes wavy or irregular. The wood may have a slightly sour odor and a bitter taste. The latter may become evident when the fine sawdust arising from machining comes in contact with the lips. The wood is very heavy, weighing about 64 pounds per cubic foot.

The wood dries very slowly with appreciable degrade. Shakes which are prevalent in the freshly sawn timber tend to extend during seasoning. Surface checking develops rapidly and degrade from cupping and twisting is likely to be serious. In kiln drying trials, considerable warp and some collapse is reported even when the wood is dried under a prolonged mild schedule.

The shrinkage is high and movement is also rather high, both species being rather unstable in use.

Mora is appreciably heavier and stronger than white oak and in this respect its properties are more nearly like those of greenheart.

The wood is moderately difficult to work and tends to spring in sawing. It finishes to smooth surfaces but pick up and chipped grain are likely ‘to occur with interlocked and irregular grain. Timbers containing boxed heart are likely to split rather badly, and for this reason such timbers should be sawn to exclude the pith region.

The heartwood is rated as durable with respect to decay and insect attack Morabukea is reported to be highly resistant to drywood termites and mora is rated as being more susceptible in this respect. Mora sapwood is readily impregnated with preservatives, but the heartwood is very resistant to impregnation. The timber is not resistant to marine borers.

The Mora species are utilized for heavy duty and durable construction.

NAUCLEA DIDERRICHII AF

Bilinga, opepe

Bilinga is a widely distributed species ranging from Sierra Leone through tropical West Africa, the Congo, and into East Africa. Most of the available literature is found under the synonymous name Sarcocephalus diderrichii.

The heartwood is a uniform and rather distinctive yellow or orange-brown. The pale colored sapwood is about 2 inches thick and distinctly defined. The texture is coarse. Luster medium Grain is usually interlocked and irregular, producing a variety of patterns on quartered surfaces.

Quartersawn lumber is reported to season fairly well with little checking and warping, but flatsawn lumber may suffer considerable degrade from checking, splitting, and distortion. The in-service movement of seasoned lumber is classified as small.

The heartwood is rated as very durable and moderately resistant to preservative treatment.

Bilinga is reported to work with moderate ease in most machining operations, but irregularity of grain is likely to cause difficulty in planing operations.

Bilinga is somewhat heavier on the average than white oak and its strength properties are proportionately higher.

Since the wood has appreciable strength and natural durability it would appear to be fitted for heavy duty construction as in dock work. The color of the wood and rather "wild" grain effect have mitigated against the acceptance of bilinga in the fancy veneer trade.

NOTHOFAGUS PROCERA AM

Rauli

Rauli is a south temperate zone member of the beech family (Fagaceae) occurring in Chile and adjacent Argentina between 36° and 40° south latitude. It is the most important of the several species of Nothofagus occurring in the region.

The heartwood is a uniform reddish-brown resembling the darker shades of sweetgum, but with a more distinctive reddish cast. The texture is very fine. The grain is straight. Luster is low. The wood weighs about 34 pounds per cubic foot.

The wood is reported to season rather slowly but with little degrade.

Under Chilean conditions the wood is reported to be durable.

The strength properties of rauli are generally similar to those of silver maple.

The wood works easily, takes stains and finishes readily, and presents no difficulties in gluing.

In Chile, the wood is used for every imaginable purpose. The demand locally is appreciable and it is unlikely that any large volume will be available for export.

OCHROMA PYRAMIDALE AM

Balsa

Balsa is widely distributed throughout tropical America from southern Mexico to southern Brazil and Bolivia.. Ecuador has been the principal source of lumber since the time the wood gained commercial importance. Most of the literature relative to balsa refers to the species as Ochroma lagopus, but apparently the correct and proper designation is Ochroma pyramidale.

The wood is a white to a very pale gray and may show a pinkish cast. The texture is coarse and the vessel lines generally show prominently, Grain is straight or very shallowly interlocked. The wood rays appear prominently on quartered surfaces because of their darker colored contents. Luster is high and the wood has a very unique "velvety" feel. The wood selected for use in the United States averages about 11 pounds per cubic foot. Balsa is the lightest and softest wood on the commercial market.

Because the imported lumber is rather carefully selected in Ecuador primarily on the basis of density, little difficulty is encountered in further drying upon arrival in the United States. Some lumber is known to contain "pockets" of high moisture content and these are likely to collapse in drying, but because most of the lumber is predried in Ecuador, such lumber is generally excluded in the grading process.

Because of its light weight, balsa can be easily worked, but sharp tools are required to prevent crumbling under the cutting edges.

Balsa, within the density ranges imported, is highly efficient where buoyancy, insulation against heat or cold, or absorption of sound and vibration are important considerations. It is one of the best energy absorbers known. It is practically impossible to "waterlog" balsa and this is particularly true in the lower range of densities. Only the

vessels. which are few in number per cross-sectional area, are capable of absorbing solutions.

The principal uses of balsa include all types of flotation gear, core stock in metal-faced sandwich construction, sound modifiers, aircraft models, and novelties. It is particularly important as an insulator in the transportation of liquified gases which are at extremely low temperatures. At these low temperatures the strength properties of the wood are higher than those obtained at normal room temperature.

OCOTEA RODIAEI AM

Greenheart

The range of greenheart is very limited and commercial quantities occur only in Guyana (British Guiana). This species has also been found in Surinam and adjacent areas of Brazil.

The heartwood is light to dark olive green and may be marked with streaks of black or brown. The sapwood is a pale yellowish-brown or greenish, about 1 or 2 inches wide, and merges gradually into the heartwood. Local distinctions between so-called varieties (known as black, brown, yellow, etc.) are based on variation in the superficial appearance of the wood from different trees or even different parts of the same tree. There is no reliable evidence that the useful properties of the timber are related to these color variations. The texture is moderately fine and uniform; grain is straight. The wood weighs about 64 pounds per cubic foot.

The wood seasons very slowly and with considerable degrade, particularly in the thicker sizes. Kiln drying from the green conditions cannot be regarded as economical for thick lumber, and in practice, lumber over 1 inch in thickness would have to be partially air dried. Distortion is not serious, but checking and splitting tend to be severe during seasoning. The British Laboratory reports that the shrinkage from the green condition to a moisture content of 12 percent is about 3.0 radially and 4.5 percent tangentially. The movement is rated as medium

Greenheart is fairly difficult to work with both hand and machine equipment because of its high density, It has an appreciable dulling effect on tool cutting edges, although it is not a silica-accumulating species. Where smooth surfaces are essential, it is important to keep planer knives in top condition, because even mild dullness is likely to produce a fibrous or slightly torn surface. The fine dust arising from machining the seasoned wood may produce allergic responses in certain individuals, which are manifested in the form of irritations of the mucous membranes.

The strength properties of greenheart are of an exceptionally high order even when its weight is taken into account. Its only deficiency is that it splits easily, but only in the radial direction and in this respect offers about the same resistance as oak.

The heartwood is rated as very durable and extremely resistant to preservative treatment.

Greenheart is used principally where strength and resistance to wear are required. Uses include ship and dock building, lockgates, wharves, piers, jetties, engine bearers, planking, flooring, bridges, and trestles.

OCOTEA RUBRA AM

Determa, wana, louro vermelho

Ocotea rubra is distributed throughout the Guianas and the lower Amazon region of Brazil. This species is closely related botanically to greenheart (Ocotea rodiaei) but differs in many respects. The wood is distinctive and this, in conjunction with range limitations, makes it possible to obtain the timber true to name.

The heartwood is a uniform reddish-brown separated from the sapwood, which is narrow and dull gray or pale yellowish-brown. Texture is coarse; grain is interlocked; luster is high on quartered surfaces. The wood weighs about 38 pounds per cubic foot. It is very similar in general appearance to red lauan and tangile of the Philippines.

The wood seasons at a moderate rate with some tendency to check and split. The lumber can be kiln dried using the same schedule as that for the red lauans. Thick stock is extremely difficult to dry even with prolonged kiln runs. Shrinkage is low, and the wood is very stable in use.

Ocotea rubra averages somewhat heavier than the Philippine lauans, but its strength properties on the basis of Yale tests would place it on a par with the species belonging to the "light red" group. Tests conducted in Holland on heavier wood than that tested at Yale gave values which were equal to those of tangile.

The wood is easy to work and working qualities

are said to be comparable with those of moderately dense mahogany, Ordinary conditions of machining produce generally good results. The wood can be glued satisfactorily,

Ocotea rubra is rated as durable to very durable with respect to fungus attack and is included among the species that exhibit considerable resistance to marine borer attack. The wood shows excellent weathering characteristics and is highly resistant to moisture absorption, surpassing teak in this respect. The abundance of tyloses in the vessels of the heartwood suggests that it may be extremely resistant to preservative treatment.

Ocotea rubra is one of the more common and most widely used timbers within its region of growth. It is readily available in considerable volume and large sizes, and this, coupled with its ease of working and inherent natural durability, provides a timber which is used for a multitude of purposes under both interior and exterior applications.

Ocotea rubra appears to be a species of considerable potential which has been overlooked by the United States market. It should find considerable application in both the solid and veneer form in the decorative wood field and particularly in the boat-manufacturing field.

OXYSTIGMA OXYPHYLLUM AF
Tchitola

Tchitola occurs in tropical Africa from Nigeria through the Cameroons and Gabon to the Congo and Cabinda. This species was formerly known as Pterygopodium oxlphyllum.

This species is closely related botanically to cativo (Prioria) of the American tropics ‘and the wood is similar in most respects. The wood of tchitola averages about 38 pounds per cubic foot and is thus somewhat heavier than cativo. Available shrinkage values for tchitola indicate that its total shrinkage is about twice that of cativo.

Tchitola is not likely to become a significant species on the United States lumber market.

PARASHOREA PLICATA AS
Bagtikan, white seraya

The genus Parashorea consists of about seven species occurring in Southeast Asia. The principal species in the United States lumber trade is P. plicata of the Philippines and Borneo. The other species of Parashorea produce appreciably heavier timbers and these are not considered in this description. In the United States, bagtikan may be encountered under its usual common name or more frequently with the species comprising the light-red group of lauans. The heartwood is gray to straw-colored or very pale brown and sometimes has a pinkish cast. It is not always clearly demarcated from the sapwood. The wood weighs about 34 pounds per cubic foot. The texture is similar to that of the light-red group of Philippine lauans. The grain is interlocked and shows a rather widely spaced stripe pattern on quartered surfaces.

Kiln drying is fairly rapid. Principal degrade encountered is twist in the thinner stock, which may be attributed to the wide interlocking of the grain and is most apparent in flatsawn lumber.

With respect to strength, Philippine bagtikan exceeds the lauans in all properties. Its natural durability is very low and it is resistant or extremely resistant to preservative treatment.

The wood works fairly easily with hand and machine tools and has little blunting effect on tool cutting edges. In machining tests conducted at the Forest Products Laboratory, bagtikan was rated as being intermediate, together with red lauan, in all or most of the tests conducted. In these tests, results for bagtikan were exceeded by apitong and tanguile, but were superior to those for mayapis, almon, and white lauan.

Bagtikan is used for many of the same purposes as the Philippine lauans, but in the solid form and in thin stock it is best utilized in the quartersawn condition to prevent excessive “working” with changes in moisture conditions of service. It is perhaps most useful as a veneer for plywood purposes. In Britain it is best known as a decking timber which has been specially selected for this use in vessels.

PARATECOMA PEROBA AM
Peroba de campos

Peroba de campos occurs in the coastal forests of eastern Brazil ranging from Bahia to Rio de Janeiro. It is the only species in the genus.

The heartwood is variable in color, but generally is in shades of brown with tendencies

toward casts of olive and reddish color. The sapwood is a yellowish-gray, clearly defined from the heartwood. The texture is relatively fine and approximates that of birch, The grain is commonly interlocked and may show a broken stripe or curly and wavy figure. Luster is high. The wood averages about 47 pounds per cubic foot.

The wood appears to season readily and with negligible splitting. Distortion is not generally serious, although it may become severe in thin stock with very irregular grain. The British Laboratory reports that the shrinkage from the green condition to a moisture content of 12 percent is 3.5 percent tangentially and 2.0 percent radially.

The wood machines easily, but when smooth surfaces are required particular care must be taken in planing to prevent excessive grain tearing of quartered surfaces because of the presence of interlocked or irregular grain. There is some evidence that the fine dust arising from machining operations may produce allergic responses in certain individuals.

Peroba de campos is heavier than teak or white oak and is proportionately stronger than either of these species.

The heartwood is rated as very durable with respect to fungus attack and is rated as resistant to preservative treatment.

In Brazil, the wood is used in the manufacture of fine furniture, flooring, and decorative paneling. The principal use in the United States is in shipbuilding, where it serves as an alternate for white oak for all purposes except bent members. The wood is classified as a poor "bender."

PELTOGYNE spp. AM

Purpleheart, amaranth

The genus Peltogyne is essentially limited to tropical South America and extends northward to Panama and Trinidad. The majority of the species are found in the Amazon Basin. The genus consists of about 27 species.

Purpleheart is unique among tropical American hardwoods because of its distinctive purplish or violet-colored heartwood. When freshly cut, the heartwood is brown, but with exposure it assumes the purplish hue which darkens with time. Because of the number of species that may be encountered, variation with respect to depth of coloration, texture, and density is to be expected. The sapwood is an off-white to gray-brown and may be rather wide. The texture is fine to medium. Luster is low. Grain is straight, but occasionally interlocked or irregular. The wood is very heavy, averaging about 52 pounds per cubic foot.

The wood is reported to season well and fairly rapidly with little degrade.

Purpleheart is moderately difficult to work because of its high density, but smooth surfaces are readily obtainable.

The heartwood is very durable, but very resistant to preservative treatment.

Because of the high average density of purpleheart, its strength properties are also very high and in general greatly exceed the requirements of the uses to which it is put. In side hardness, for example, purpleheart is about twice as hard as white oak.

In the United States, purpleheart is utilized in the form of sliced veneer for decorative inlay work and in solid form for specialty items of turnery.

PERICOPSIS ELATA AF

Afrormosia, kokrodua

Afrormosia is native to Ivory Coast, Ghana, Cameroon, and the Congo. The range of this species is rather extensive, but the principal production is limited to the boundary area of Ivory Coast and Ghana. This species was formerly known under the botanical designation Afrormosia elata.

The freshly cut heartwood is a yellowish-brown. turning darker upon exposure to a pale brown or medium brown and losing most of its yellowish cast. The sapwood is narrow, usually less than 1 inch in width, and slightly lighter in color than the heartwood The grain may be straight or slightly interlocked, the latter producing a narrow stripe pattern when the wood is quartersawn. Flatsawn lumber may show a distinctive pattern arising from concentric zones of darker colored wood. The texture is fine to medium and only slightly coarser than that of birch. The wood weighs about 43 pounds per cubic foot.

The wood is reported to season rather slowly, but very well, and with little degrade. The total shrinkage for kokrudua is small and the in-service movement is rated as small.

Kokrodua is readily workable with both hand

and machine tools. Attention must be paid to proper cutting angles when planing lumber with interlocked grain. The heartwood is classified as moderate in steam bending.

The heartwood is rated as resistant to very resistant with respect to decay organisms and it shows a substantially higher level of resistance than is generally found in the white oaks.

Kokrodua averages heavier than white oak and its strength properties are also higher, with the exception of shear where the two species are similar.

Principal uses of kokrodua in the United States are in boat construction, interior trim, and decorative veneer. Perhaps its most important utilization in the United States is in the boatbuilding industry where it serves as an alternate for teak.

PHOEBE POROSA AM
Imbuia

Imbuia is native to the "Parana pine" forest of southeastern Brazil in the States of Parana and Santa Catharina.

The heartwood varies through shades of brown from yellowish to chocolate. The sapwood is gray and usually distinct from the heartwood. The texture approximates that of birch and maple. Grain is straight to curly and wavy. Luster is high. The wood weighs about 36 pounds per cubic foot.

The wood is reported to be easy to dry. The ratio of tangential to radial shrinkage is fairly high and would suggest some difficulty with warp, but this has not been reported in the available literature.

The strength values for imbuia are very much like those for black cherry.

The wood is reported to be easy to work and finishes well, but care must be taken in planing lumber with irregular grain to ensure smooth surfaces. The fine sawdust produced in machining operations is reported to be very irritating to certain individuals.

Imbuia is used in Brazil for furniture, cabinet work, interior trim, paneling, flooring, and many other purposes. It has been utilized to a limited extent in the United States in the form of veneer for decorative paneling. Supplies of imbuia are apparently limited and the demand in the consuming centers of southeastern Brazil exceeds availability.

PINUS CARIBAEA AM
Caribbean pine

Caribbean pine occurs along the Caribbean side of Central America from British Honduras to northeastern Nicaragua. It is also native to the Bahamas and Cuba. It is primarily a tree of the lower elevations.

The heartwood is a golden brown to red brown and distinct from the sapwood which is 1 to 2 inches in thickness and a light yellow. The wood has a strong resinous odor and a greasy feel. The wood averages about 51 pounds per cubic foot.

The lumber can be kiln dried satisfactorily using the same schedule as that for ocote pine.

Caribbean pine is easy to work in all machining operations but the high resin content may necessitate occasional stoppages to permit removal of accumulated resin from the equipment.

Caribbean pine is an appreciably heavier wood than slash pine (Pinus elliottii), but the mechanical properties of these two species are rather similar.

Caribbean pine is used for the same purposes as the southern pines of the United States.

PINUS OOCARPA AM
Ocote pine

Ocote pine is a species of the higher elevations and occurs from northwestern Mexico southward through Guatemala into Nicaragua. The largest and most extensive stands occur in northern Nicaragua and Honduras.

The sapwood is a pale yellowish-brown and generally up to 3 inches in thickness. The heartwood is a light reddish-brown. Grain is straight. Luster is medium. The wood has a resinous odor, and weighs about 41 pounds per cubic foot.

Ocote pine is classed among the woods easy to season and is comparable in this respect with shortleaf pine (Pinus echinata). It air seasons at a fast to moderate rate with a minimum of seasoning defects.

The strength properties of ocote pine are comparable in most respects with those of longleaf pine (Pinus palustris).

Decay resistance studies show ocote pine heartwood to be very durable with respect to attack by a white rot fungus and moderately durable with

respect to brown rot.

Ocote pine is comparable to the southern pines in workability and machining characteristics.

Ocote pine is a general construction timber and is suited for the same uses as the southern pines.

POMETIA spp. AS
Kasai, malugai

Four species comprise the genus Pometia in Southeast Asia. Their range is from the Philippine Islands, through Indonesia, and Malaysia to Ceylon and includes many of the Pacific Islands. The most widespread and perhaps most important species are P. pinnata and P. tomentosa, The common name kasai is applied to the various species occurring in Malaysia and the name malugai is applied to the Philippine species.

The sapwood is 2 to 3 inches in thickness and more or less clearly differentiated from the light red-brown to dark red-brown heartwood. Grain is straight to widely interlocked and inclined to be wavy. Luster is low, and medium-sized to moderately large vessels appear as coarse scratches on longitudinal surfaces and constitute a characteristic feature of these surfaces. The appearance of the wood from quartered surfaces reminds one of the lauan species. The wood weighs about 40 pounds per cubic foot.

The wood is reported to season well, but flat-sawn lumber is likely to twist excessively, particularly if wide interlocking grain is present. No kiln schedules are reported for this species.

Strength tests reported for two species of Pometia indicate similarity to results for native United States oak species,

The heartwood is rated as moderately durable when exposed to the weather or in contact with the ground. Tie service tests conducted on kasai in Malaya have given excellent results. The ties were treated by a full-cell process arid average absorptions of 4.1 pounds per cubic foot were obtained using a mixture of 50 percent creosote and 50 percent diesel fuel. After 13 years, only 21 percent of the ties were rejected, The wood is described as fairly easy to work and in this respect should be quite similar to red lauan and bagtikan.

The woods of this genus are unknown in the United States trade, but if available in commercial quantity could be used for the same purposes as the red lauans from the Philippines. On infrequent occasions some of the lumber has entered the United States in mixture with red lauan.

PRIORIA COPAIFERA AM
Cativo

Cativo ranges from Nicaragua to Colombia and the timber stands of greatest volume occur in Panama and Colombia. This is one of few tropical American species that may be said to form “pure” stands. The genus consists of a single species.

The wood is generally quite uniform in color and varies from a gray to pinkish or distinctly reddish. The “heartwood” generally consists of a small core of black wood which is appreciably harder than normal wood and may possibly be of traumatic origin. This central core may be surrounded by a zone of irregularly pigmented black or brown lines, and sometimes only the pigmented lines are present. The grain is straight and the texture is uniform and comparable to that of mahogany. The luster is low, and the wood is without distinctive odor or taste. The wood averages about 28 pounds per cubic foot.

The normal or light-colored wood of cativo can be dried easily and rapidly with little or no degrade. Lumber containing pigmented zones requires careful seasoning to prevent collapse and honeycombing within these areas. It is essential that high temperatures be used in the final stages of kiln drying because the gum content of the lumber is materially reduced and what remains is not so prone to “bleed” onto the surfaces of the wood. Cativo has very good dimensional stability.

Cativo is classed as a nondurable wood with respect to both decay and insect attack. Logs are attacked quickly unless converted in a very short time or protected by preservatives.

Normal cativo lumber machines easily in all operations. Wood that is above average indensity is likely to contain appreciable quantities of tension wood, which makes ripping difficult because of the pinching effect on saws and the resulting burning of the teeth.

Cativo and yellow-poplar have about the same average weight, but yellow-poplar is stronger in practically all properties; cativo exceeds yellow-poplar only with respect to hardness.

In Colombia, cativo is used for general utility purposes in both the solid form and in plywood, In the United States, it is used for furniture and

cabinet parts (concealed), as plywood and lumber core, and other similar uses. The most important utilization in the United States is in the form of resin-stabilized veneer used in particular by the automotive industry as a pattern material because of its exceptional dimensional stability.

PTEROCARPUS ANGOLENSIS AF
Muninga

Muninga has a rather extensive range from Angola and the Congo, through much of East Africa and the northern parts of the Union of South Africa. It is a tree of the drier open woodlands.

The heartwood varies through shades of brown from light lo dark, frequently with a reddish or purplish cast; darker streaks are often present. Upon exposure the wood lends to assume a uniform golden brown color, but retains the streaks of darker color. The sapwood is very light colored and sharply demarcated from the heartwood. The texture is coarse and even. Grain is interlocked or irregular. The wood averages about 41 pounds per cubic foot in weight. Muninga is generally lighter in weight than the related species of the Orient.

The wood is reported to season readily but rather slowly, and there is little tendency toward splitting and distortion. The movement of seasoned wood is classified as small.

The wood works readily, although irregular grain may produce some difficulties in planing. The wood finishes well and can be readily glued.

The heartwood is rated as very durable and as resistant to preservative treatment.

Muninga is utilized lo a limited extent in the United States in the form of veneer for decorative purposes.

PTEROCARPUS INDICUS As
Narra

One of the classic furniture woods of the Orient. particularly the Philippines. The wood is highly regarded because it combines high decorative values, dimensional stability, and resistance lo decay and insects, with ease of seasoning, machining, and finishing.

Narra varies appreciably with respect to color and weight and these variations are presumed to be correlated with conditions of growth. Two forms are generally recognized: yellow narra which is golden-brown to brown, and red narra which is red-brown to distinctly red. Yellow narra apparently comes from trees of moderate lo rapid growth and is lower in density than red narra which is associated with slow growth and darker color. The fresh wood or newly exposed surfaces are distinctly aromatic.

The grain is interlocked and produces a stripe figure on quartered surfaces. Because the wood is ring-porous, a growth ring pattern is produced on flatsawn surfaces and the latewood portion may also show a fine feathering pattern produced by the bands of parenchyma tissue.

The trees are nowhere abundant. Because of its long established reputation, the wood is much in demand locally for high-grade furniture, decorative case goods, and novelly items. Veneer grade logs are used for both rotary and sliced veneer. Quartered veneer is generally available, but it is in the costly price range.

PTEROCARPUS SOYAUXII AF
African padauk

African padauk occurs in Nigeria, Cameroon, French Equatorial Africa, and the Congo.

The heartwood of this species is striking because of its deep red color. The sapwood is a grayish-white, up lo 8 inches thick, and very sharply defined. The texture is coarse and somewhat uneven; the pore lines generally are quite conspicuous. The grain may be straight, but more commonly it is interlocking, which produces a narrow stripe pattern on quartered surfaces. The wood averages about 44 pounds per cubic fool in weight.

The lumber is reported to machine remarkably well, and it finishes and glues easily. The wood has a low total shrinkage and apparently exhibits little movement in service.

In the United States it is utilized only as veneer for decorative purposes.

PYCNANTHUS ANGOLENSIS AF
Ilomba

Ilomba is a tree of the rain forest and ranges from French Guinea and Sierra Leone through west tropical Africa lo Uganda and Angola. This

species also referred lo in the literature under the synonymous name Pycnanthus kombo.

The wood is a grayish-while lo pinkish-brown and in some trees may be a uniform light brown. There is generally no distinction between heartwood and sapwood. The texture is moderately coarse and even. Luster is low. Grain is generally straight. The wood weighs about 32 pounds per cubic fool. This species is generally similar lo banak (Virola), but is somewhat coarser textured.

The wood is rated as perishable, but permeable lo preservative treatment. The general characteristics of ilomba would suggest similarity to banak in working properties, seasoning, finishing, and utilization.

This species has been utilized in the United States only in the form of plywood for general utility purposes.

QUERCUS spp. AM

Encino, roble, oak

The oaks are abundantly represented in Mexico and Central America with about 150 species, which are nearly equally divided between red and while oak groups. Mexico is represented with over 100 species and Guatemala with about 25; the numbers diminish southward to Colombia, which has two species. To the northern visitor the oaks of tropical America are hardly recognizable by their leaves, although they would certainly be recognized whenever acorns are available. The usual Spanish name applied is encino or roble and no distinction is made in the use of these names, nor are the different species given distinctive names.

The wood of the various species is in most cases heavier than the species of the United Slates and is diffuse-porous like the live oak of the South, rather than ring-porous like the commercial red and while oaks. The chemical test used for differentiating between the commercial red and while oaks serves equally well for the tropical species.

Strength data are available for only four species and the values obtained fall between those of white oak and the southern live oak or are equal to those of the latter. The average specific gravity for these species is 0.72 based on volume when green and weight ovendry, with an observed maximum average for one species from Guatemala of 0.86.

The tropical oaks are difficult lo machine, due mainly lo their high density. They can be finished smoothly on tangential surfaces, but have a tendency toward "tear-out" on quartered faces.

The wood is very difficult to season without degrade, and in air seasoning the lumber is very prone lo severe checking and collapse. Shrinkage is high and the ratio of radial to tangential shrinkage is also high.

Utilization of the tropical oaks is very limited al present due to difficulties encountered in the drying of the wood The major volume is used in the form of charcoal. It is reported that Quercus costaricensis and Q. eugeniaefolia from Costa Rica are being manufactured into staves which are exported to Spain where they are manufactured into wine barrels.

SHOREA spp. AS

Lauans, "Philippine mahogany"

The term "Philippine mahogany" is applied commercially in the United States to Philippine woods belonging to three genera--Shorea, Parashorea, and Pentacme. The group is further subdivided into types based on heartwood color as follows:

Dark red:

red lauan (Shorea negrosensis)	Dark reddish-brown to brick red
tanguile (Shorea polysperma)	Red to reddish-brown
Tianong (Shorea agsaboensis)	Light red to light reddish-brown

light red:

Almon (Shorea almon)	Light red to pinkish
Bagtikan (Parashorea plicata)	Grayish-brown
Mayapis (Shorea squamata)	Light red to reddish-brown
White lauan (Pentacme contorta & P. mindanensis)	Grayish to very light red

The species within each group may be shipped interchangeably when purchased in the form of lumber or veneer. Mayapis of the light red group is quite variable with respect to color and frequently shows exudation of resin. For this reason, some purchasers specify that mayapis be excluded from their shipments. Resin ducts are common to all of the Shorea woods and occur in tangential bands. Normally they are quite large and may be very conspicuous, particularly in the wood of the dark colored group where the white deposits of the canals are prominently defined These have been mistaken for zones of decay and other anomalies.

The lauans, as a whole, are coarser textured than mahogany (Swietenia) of the American tropics or the African khaya (Khaya). All species of lauan show varying degrees of interlocked grain.

The strength properties of the dark red group are generally on a par with those of American mahogany.

Studies conducted at the Forest Products Laboratory showed that the average decay resistance was greater for American mahogany than for either the African khaya or the Philippine lauans. Among the Philippine species, the woods classified as dark red were usually more resistant than those of the light red group.

In machining trials at the Forest Products Laboratory, the lauans as a whole appeared to be about equal to the better hardwoods found in the United States. Tanguile was consistently better than average in all or most of the tests conducted Mayapis, almon, and white lauan were consistently below average, with red lauan and bagtikan being rated as intermediate.

Kiln drying can be accomplished without particular difficulty. The shrinkage and swelling characteristics of the lauans are comparable to those found in the oak and maples of the United States.

Principal uses include interior trim, paneling, flush doors, plywood, cabinets, furniture, siding, and boat construction. The use of the woods of the dark red group for boat building in the United States exceeds in quantity that of any other imported species.

SIMAROUBA AMARA — AM

Aceituno, marupa

The genus Simarouba consists of about six species distributed from southern Florida, the West Indies, and southern Mexico through central America to Bolivia and Peru. The most important species is Simarouba amara, commonly known in Central America as aceituno and in Brazil as marupa.

The wood is yellowish-white or a uniform light yellow with no distinction between sapwood and heartwood. Texture is medium and uniform. Grain is usually straight: luster is high The wood is without odor, but has a mild to decidedly bitter taste. The wood weighs about 27 pounds per cubic foot.

The wood dries easily and rapidly with little degrade. Dimensional stability is very good. No kiln drying schedules are reported in the literature, but presumably the lumber could be dried using the same procedure as for mahogany.

Although Simarouba is classified as a hardwood, its average density and strength properties are on a par with those of ponderosa pine.

The heartwood is not durable in contact with the ground. being attacked readily by decay fungi and termites. The wood can be readily treated with preservatives.

Simarouba is easily worked with both hand and machine tools. The wood takes all types of finishes readily and is easy to glue.

Locally the wood is used primarily for interior applications of general utility. Its properties Suggest more extensive utilization in the form of core stock, patterns, and moldings. Simarouba has been used in the United States to a limited extent for piano keys because of its grain characteristics and good dimensional stability.

STERCULIA OBLONGA — AF

Okoko, yellow sterculia

Yellow sterculia ranges from Ivory Coast through West Africa into Cameroon and Gabon.

The heartwood ranges from a creamy yellow to a light yellowish-brown. The sapwood, which may be up to 8 inches thick, is not clearly differentiated from the heartwood. Texture is rather coarse. Grain is broadly interlocked The high wood rays produce an attractive and very lustrous pattern on true radial surfaces. The banded parenchyma produces a “partridge” pattern on flatsawn surfaces, but is not distinctive because of the lack of contrast. The wood weighs about 49 pounds per cubic foot.

The wood is reported to season slowly and with a marked tendency toward surface checking. End splitting may be troublesome and cupping may be a serious defect in thin flatsawn lumber. The in-service movement of seasoned wood is classified as medium.

Yellow sterculia averages heavier than white oak and its strength properties are proportionately higher.

The heartwood is rated as nondurable, but extremely resistant to preservative treatment.

The wood can be worked fairly readily provided sufficient attention is given in planing operations. The wood finishes well and can be glued satisfactorily,

This species has received some attention in the United States veneer trade because its light color permits ease of staining and finishing to meet current requirements. Some of the wood is sliced on the quarter to produce the unusual figure combination resulting from the effect of the wood rays and interlocked grain.

SWIETENIA MACROPHYLLA AM
Mahogany

Three species are recognized, hut Swietenia macrophylla provides the major volume of the timber on the commercial market. It occurs from southern Mexico, through Central America, Colombia, and Venezuela into the Amazon Basin to northern Bolivia and eastern Peru. Swietenia mahagoni occurs in the West Indies and southern Florida; S. humilis is native to the Pacific side of southern Mexico and extends southward to Costa Rica. The two latter species are generally heavier woods and, because of the limited volumes available, are utilized almost entirely within their areas of growth.

The freshly sawn heartwood is a yellowish-white to salmon pink, but after exposure to air and light it changes to a rich golden brown. Wood from Brazil, Bolivia, and Peru tends to be darker colored and slightly heavier than that originating in Central America, Luster is high. Texture is medium and uniform. Grain is usually straight, but certain trees may produce a wide variety of figure such as fiddleback, blister, stripe, swirl, and mottle. The wood is without odor or taste. It weighs about 32 pounds per cubic foot.

The lumber seasons easily and rapidly with minimal degrade. Shrinkage is low, and dimensional stability is excellent.

Mahogany is very easy to work and produces very good results in all operations. Because of its excellence, it is generally used as a standard for the rating of other tropical species. Tension wood zones, when present, are likely to produce fuzzy or torn grain surfaces in planing operations.

The strength properties of mahogany are generally similar to those of paper birch and black cherry.

In evaluations of decay resistance at the Forest Products Laboratory, mahogany showed a higher average level of decay resistance than the other species commonly called mahogany (non-Swietenia species). Most tests showed it to be in the resistant or very resistant class. The West Indian species and Peruvian wood was, in general, much better than the Central American wood in this respect.

Mahogany is used wherever an attractive and dimensionally stable wood is required. Some of the more important applications are for home and office furniture, architectural woodwork and paneling, radio and television cabinets, models and foundry patterns, boats and ships, sculpture, turning and carving, and numerous other uses.

TABEBUIA ROSEA AM
Apamate, mayflower

Apamate ranges from southern Mexico through Central America to Venezuela and Ecuador. The name roble is frequently applied to this species because of some fancied resemblance of the wood to that of oak (Quercus); roble is the Spanish name for oak. Much of the information relative to this species appears in the literature under the name Tabebuia pentaphylla.

The sapwood is a yellowish-white when freshly cut and becomes a pale brown upon exposure. The heartwood varies through the browns, from a golden to dark brown. The heartwood and sapwood are not always clearly differentiated Texture is medium, and luster is medium. Grain is closely and narrowly interlocked. The tangential alinement of the pores associated with parenchyma produces a rather distinctive “feather” pattern on flatsawn surfaces. Heartwood is without distinctive odor or taste. The wood weighs about 38 pounds per cubic foot.

Apamate may be air seasoned at a fast rate with little or no checking and only slight warping.

In its air seasoning properties it compares with yellow-poplar. Total shrinkage for apamate is intermediate between mahogany and black walnut and in-service movement anticipated would be equal to that of yellow-poplar.

Apamate has excellent working properties in all machine operations. It finishes attractively in natural color and takes finishes with good results.

The mechanical properties of apamate are higher than average for most species of comparable density. Apamate averages lighter in weight than the average of the American white oaks, but is comparable with respect to bending and compression parallel to grain. The white oaks are superior with respect to side hardness and shear.

The heartwood of apamate is generally rated as durable to very durable with respect to fungus attack; the darker colored and heavier wood is regarded as more resistant than the lighter forms.

Within its region of growth, apamate is used extensively for furniture, interior trim, doors, flooring, boat building, ax handles, and general construction. The wood veneers well and produces an attractive paneling.

TABEBUIA spp. (Lapacho series) AM
Lapacho, ipe

The lapacho group or series of the genus Tabebuia consists of about 20 species of trees and occurs in practically every Latin American country except Chile. The common name adopted there is lapacho, which is derived from the yellow-green compound lapachol which occurs in the heartwood vessels of this group. Lapachol is usually visible on planed surfaces confined to the vessel lines, or in some specimens may cover the entire surface during sawing. In the presence of alkaline solutions the Iapachol turns a bright red.

The sapwood is relatively thick, yellowish-gray or gray brown and sharply differentiated from the heartwood. which is a light to dark olive brown. The texture is fine. Grain is closely and narrowly interlocked Luster is medium. The wood is very heavy and averages about 64 pounds Per cubic foot. Thoroughly air-dry specimens of heartwood generally sink in water.

The wood is fairly easy to season and dries rapidly with minimal warping, and checking, despite its very high density, The total shrinkage is remarkably low for a wood of this density and the in-service movement is also rather low.

Lapacho is moderately difficult to machine because of its high density and hardness. Glassy smooth surfaces can be readily produced, The lapachol in the wood, when especially abundant, can be a nuisance in sawing or turning and may cause a mild form of dermatitis in some individuals.

Being a very heavy wood, lapacho is also very strong in all properties and in the air dry condition is comparable to greenheart.

Lapacho is highly resistant to decay and insects, including both subterranean and drywood termites. It is, however, susceptible to marine borer attack. The heartwood is impermeable, but the sapwood can be readily treated with preservatives.

Lapacho is used almost exclusively for heavy duty and durable construction. Because of its hardness (two to three times that of oak or apitong) and very good dimensional stability, it would be particularly well suited for heavy duty flooring in trucks and box cars.

TABBIETIA spp. AS
Lumbayau, menkulang

A genus of about four species in the Philippines, Indonesia, and Malay Peninsula. Two species that have some degree of commercial value within their respective range are Tarrietia javanica, the lumbayau of the Philippines, and T. simplicifolia, the menkulang of Malaya. The genus provides good quality timber but is generally not marketed under its own name, being included with other “red-colored” timbers of medium weight: with meranti in Malaya and red lauan in the Philippines. Small quantities have entered the United States in mixture with lauan.

The heartwood is of various shades of brown, red brown to quite red or dark red brown. The lighter colored sapwood may be 2 to 5 inches wide, and is not always clearly differentiated. Grain is straight to shallowly and widely interlocked. Texture is slightly coarse to moderately coarse and even. The wood is generally similar in appearance to the red lauan species, and weighs about 47 pounds per cubic foot.

The wood is reported to be easy to dry but requires careful stacking to prevent warping. The shrinkage values are on a par with those of the red lauans. No kiln drying schedule is re-

ported in the literature, although the United States schedule T6-D2 suggested for the red lauans should be applicable to these species.

Both menkulang and lumbayau are said to be easy to work and finish but, because of the presence of silica, they have a decided dulling effect on tool cutting edges. The silica content values reported are generally under 0.50 percent of the dry weight of the wood.

Vertical intercellular canals of the traumatic type are not uncommon in the wood. They are usually larger than the pores and are made conspicuous on all surfaces because of their dark-colored, gum-like deposits. These canals constitute a defect where appearance is of prime importance.

Although harder on tools than red meranti and red lauan, the timbers should find utilization for much the same purposes. The wood is easy to veneer and would find a ready outlet in the plywood trade.

TARRIETIA UTILIS AF

Niangon, whismore

Tarrietia utilis is native to the rain forests of West Africa, ranging from Sierra Leone to Cameroon and Gabon. It is not reported to occur in Nigeria.

The heartwood varies from a pale pinkish-brown to a red brown. The sapwood, which may be up to 3 inches wide, is not always clearly differentiated from the heartwood. Texture is moderately coarse. Luster is medium to low. Grain is interlocked, generally showing a widely spaced stripe pattern on quartered surfaces. The high wood rays are rather prominent on true radial faces. The heartwood has a characteristic waxy or oil feel, which is most pronounced in the darker colored wood. The wood averages about 39 pounds per cubic foot.

Niangon is reported to season fairly rapidly and well. The movement of seasoned lumber in service is classified as medium.

Niangon has a slightly lower average density than white oak and its strength properties are generally lower, except in compression parallel to grain and side hardness where they are similar.

The heartwood is rated as moderately durable and extremely resistant to preservative treatment.

The wood works fairly well in all machining operations, but interlocked or irregular grain may produce some degree of difficulty on quartered surfaces. Wood which is particularly waxy or oily is likely to give trouble in finishing and gluing.

Niangon is used in Europe as a general construction timber and has found some application in the ship-building industry.

TECTONA GRANDIS AS

Teak

Teak is native to India, Burma, Thailand, Indo-China, and Indonesia, particularly in Java, Plantations have been developed within its natural range as well as in many tropical areas of Latin America and Africa.

The heartwood varies from a yellow brown to a rich brown and frequently may show streaks of dark color. These pigmented zones eventually fade with age. The wood has a coarse texture, is usually straight-grained, and has a distinctly oily feel. The wood has a mild but somewhat unpleasant odor, which may be accentuated when wetted or heated.

Teak seasons well but rather slowly. It requires more than ordinary care in determining both the initial and final moisture contents, as variations in the drying rates of some boards are occasionally great. The wood is very liable to color change, but the color becomes uniform within a reasonable time after kiln drying. Total shrinkage is exceptionally small in teak

Although generally not used in the United States where strength is of prime importance, the values for-teak are generally on a par with those of our native oaks.

Teak is rated as very durable with respect to decay and insect attack and extremely resistant to preservative treatment.

Teak is somewhat variable but generally works with moderate ease with hand and machine tools. Its dulling effect on cutting edges is sometimes considerable, and in general may be considered as appreciable, For extensive machining runs, the use of special wear-resistant Steel is necessary to ensure economical operation. Silica content is variable and values up to 1.4 percent have been reported. The wood can be finished and glued satisfactorily, although some prefinishing treatments may have to be considered to ensure good bonding of finishes and glues.

Intrinsically, teak is one of the most valuable of all woods, but its use in the United States is limited by high cost. Teak is unique in that it does not cause rust or corrosion when in contact with metal; hence, it is extremely useful in the shipbuilding industry. It is currently used in the construction of expensive boats, furniture, decorative objects, and as veneer for decorative plywood.

TERMIINALIA IVORENSIS AF
Emeri, framire, idigbo

Emeri ranges from French Guinea through Ivory Coast, Ghana, southern Nigeria into Cameroon.

The wood is yellowish or light yellowish-brown and generally shows no clear distinction between the heartwood and sapwood. The texture is medium to fairly coarse. Luster is medium. Grain is straight to interlocked. The wood is unusually variable in weight, and this is attributed in part to the prevalence of light-weight timber from the center of the tree. The recorded range is 23 to 46 pounds per cubic foot, but for sound timber the range is usually 30 to 39 pounds with an average of about 34 pounds.

The lumber seasons rapidly and with only minimal degrade. The in-service movement of seasoned wood is classified as small.

The mechanical properties of normal emeri are very similar to those of mahogany. The heartwood is rated as durable and extremely resistant to preservative treatment.

The wood is easy to work with machine tools, finishes readily, and can be glued satisfactorily.

Emeri is utilized primarily for furniture, interior trim, and decorative paneling.

TERMINALIA SUPERBA AF
Limba, "Korina"

Limba is a widely distributed species ranging from Sierra Leone to the Congo and Angola.

The wood is ordinarily a uniform grayish-white or light yellowish-brown. The sapwood is ordinarily indistinct or not clearly differentiated from the heartwood, but may be up to 6 inches thick. Some logs contain an irregular dark heart with gray-brown or nearly black markings that produce an attractive appearance, As in emeri, the wood shows considerable variability in weight and compression failures are common in the wood of lower densities. The average weight may be taken as 34 pounds per cubic foot. The grain varies from straight to shallowly interlocked or irregular. The texture is moderately coarse and even.

The wood seasons rapidly and with only minimal degrade. Movement of seasoned wood is classified as small.

The mechanical properties of limba are similar to those of emeri. Low-density wood should be avoided where bending strength is important, because of the prevalence of compression failures in wood of this type.

The wood is rated as nondurable and as moderately resistant to preservative treatment.

Limba works readily with both hand and machine tools, finishes easily and can be glued very satisfactorily.

Limba is suitable for many types of interior use, and in the United States it is used primarily in the form of decorative plywood. Selected limba plywood is sold in the United States under the copyrighted name korina.

TETRABERLINIA TUBMANIANA AF
Gola

Gola is known presently only from Liberia. The names "African pine" and "Liberian pine" have been applied to this species, but because it is a hardwood and not a pine, these names are most inappropriate and very misleading. The name gola, which was proposed by the College of Forestry at Monrovia, Liberia, is adopted here.

The heartwood is light reddish-brown and is distinct from the lighter colored sapwood, which may be up to 2 inches thick. The wood is moderately coarse textured. Luster is medium. Grain is interlocked, showing a narrow stripe pattern on quartered surfaces. The wood weighs about 39 pounds per cubic foot.

Tests made at the Forest Products Laboratory indicate no potential difficulties in the machining of gola. It also peels and slices very well.

Gola is a very recent newcomer to the timber market and its potential has yet to be developed. Its workability and relatively light color should permit utilization in both the solid and veneer form for both utility and decorative purposes.

TIEGHEMELLA HECKELII AF
Makore

This monotypic genus is distributed in West Africa from Sierra Leone to Southern Nigeria. References to this species may also be found in the literature under the synonymous names Mimusops heckelii and Dumoria heckelii.

The heartwood color varies from a pinkish- or purplish-brown to dark blood-red. The rather drab appearing sapwood may be 2 to 3 inches thick. Texture is fine and uniform; luster is medium. Grain is usually straight, but individual trees may have interlocked or irregular grain which produces a broken stripe pattern on quartered surfaces. A silica content of 0.24 percent has been reported for this species. The wood weighs about 39 pounds per cubic foot.

The wood seasons at a moderate rate with little degrade. The movement of seasoned wood is classified as small.

The strength properties of makore are about intermediate between those of American mahogany and white oak.

Makore machines rather easily, although blunting of saw teeth is particularly noted in the sawing of seasoned lumber. The fine machining dust is reported to be irritating to some individuals.

The heartwood is rated as very durable and extremely resistant to preservative treatment.

Makore has been used in the United States to a limited extent, generally in the form of figured veneer. The wood may be too dark for decorative use in this country, at least at this time.

TRIPLOCHITON SCLEROXYLON AF
Obeche, wawa, samba

Obeche is distributed through the Ivory Coast, Ghana, Nigeria, and Cameroon. This species is unusual in that its occurrence is rather localized within the range but markedly gregarious.

The wood is nearly white to pale straw colored with no distinction between sapwood and heartwood. The texture is moderately coarse and even. The grain is typically interlocked. The wood weighs about 24 pounds per cubic foot.

The lumber seasons very rapidly and very well with only minimal degrade. The in-service movement of the seasoned wood is classified as small.

Obeche and American basswood have about the same specific gravity, but American basswood is somewhat stronger in bending and compression parallel to grain. In side hardness and shear the two species are similar.

The wood Is rated as nondurable and resistant to preservative treatment. Obeche works readily in all machining operations, but because of the low density of this wood, sharp knives are essential for the production of smooth surfaces. The wood finishes well and glues readily,

In the United States, obeche is used primarily as veneer core.

TURRAEANTHUS AFRICANUS AF
Avodire

Avodire has a rather extensive range from Sierra Leone eastward to Cameroon and southward to the Congo and Angola. The Ivory Coast is reported to be the principal source of export logs.

The wood is a cream-white color that darkens to a golden yellow. There is no distinction between heartwood and sapwood. Texture is uniform and similar to that of primavera. Grain may be straight, interlocked, wavy, or with other irregularities that produce a variety of highly attractive figures. Such figured material compares favorably with that of Chloroxylon (satinwood), although avodire is not so finely textured. Luster is satiny. The wood is without odor or taste. The average weight is about 34 pounds per cubic foot.

The wood seasons fairly rapidly, but has a tendency to undergo a certain amount of degrade from warping. The in-service movement of seasoned wood is classified as small.

The wood is rated as nondurable and extremely resistant to preservative treatment. Avodire is relatively easy to work with machine tools, although the usual difficulties maybe encountered in planing lumber with irregular grain. The wood finishes readily and is very easy to glue.

Avodire is somewhat heavier than American mahogany and its strength properties are slightly higher.

Avodire is a well-known decorative veneer and has been utilized for this purpose for many decades.

VIROLA spp. AM

Banak

The genus Virola consists of about 40 species distributed from British Honduras and Guatemala southward through Central America to Ecuador, northern South America, and the Amazon Basin to northern Bolivia and eastern Peru. The species contributing the greatest volume to the lumber trade are Virola koschnyi of Central America and V. sebifera and V. surinamensis of northern South America, principally in the Amazon Basin.

The wood is usually a pinkish-brown or grayish-brown and is not differentiated into distinct zones of heartwood and sapwood. Because of the abundance of starch throughout the cross section, it must be regarded as a "sapwood" species. The texture is medium to coarse and uniform; grain is straight, and luster is medium The wood weighs about 33 pounds per cubic foot.

Banak is reported to be difficult to kiln dry because it is prone to all seasoning defects. However, it is also stated that it can be kiln dried satisfactorily to a moisture content of 15 percent in 3 to 4 days. During the initial stages of drying from the green condition shrinkage is appreciable and a ratio of radial to tangential shrinkage of 3 to 1 may prevail. For in-service conditions the ratio is about 1 to 1.5, which is on a par with that of yellow-poplar,

Banak machines well in all operations, but fuzzing and grain tearing are to be expected when zones of tension wood are present. The wood finishes readily and is easily glued.. It is rated as a first class veneer species.

It is rated as nondurable, being readily attacked by stain, decay, and insects unless precautionary measures are strictly adhered to from the time of felling to completion of drying.

This species is also subject to bacterial attack which may result in the formation of odoriferous compounds which may persist even in the finished plywood. (See under Ceiba samauma).

Banak is in the density range of yellow-poplar and its strength properties are quite comparable.

Banak is well suited for the manufacture of plywood, veneer, particleboard, and lumber. Large volumes are being utilized in the United States for many purposes with the major volume of the lumber going into the molding industry.

VOCHYSIA spp. AM

San Juan, yemeri

The genus Vochysia consists of about 55 species in Latin America with the majority occurring in northern South America and the Amazon Basin. Four species are native to Central America and the best known and perhaps most important is Vochysia hondurensis. This discussion is limited to the Central American wood, but for the most part is applicable to the South American species of similar density.

The heartwood is grayish-white, up to 5 inches wide, and more or less differentiated from the heartwood, which varies from a light brown to a pale reddish-brown. The texture is moderately coarse and uniform. Luster is medium Grain is interlocked and shows a rather widely spaced stripe pattern in quartered surfaces. The wood weighs about 30 pounds per cubic foot.

The wood seasons fairly rapidly with little tendency to check or split, but with pronounced twisting or cupping when the lumber is flatsawn. The green lumber has a very high moisture content, generally in excess of 200 percent. Collapse may occur in the drying of thick stock and particularly in the zones of tension wood. The ratio of radial to tangential shrinkage in the initial stages of drying may be as high as 1 to 6, and as a consequence drying must proceed carefully and slowly. Quartersawing of the lumber or quarter slicing of the veneer would practically eliminate seasoning degrade and greatly improve the utilization potential. Radial shrinkage of yemeri is very low and the movement radially for in-service conditions would be about half of that encountered in our native species such as hard maple, white oak, and yellow-poplar.

Yemeri is in the density range of cottonwood and eastern white pine and is comparable in most strength properties. except in hardness where its values are appreciably higher.

The heartwood can be rated at most as only moderately durable with respect to fungi and is not resistant to insects and termites. Both sapwood and heartwood are permeable and could be readily treated with preservatives.

Machining tests made on San Juan lumber at the Forest Products Laboratory rated the wood rather low in most operations. The majority of

the test specimens were rejected for excessive surface roughness, which was attributed to tension wood streaks. The normal wood works very easily and with only minimal grain-tear on quartered surfaces. The wood finishes readily and poses no gluing problems.

Yemeri has been little utilized even locally because of its tendency to distort during seasoning. Effective utilization requires that the lumber be quartersawn or veneer sliced on the quarter to obviate seasoning distortion and also to utilize to the fullest extent the extremely low radial shrinkage. Expected in-service radial movement of the unfinished wood would be about 0.8 percent. It should be a very good wood for core stock and other uses.

VOUACAPOUA AMERICANA AM

Acapu

Vouacapoua is a small genus of four species of trees confined to the Guianas and northern Brazil. The most important and best known species is V. americana, which reaches its best development in the State of Para, Brazil.

The sapwood is cream colored and usually narrow. The heartwood is dark brown or reddish-brown and usually shows a distinctive pattern. the so-called “partridge” produced by the fine, pale brown parenchyma lines. Luster is medium Texture is medium. Grain is straight or occasionally interlocked. The wood is very heavy, weighing about 59 pounds per cubic foot.

The wood is rated as moderately difficult to air season and dries at a moderate rate with only slight distortion or checking. Seasoning degrade is said to be appreciably reduced by slower drying procedures. A kiln drying schedule is not available. Total shrinkage of acapu is low for a wood in its density class and the values are lower than those of white oak. Acapu is reported to be a stable wood in service.

The wood has high strength properties, in general much higher than required for its present utilization

The wood is moderately difficult to work because of its high density. Acapu saws readily with no appreciable dulling effect and smooth surfaces are obtained in planing.

The heartwood has an excellent reputation for durability, being rated as highly resistant to decay and insect attack, including termites.

Acapu has been used for all types of heavy duty and durable construction, but because of its relative scarcity and high value it is utilized primarily for parquet flooring, interior trim, paneling, furniture, and cabinet work.

Table I. British and Suggested U.S. Kiln Schedules for Imported Woods

Botanical name	British 4/4-6/4	United States 4/4-6/4	8/4
Albizia lebbek	E	T6-D2	T3-DI
Albizia ferruginea	F	T6-D4	T3-D3
Alstonia congensis	H	TI0-D4S	T8-D3S
Anacardium excelsum	E	T6-D2	T3-DI
Anisoptera spp.	E	T6-D2	T3-DI
Antiaris spp.	A	T2-D4	T2-D3
Araucaria angustifolia	D	T3-D2	T3-DI
Aspidosperma spp.	E	T6-D2	T3-DI
Aucoumea klaineana	E	T6-D2	T3-DI
Berlinia spp.	E	T6-D2	T3-DI
Brachystegia spp.	E	T6-D2	T3-DI
Calophyllum brasiliense	A	T2-D4	T2-D3
Calycophyllum spp.	B	T2-C2	T2-CI
Canarium schweinfurthii	H	TI0-D4S	T8-D3S
Carapa guianensis	C	T3-C2	T3-CI
Cariniana spp.	D	T3-D2	T3-DI
Cadrela spp.	H	TI0-D4S	T8-D3S
Ceiba pentandra	J	TI0-D5S	T8-D4S
Chlorophora excelsa	E	T6-D2	T3-DI
Chloroxylon swietenia	C	T3-C2	T3-CI
Cordia spp.	E	T6-D2	T3-DI
Cybistax donnell-smithii		T6-F3 (modified)	
Dalbergia latifolia	E	T6-D2	T3-DI
Dalbergia melanoxylon	B	T2-C2	T2-CI
Dalbergia nigra	C	T3-C2	T3-CI
Dalbergia retusa	B	T2-C2	T2-CI
Dialyanthera spp.		T5-C3	
Diospyros spp. (Asia)	C	T3-C2	T3-CI
Diospyros spp. (African)	E	T6-D2	T3-DI
Dipterocarpus spp. (apitong)	D	T3-D2	T3-DI
Distemonanthus benthamianus	F	T6-D4	T3-D3
Dryobalanops lanceolata	H	TI0-D4S	T8-D3S
Dyera costulata	H	TI0-D4S	T8-D3S
Endiandra palmerstonii	E	T6-D2	T3-DI
Entandrophragma spp.	A	T2-D4	T2-D3
Enterolobium cyclocarpum	F	T6-D4	
Eucalyptus spp.	C	T3-C2	T3-CI
Gonystylus bancanus	See text		
Guarea spp.	E	T6-D2	T3-DI

Table I. British and Suggested U.S. Kiln Schedules for Imported Woods (Continued)

Botanical name	British 4/4-6/4	United States 4/4-6/4	8/4
Hura crepitans	E	T6-D2	T3-DI
Hymenaea courbaril	C	T3-C2	T3-Cl
Intsia bijuga	C	T3-C2	T3-CI
Khaya ivorensis	F	T6-D4	T3-D3
Koompassia malaccensis	E	T6-D2	T3-DI
Lophira alata	B	T2-C2	T2-Cl
Lovoa trichilloides	E	T6-D2	T3-DI
Mansonia altissima	H	TI0-D4S	T8-D3S
Mitragyna ciliata	K	TI3-C4S	TII-C3S
Mora spp.	B	T2-C2	T2-Cl
Nauclea diderrichii	E	T6-D2	T3-DI
Nothofagus procera	E	T6-D2	T3-DI
Ochroma pyramidale	H	TI0-D4S	T8-D3S
Ocotea rodiaei	B	T2-C2	T2-Cl
Ocotea rubra	E	T6-D2	T3-DI
Parashorea plicata	E	T6-D2	T3-DI
Paratecoma peroba	D	T3-D2	T3-DI
Peltogyne spp.	E	T6-D2	T3-DI
Pentacme contorta	E	T6-D2	T3-DI
Pericopsis elata	J	TI0-D5S	T8-D4S
Phoebe porosa	E	T6-D2	T3-DI
Pinus caribaea	H	TI0-D4S	T8-D3S
Pinus oocarpa	H	TI0-D4S	T8-D3S
Prioria copaifera	C	T3-C2	T3-Cl
Pterocarpus angolensis	J	TI0-D5S	T8-D4S
Pterocarpus soyauxii	J	TI0-D5S	T8-D4S
Pycnanthus angolensis	C	T3-C2	T3-CI
Quercus spp.	B	T2-C2	T2-Cl
Shorea spp. (lauan)	E	T6-D2	T3-DI
Swietenia macrophylla	F	T6-D4	T3-D3
Tabebuia rosea	E	T6-D2	T3-DI
Tabebuia spp. (lapacho)	E	T6-D2	T3-DI
Tarrietia utilis	E	T6-D2	T3-DI
Tarrietia (mengkulang)	D	T3-D2	T3-DI
Tectona grandis	H	TI0-D4S	T8-D3S
Terminalia ivorensis	J	TI0-D5S	T8-D4S
Terminalia superba	J	TI0-D5S	T8-D4S
Tieghemella heckelii	H	TI0-D4S	T8-D3S
Triplochiton scleroxylon	L	TI4-C6S	TI2-C5S
Turraeanthus africanus	E	T6-D2	T3-DI
Virola spp.	C	T3-C2	T3-CI
Vochysia spp.	A	T2-D4	T2-D3

Table 2. Total Shrinkage in Percent

	Number Trees	Radial	Tangential
Albizia falcataria	5	3.2	6.2
Albizia lebbek	5	2.9	5.8
Albizia adianthifolia		2.3	6.5
Albizia ferruginea	2	2.6	5.4
Alstonia congensis	2	3.4	5.1
Anacardium excelsum	8	2.8	5.2
Anisoptera spp.	17	3.7	8.8
Antiaris africana	2	4.4	7.2
Araucaria angustifolia	11	4.0	7.9
Aspidosperma spp.	6	3.5	7.4
Astronium graveolens Astronium fraxinifolium	7	4.1	8.2
Berlinia grandiflora		5.7	7.8
Brosimum (alicastrum) spp.	4	4.8	7.1
Brosimum (utile) spp.	3	3.9	7.8
Bursera simaruba	10	2.5	4.0
Calophyllum brasiliense	11	5.4	7.9
Calycophyllum candidissimum	2	4.8	8.6
Calycophyllum spruceanum	4	4.7	8.5
Carapa guianensis	4	4.0	7.8
Carapa nicaraguensis	4	5.1	8.1
Carapa surinamensis	2	4.7	8.3
Cariniana brasiliensis	3	2.9	5.4
Cedrela spp.	23	4.1	6.3
Ceiba pentandra	10	2.4	6.6
Ceiba samauma	3	3.7	6.6
Chlorophora excelsa	6	3.3	4.1
Chloroxylon swietenia	10	5.5	7.1
Cordia alliodora	21	3.5	7.1
Cordia goeldiana	3	4.2	7.2
Cordia trichotoma		4.9	6.6
Cybistax donnell-smithii	8	3.1	5.2
Dalbergia latifolia	10	2.5	5.7
Dalbergia nigra	1	3.4	7.7
Dalbergia retusa	1	2.7	4.3
Dialyanthera spp.	1	5.3	9.6
Dicorynia guianensis	4	5.2	8.8
Diospyros (Asia)	5	5.0	8.5
Dipterocarpus spp.	93	5.2	10.9
Distemonanthus benthamianus	1	3.1	5.2
Dracontomelon dao	2	4.1	8.7
Dryobalanops spp.	2	4.6	10.2

Table 2. Total Shrinkage in Percent (Continued)

	Number Trees	Radial	Tangential
Endiandra palmerstonii	1	4.5	8.6
Entandrophragma angolense	3	7.2	9.0
Entandrophragma cylindricum	2	5.7	8.5
Enterolobium cyclocarpum	2	2.4	4.7
Eucalyptus diversicolor	6	7.8	12.4
Eucalyptus marginata	6	6.9	9.4
Euxylophora paraensis	3	6.0	6.7
Fitzroya cupressoides	1	3.8	5.8
Gonystylus macrophyllus	4	3.9	8.7
Guarea cedrata	1	3.5	6.0
Guarea thompsonii	3	4.6	6.8
Guibourtia ehie	1	3.4	8.0
Guibourtia tessmannii	1	4.9	5.9
Hura crepitans	9	2.8	4.6
Hymenaea courbaril	19	4.3	8.1
Intsia	9	2.6	4.5
Juglans neotropica	1	2.8	5.5
Khaya spp.	10	4.1	5.8
Koompassia excelsa	1	6.3	8.0
Lophira alata	6	6.3	9.3
Lovoa trichilioides	2	4.4	7.2
Mansonia altissima	1	4.6	6.4
Mitragyna ciliata	1	4.2	8.8
Mora excelsa	4	6.4	9.6
Mora gonggrijpii	3	7.1	10.1
Mora megistosperma	1	3.7	7.3
Nauclea diderrichii	2	5.3	8.4
Nothofagus procera	1	3.5	7.0
Ochroma pyramidale	5	3.0	7.6
Ocotea rodiaei	2	8.2	9.0
Ocotea rubra	4	3.5	8.0
Oxystigma oxyphyllum	2	5.1	10.7
Parashorea plicata	14	4.2	7.8
Paratecoma peroba	3	3.8	6.6
Peltogyne spp.	8	4.0	6.7
Pentacme contorta	19	3.9	7.6
Pericopsia elata	2	3.2	6.3
Phoebe porosa	4	3.3	8.2
Pinus caribaea	3	6.3	7.8

Table 2. Total Shrinkage in Percent (Continued)

	Number Trees	Radial	Tangentia l
Pinus oocarpa	3	4.6	7.5
Pometia pinnata	3	5.I	8.9
Prioria copaifera	4	2.3	5.3
Pterocarpus indicus	6	2.5	4.3
Pterocarpus soyauxii	2	3.6	5.3
Pycnanthus angolensis	3	3.9	7.8
Quercus aaata	3	6.6	I7.7
Quercus copeyonsis	5	9.I	I7.0
Quercus costaricensis	2	5.0	I4.6
Quercus eugeniaefolia	I	6.8	I9.9
Quercus oleoides	I	5.8	II.7
Shorea almon	I4	3.2	7.6
Shorea negrosensis	20	3.8	7.6
Shorea polysperma	I4	4.5	8.5
Shorea squamata	I0	3.5	8.2
Simarouba amara	8	2.4	5.4
Swietenia macrophylla	46	3.7	5.I
Tabebuia rosea	I0	3.5	6.0
Tabebuia (lapacho,	I6	5.7	7.8
Tarrietia utilis	I	2.9	5.9
Tarrietia javanica	I	4.2	9.5
Tectona grandis	59	2.2	4.0
Terminalia ivorensis	I	3.I	4.9
Terminalia superba	I0	4.4	5.4
Tetraberlinia tubmaniana	II	5.6	I0.2
Tieghemella heckelii	I	5.3	7.8
Triplochiton scleroxylon	5	3.I	5.3
Turraeanthus africanus	4	3.7	6.5
Virola spp.	I4	4.6	8.8
Vochysia spp.	I5	3.4	9.2
Vouacapoua americana	3	4.9	6.9

Table 3. Strength properties of certain imported tropical woods and selected species of the U.S. (Results based on small, clear specimens in the green condition.)

Botanical name	Origin*	No. trees	Moisture content percent	Sp. gr.[1]	Static bending			Compression parallel to grain	Hardness side	Shear parallel to grain
					Modulus of rupture psi	Modulus of elasticity 1,000 psi	Work to maximum load In.-Lb./cu. in.	Maximum crushing strength psi	lbs.	Maximum shearing strength psi
Acer rubrum	US	14	63	0.49	7,700	1,390	11.4	3,280	700	1,150
Acer saccharum	US	17	58	.56	9,400	1,550	13.3	4,020	970	1,460
Albizia falcataria	AS	5	GR	.28	4,490	900	--	2,480	350	630
Albizia falcataria	HA	5	GR	.32	5,300	1,080	5.5	2,610	360	800
Albizia lebbek	AS	5	GR	.55	9,560	1,590	8.3	5,100	1,020	1,400
Alnus rubra	US	6	98	.37	6,500	1,170	8.0	2,960	440	770
Alstonia boonei	AF	1	123	.36	4,940	995	4.2	2,803	370	678
Anacardium excelsum	CS	6	111	.41	5,320	1,060	4.1	2,460	400	740
Anisoptera spp. (palosapis)	AS	18	GR	.51	7,550	1,430	--	3,780	810	1,000
Araucaria angustifolia	BR	11	GR	.48	8,200	--	--	3,700	600	970
Aspidosperme peroba	BR	6	GR	.69	12,100	--	--	5,800	1,520	1,720
Aspidosperme (peroba rosa)	BR	1	35	.67	10,930	1,290	10.5	5,540	1,580	1,870
Astronium graveolens	CS	4	45	.86	12,400	1,900	7.4	6,880	1,990	1,840
Berlinia grandiflora	AF	5	75	.61	9,975	1,412	10.9	4,733	1,000	1,206
Betula alleghaniesis	US	17	67	.55	8,300	1,500	16.1	3,380	780	1,110
Brachystegia nigerica	AF	5	69	.60	10,830	1,370	11.2	5,491	1,220	1,514
Brosimum alicastrum	GU	1	49	.72	16,750	1,990	--	--	2,090	--
Bursera simaruba	US	5	99	.30	3,300	560	3.5	1,510	230	590
Bursera simaruba	GU	1	97	.38	5,150	940	--	--	330	--
Calophyllum brasiliense rekoi	CA	18	62	.54	10,470	1,570	10.6	5,160	1,010	1,290
Calycophyllum candidissimum	VE	2	GR	.67	14,290	1,930	18.6	6,200	1,630	1,660
Canarium schweinfurthii	AF	4	94	.45	5,605	963	5.1	3,005	520	818
Carapa guianensis	BR	2	72	.56	11,110	1,560	11.4	4,930	1,060	1,320
Carapa surinamensis	SU	2	58	.53	9,480	1,820	8.2	4,640	710	1,120
Cariniana brasiliensis	BR	3	GR	.46	9,700	--	--	4,500	860	1,270
Carya illinoensis	US	5	63	.60	9,800	1,370	14.6	3,990	1,310	1,480
Cedrela angustifolia	BR	2	84	.38	6,730	1,170	7.4	3,100	450	790
Cedrela oaxacensis	PA	3	67	.41	7,510	1,310	7.1	3,370	550	990
Cedrela odorata	NI	1	73	.34	5,220	870	7.4	2,760	350	720
Cedrela odorata	GU	1	75	.43	9,500	1,480	--	--	620	--
Ceiba pentandra	VE	3	GR	.25	2,180	410	1.2	1,060	220	350
Chlorophora excelsa	AP	2	92	.59	10,165	1,284	10.5	4,915	1,080	1,311
Chloroxylon swietenia	AS	5	GR	.77	12,920	1,660	11.1	6,230	1,830	1,780
Chloroxylon swietenia	AS	5	GR	.83	12,310	1,640	9.5	6,810	1,850	1,770

*Key to code letters: AF, Africa; AS, Southeast Asia; AU, Australia; BR, Brazil; CA, Central America; CH, Chile; CR, Costa Rica; CS, Central & South America; EC, Ecuador; GU, Guatemala; GY, Guyana (British Guiana); HA, Hawaii; HO, Honduras; IN, India; NI, Nicaragua; PA, Panama; PE, Peru; PH, Philippine Islands; SM, South America; SU, Surinam; US, United States; and VE, Venezuela.

Table 3. Strength properties of certain imported tropical woods and selected species of the U.S. (Results based on small, clear specimens in the green condition.)

Botanical name	Origin	No. trees	Moisture content percent	Sp. gr.[1]	Static bending. Modulus of rupture psi	Static bending. Modulus of elasticity 1,000 psi	Static bending. Work to maximum load In.-Lb./cu. in.	Compression parallel to grain. Maximum crushing strength psi	Hardness side lbs.	Shear parallel to grain. Maximum shearing strength psi
Cordia alliodora	CA	13	106	.44	8,840	1,260	9.5	4,000	790	1,130
Cordia goeldiana	BR	2	53	.52	10,540	1,830	11.2	4,940	1,030	1,080
Cordia trichotoma	BR	1	38	.50	9,600	1,420	12.7	4,110	880	1,050
Cornus florida	US	5	62	.64	8,800	1,180	21.0	3,640	1,410	1,520
Cybistax donnell-smithii	HO	4	59	.39	7,710	980	6.9	3,630	660	1,050
Dalbergia latifolia	AS	5	GR	.75	9,190	1,190	11.6	4,530	1,270	1,400
Dalbergia sissoo	AS	5	GR	.65	11,170	1,200	14.1	5,440	1,520	1,630
Dalbergia sissoo	AS	5	GR	.69	10,220	1,260	11.9	5,000	1,380	1,410
Dalbergia sp.	BR	1	GR	.80	14,140	1,840	13.2	5,510	2,440	2,360
Dicorynia guianensis	SU	2	79	.60	11,410	1,840	12.0	5,590	1,100	1,340
Diospyros philippensis	AS	3	GR	.80	10,690	1,640	--	--	1,740	1,450
Diospyros pilosanthera	AS	1	GR	.81	10,610	2,010	--	4,620	1,490	--
Diospyros virginiana	US	5	58	.64	10,000	1,370	13.0	4,170	1,280	1,470
Dipterocarpus spp. (apitong)	AS	57	GR	.59	9,220	1,790	--	4,410	800	1,040
Dracontomelon dao	AS	2	GR	.54	6,730	1,350	--	4,610	860	1,170
Dracontomelon mangiferum	AS	7	GR	.46	8,540	1,400	--	4,300	750	1,140
Dryobalanopa lanceolata	AS	5	64	.64	12,160	1,701	12.8	5,971	980	1,038
Entandrophragma angolense	AF	3	74	.50	7,125	1,070	7.4	3,533	770	942
Entandrophragma cylindricum	AF	5	62	.60	10,165	1,487	10.5	5,011	1,020	1,250
Entandrophragma utile	AF	1+	50	.57	10,830	1,487	10.3	5,318	1,080	1,382
Enterolobium cyclocarpum	GU	1	226	.31	5,030	610	--	--	350	--
Eucalyptus diversicolor (karri)	AU	26	GR	.70	10,600	2,070	--	5,250	1,360	1,335
Eucalyptus marginata (jarrah)	AU	28	GR	.67	9,880	1,480	--	5,190	1,285	1,325
Euxylophora paraensis	BR	3	59	.70	13,200	2,040	10.6	6,440	1,610	1,520
Praxinus americana	US	23	42	.55	9,600	1,460	16.6	3,990	960	1,380
Gonystylus bancanus	AS	9	37	.59	9,785	1,573	9.0	5,395	640	994
Gossweilerodendron balsamiferum	AF	31	56	.45	7,125	931	8.6	3,379	620	977
Guarea cedrata	AF	2	99	.48	10,260	1,380	12.1	4,934	870	1,382
Guarea thompsonii	AF	4	52	.56	11,780	1,648	12.8	6,010	950	1,346
Hura crepitans	CS	7	65	.38	6,130	1,010	6.8	2,650	430	810
Hymenaea courbaril	CS	9	59	.72	12,950	1,820	15.7	5,800	2,030	1,770
Intsia bijuga	AS	14	GR	.70	15,000	2,150	--	8,040	1,700	1,830
Intsia palembanica	AS	5	GR	.68	12,850	2,020	12.8	6,770	1,390	1,560
Juglans regia	AS	10	GR	.47	8,710	1,310	10.4	4,010	670	1,060

Table 3. Strength properties of certain imported tropical woods and selected species of the U.S. (Results based on small, clear specimens in the green condition.)

Botanical name	Origin	No. trees	Moisture content percent	sp. gr.[1]	Static bending: Modulus of rupture psi	Static bending: Modulus of elasticity 1,000 psi	Static bending: Work to maximum load In.-Lb./cu. in.	Compression parallel to grain: Maximum crushing strength psi	Hardness side lbs.	Shear parallel to grain: Maximum shearing strength psi
Khaya anthotheca	AF	4	61	.46	7,315	1,156	8.5	3,533	730	1,056
Khaya anthotheca	AF	5	54	.47	8,265	1,198	9.8	3,955	730	1,118
Khaya ivorensis	AF	11	64	.43	7,400	1,160	8.3	3,500	640	930
Khaya grandifoliola	AF	5	54	.57	9,500	1,412	9.7	4,992	1,170	1,540
Koompassia malaccensis	AS	5	GR	.72	14,530	2,410	--	7,930	1,480	--
Lovoa trichilioides	AF	2	61	.48	7,790	1,134	--	4,147	690	--
Mansonia altissima	AF	1	44	.57	12,350	1,498	16.4	6,144	1,210	1,602
Mitragyna sp.	AF	1	101	.48	7,505	1,263	6.9	3,802	700	--
Nauclea diderrichii	AF	4	75	.67	13,015	1,840	10.0	7,190	1,520	1,672
Ocotea rodiaei	GY	5	42	.83	19,400	2,980	13.0	10,360	2,190	1,480
Ocotea rubra	SM	5	89	.51	7,620	1,420	4.8	3,630	500	840
Parashorea plicata	AS	5	70	.43	7,790	1,198	6.8	4,118	580	810
Parashorea plicata	AS	5	66	.46	8,360	1,412	7.0	4,435	660	906
Parashorea plicata	AS	22	GR	.49	9,100	1,550	--	4,400	730	1,050
Paratecoma peroba	BR	3	GR	.63	13,400	--	--	6,300	1,430	1,690
Peltogyne confertiflora	BR	1	GR	.77	20,000	--	--	8,900	2,180	2,160
Peltogyne densiflora	BR	1	64	.75	16,200	2,610	17.0	9,020	2,090	1,640
Peltogyne pubescens	GY	1	42	.92	21,100	4,260	16.4	10,970	3,290	1,830
Peltogyne venosa	SU	3	71	.67	13,690	2,000	14.8	7,020	1,810	1,640
Pentacme contorta	AS	19	GR	.43	7,500	1,380	--	3,700	580	910
Pericopsis elata	AF	6	62	.66	14,820	1,766	19.5	7,488	1,600	1,672
Phoebe porosa	BR	3	113	.52	7,700	1,080	8.9	3,380	880	1,170
Pinus caribaea	CA	19	37	.68	9,980	1,690	12.0	4,780	820	1,200
Pinus elliottii	US	30	GR	.56	8,900	1,580	9.5	4,340	630	1,000
Pinus monticola	US	5	54	.36	5,200	1,170	5.0	2,650	310	640
Pinus oocarpa	HO	3	41	.55	7,970	1,740	6.9	3,690	580	1,040
Pinus palustris	US	44	63	.54	8,700	1,600	8.9	4,300	590	1,040
Pometia pinnata	AS	5	GR	.57	9,650	1,620	--	4,560	930	1,170
Pometia tomentosa	AS	7	GR	.56	9,020	1,700	--	4,160	840	1,170
Populus deltoides	US	5	111	.37	5,300	1,010	7.3	2,280	340	680
Prioria copaifera	PA	4	102	.40	5,930	950	5.4	2,590	450	860
Pterocarpus angolensis	AF	3	64	.59	11,685	1,177	12.4	5,654	1,300	1,593
Pterocarpus indicus	AS	15	GR	.53	10,700	1,470	--	5,570	950	1,220
Quercus alba	US	20	68	.60	8,300	1,250	11.6	3,560	1,060	1,250
Quercus oleoides	GU	1	38	.91	11,490	1,800	--	--	2,010	--
Quercus virginiana	US	5	50	.81	11,900	1,580	12.3	5,430	1,880	2,210

Table 3. Strength properties of certain imported tropical woods and selected species of the U.S. (Results based on small, clear specimens in the green condition.)

Botanical name	Origin	No. trees	Moisture content percent	sp. gr.[1]	Static bending: Modulus of rupture psi	Static bending: Modulus of elasticity 1,000 psi	Static bending: Work to maximum load In.-Lb./cu. in.	Compression parallel to grain: Maximum crushing strength psi	Hardness side lbs.	Shear parallel to grain: Maximum shearing strength psi
Samanea saman	VE	3	GR	.48	8,100	910	10.4	3,760	750	1,100
Samanea saman	AS	6	GR	.49	6,600	660	--	3,270	990	1,240
Shorea almon	AS	12	GR	.41	7,500	1,440	--	3,750	500	840
Shorea dasyphylla	AS	2	56	.43	8,645	1,498	8.8	4,454	560	--
Shorea leptocladus	AS	5	73	.39	6,935	1,081	6.3	3,763	450	748
Shorea negrosensis	AS	15	GR	.44	7,700	1,380	--	3,700	570	930
Shorea parvifolia	AS	5	84	.39	6,650	1,038	6.2	3,322	440	713
Shorea pauciflora	AS	5	69	.50	9,405	1,498	0.5	4,723	700	1,109
Shorea philippinensis	AS	6	GR	.41	6,900	1,200	--	3,360	530	920
Shorea polita	AS	4	GR	.47	7,980	1,330	--	4,010	710	1,000
Shorea polysperma	AS	19	GR	.46	8,100	1,540	--	3,940	620	940
Shorea smithiana	AS	5	64	.40	6,840	1,124	5.9	3,523	440	607
Shorea squamata	AS	14	GR	.41	7,300	1,400	--	3,470	480	770
Shorea waltonii	AS	4	70	.36	7,125	1,252	6.8	3,677	460	968
Simarouba amara	SU	2	69	.38	6,310	1,140	4.5	2,970	390	790
Simarouba glauca	US	4	81	.33	3,500	700	1.8	1,810	240	710
Spondias mombin	GU	1	85	.39	6,180	1,510	--	--	460	--
Spondias mombin	VE	3	131	.40	6,400	1,160	3.8	2,560	530	770
Sterculia oblonga	AF	5	60	.69	11,115	1,605	12.1	5,386	880	924
Swietenia macrophylla	CS	77	67	.45	9,280	1,280	9.6	4,510	700	1,310
Tabebuia heterotricha	PA	3	41	.80	20,080	2,120	27.3	7,680	2,530	2,140
Tabebuia rosea	CS	10	62	.51	10,650	1,470	11.2	4,930	890	1,240
Tabebuia serratifolia	SM	3	31	.92	22,850	3,060	25.6	10,660	2,970	2,050
Tarrietia utilia	AF	7	47	.56	9,690	1,305	9.6	5,088	1,050	1,276
Tectona grandis	IN	134	67	.57	10,980	1,510	10.8	5,470	1,070	1,290
Tieghemella heckeli	AF	4	44	.54	10,355	1,273	13.5	5,088	930	1,364
Tilia americana	US	8	105	.12	5,000	1,040	5.3	2,220	250	600
Triplochiton scleroxylon	AF	2	76	.33	5,130	706	6.2	2,573	420	669
Virola koschnyi	CA	8	75	.44	6,200	1,470	5.3	3,050	440	660
Virola melinonii	SU	3	50	.42	6,340	1,740	4.6	3,100	400	730
Virola surinamensis	BR	2	94	.42	5,600	1,640	4.1	2,390	320	720
Vochysia hondurensis	CA	5	200	.35	5,750	1,050	4.6	2,800	460	700
Vochysia hondurensis	GU	1	148	.40	6,850	1,260	--	--	570	--
Vouacapoua americana	SU	3	48	.79	15,850	2,620	14.5	9,170	1,610	1,510

[1] Specific gravity based on volume when green and weight when ovendry.

Table 4. Strength properties of certain imported tropical woods and selected species of the U.S. (Results based on small, clear specimens at a moisture content of 12 or as indicated.)

Botanical name	Origin	No. trees	Moisture content percent	Sp. gr[1]	Static bending: Modulus of rupture psi	Static bending: Modulus of elasticity 1,000 psi	Static bending: Work to maximum load In.-Lb./cu. in.	Compression parallel to grain: Maximum crushing strength psi	Hardness side lbs.	Sheer parallel to grain: Maximum shearing strength psi
Acer rubrum	US	14	12	0.49	13,400	1,640	12.5	6,540	950	1,850
Acer saccharum	US	17	12	.56	15,800	1,830	16.5	7,830	1,450	2,330
Afzelia sp.	AF	3+	12	.71	17,195	2,033	24.1	11,030	1,770	2,121
Albizia falcataria	AS	4	12	.28	6,960	1,000	--	3,840	330	940
Albizia falcataria	HA	5	12	.32	8,400	1,280	8.7	4,490	450	1,130
Albizia lebbek	AS	5	8	.55	14,430	1,830	7.7	8,770	1,250	1,850
Albizia sp.	AF	1+	12	.63	14,440	1,659	9.3	9,005	1,390	2,121
Alnus rubra	US	6	12	.37	9,800	1,380	8.4	5,820	590	1,080
Alstonia boonei	AF	1	12	.36	8,170	1,284	6.5	5,030	410	845
Anacardium excelsum	CS	6	12	.41	7,960	1,280	5.6	4,530	470	900
Anisoptera spp. (palosapis)	AS	16	12	.51	12,780	1,820	--	6,630	920	1,410
Antiaris africana	AF	1+	12	.39	8,170	1,124	4.9	5,213	510	1,012
Araucaria angustifolia	BR	11	15	.48	11,800	--	--	5,800	--	--
Aspidosperma (peroba rosa)	BR	1	12	.67	12,160	1,540	9.2	7,920	1,730	2,490
Astronium graveolens	CS	4	12	.86	17,070	2,170	10.4	10,560	2,230	2,060
Berlinia grandiflora	AF	5	12	.61	14,535	1,680	13.3	7,382	1,360	1,954
Betula alleghaniensis	US	17	12	.55	16,600	2,010	20.8	8,170	1,260	1,880
Brachystegia nigerica	AF	5	12	.60	14,440	1,637	11.8	7,939	1,430	2,341
Brachystegia spiciformis	AF	8	12	.71	17,290	2,087	16.2	9,542	1,830	2,086
Brachystegia sp.	AF	7	12	.71	17,290	1,937	15.1	9,571	1,970	2,103
Brosimum costaricanum	CR	1	12	.64	16,070	1,850	10.9	--	1,710	--
Brosimum	VE	1	12	.65	17,630	2,350	15.6	10,240	2,000	1,990
Brosimum utile	EC	1	13	.36	--	--	--	4,490	350	770
Brosimum utile	EC	1	13	.39	--	--	--	--	530	--
Brosimum utile	EC	3	12	.41	--	--	--	6,310	500	--
Bursera simaruba	us	5	12	.30	4,800	740	3.0	3,080	270	800
Bursera simaruba	CR	1	12	.32	5,560	1,080	2.0	--	250	--
Calophyllum brasiliense rekoi	CA	18	12	.54	14,760	1,820	13.2	8,060	1,210	1,910
Calycophyllum candidissimum	VE	2	12	.67	22,300	2,270	27.0	9,670	1,940	2,120
Calycophyllum spruceanum	PE	1	14	.76	--	--	--	9,280	2,550	--
Canarium schweinfurthii	AF	4	12	.45	9,595	1,263	5.8	5,914	670	1,505
Carapa guianensis	BR	2	12	.56	15,620	1,850	13.4	7,900	1,220	1,680
Carapa nicaraguensis	EC	3	13	.42	--	--	--	6,240	1,240	--
Carapa surinamensis	SU	2	12	.53	15,450	2,140	14.7	8,340	1,040	1,340
Cariniana brasiliensis	BR	3	15	.46	11,800	--	--	6,100	--	--
Cariniana	BR	1	12	.58	13,110	1,500	13.8	6,820	1,020	1,790
Carya illinoensis	US	5	12	.60	13,700	1,730	13.8	7,850	1,820	2,080
Cedrela angustifolia	BR	2	12	.38	11,300	1,420	12.5	6,010	570	1,200
Cedrela oaxacensis	PA	3	12	.41	11,530	1,440	9.4	6,210	600	1,100

Table 4. Strength Properties of certain imported tropical woods and selected species of the U.S. (Results based on small, clear specimens at a moisture content of 12 or as indicated.)

Botanical name	Origin	No. trees	Moisture content percent	Sp. gr[1]	Static bending: Modulus of rupture psi	Static bending: Modulus of elasticity 1,000 psi	Static bending: Work to Maximum load In.-Lb./cu. in.	Compression parallel to grain: Maximum crushing strength psi	Hardness side lbs.	Shear parallel to grain: Maximum shearing strength psi
Cedrela odorata	NI	1	12	.34	7,860	1,010	5.6	4,450	500	--
Ceiba pentandra	VE	3	12	.25	4,330	540	2.8	2,380	240	550
Ceiba samauma	PE	1	13	.50	--	--	--	--	740	--
Chlorophora excelsa	AF	2+	12	.59	12,445	1,455	9.0	7,594	1,260	1,804
Chloroxylon swietenia	AS	5	15	.85	16,500	2,020	11.2	10,030	2,600	2,510
Cordia alliodora	CA	13	12	.44	12,060	1,490	9.7	6,280	790	1,220
Cordia goeldiana	BR	2	12	.52	14,700	2,090	15.9	7,240	1,190	1,410
Cybistax donnell-smithii	HO	4	12	.39	10,900	1,220	10.3	6,140	700	1,710
Dalbergia latifolia	AS	5	12	.75	16,920	1,780	13.1	9,220	2,630	2,090
Dalbergia sissoo	AS	5	10	.65	15,360	1,740	12.1	8,990	1,560	2,000
Dalbergia	BR	1	12	.80	18,970	1,880	--	9,600	2,720	2,110
Dicorynia guianensis	SU	2	12	.60	17,390	2,190	15.2	8,770	1,290	1,660
Dicorynia guianensis	SU	3	15	.68	18,680	2,130	4.4	--	1,690	1,690
Diospyros crassiflora	AF	6	12	.90	26,030	2,739	28.1	12,816	3,220	2,473
Diospyros mespiliformis	AF	1+	12	.71	16,150	1,659	18.2	8,170	2,130	2,446
Diospyros pilosanthera	AS	1	12	.81	20,500	2,630	--	10,680	3,890	--
Diospyros virginiana	US	5	12	.64	17,700	2,010	15.4	9,170	2,300	2,160
Dipterocarpus spp. (apitong)	AS	53	12	.59	16,210	2,350	--	8,540	1,200	1,690
Distemonanthus benthamianus	AF	1+	12	.60	14,915	1,766	12.8	7,978	1,230	1,857
Dracontomelon dao	AS	2	12	.54	14,650	1,820	--	7,200	1,130	1,520
Dracontomelon mangiferum	AS	7	12	.46	11,800	1,660	--	6,700	830	1,600
Dryobalanops lanceolata	AS	5	12	.64	17,385	2,022	15.5	9,696	1,230	1,707
Entandrophragma angolense	AF	3	12	.50	10,640	1,338	7.8	6,288	940	1,602
Entandrophragma cylindricum	AF	5	12	.60	15,295	1,819	15.7	8,160	1,510	2,288
Entandrophragma utile	AF	4+	12	.57	14,250	1,669	10.1	8,410	1,260	2,156
Eucalyptus diversicolor (karri)	AU	21	12	.70	19,200	2,760	--	10,400	2,030	2,135
Eucalyptus marginata (Jarrah)	AU	28	12	.67	16,200	1,880	--	8,870	1,915	2,185
Euxylophora paraensis	BR	3	13	.70	16,200	2,180	13.0	9,050	1,820	2,160
Fitzroya cupressoides	CH	1	12	.38	8,670	1,170	--	5,150	560	1,190
Fraxinus americana	US	23	12	.55	15,400	1,770	17.6	7,410	1,320	1,950
Gonystylus bancanus	AS	9	12	.59	18,430	2,172	17.0	10,080	1,300	1,514
Gosweilerodendron balsamiferum	AF	36	12	.45	11,210	1,177	10.8	6,019	740	1,487
Guarea cedrata	AF	2	12	.48	14,155	1,466	13.5	7,411	900	1,962
Guara thompsonii	AF	4	12	.56	14,725	1,680	12.1	8,333	1,100	1,725
Hopea odorata	AS	5	12	.64	13,740	1,670	11.7	6,710	1,460	1,610
Hura crepitans	CS	7	12	.38	8,610	1,190	6.9	4,700	530	1,020
Hymenaea courbaril	CS	9	12	.72	19,400	2,170	17.6	9,680	2,440	2,470
Intsia bijuga	AS	14	12	.70	21,300	2,610	--	11,700	1,910	2,630
Intsia palembanica	AS	5	15	.68	16,810	2,230	--	8,440	1,510	--
Juglans regia	AS	10	8	.47	13,090	1,540	9.8	7,320	860	1,320

Table 4. Strength properties of certain imported tropical woods And selected species of the U.S. (Results based on small, clear specimens at a moisture content of 12 or as indicated.)

Botanical name	Origin	No. trees	Moisture content percent	Sp. gr[1]	Static bending: Modulus of rupture psi	Static bending: Modulus of elasticity 1,000 psi	Static bending: Work to maximum load In.-Lb./cu. in.	Compression parallel to grain: Maximum crushing strength psi	Hardness side lbs.	Shear parallel to grain: Maximum shearing strength psi
Khaya anthotheca	AF	4	12	.46	11,400	1,402	9.8	6,173	860	1,593
Khaya anthotheca	AF	5	12	.47	11,495	1,423	9.8	6,394	930	1,778
Khaya grandifoliola	AF	5	12	.57	13,395	1,648	11.8	7,680	1,370	2,209
Khaya ivorensis	AF	11	12	.43	10,700	1,390	8.3	6,460	830	1,500
Lophira alata	AF	10	12	.94	32,654	--	--	13,198	--	--
Lovoa trichilioides	AF	2	12	.48	11,305	1,434	--	6,710	940	1,276
Mansonia altissima	AF	1	12	.57	16,815	1,691	18.2	8,160	1,290	1,971
Mitragyna sp.	AF	1	12	.48	11,780	1,445	9.8	6,470	780	--
Mora excelsa	SM	24	12	.89	23,100	2,970	21.4	12,200	2,460	2,550
Mora gonggrijpii	GY	9	12	.92	25,600	3,190	24.7	13,610	2,950	2,640
Mora megistosperma	EC	1	12	.60	--	--	--	5,730	1,150	--
Nauclea diderrichii	AF	4	12	.67	16,530	2,076	11.7	9,984	1,630	2,182
Nothofagus procera	CH	12	12	.42	10,360	1,080	12.8	4,760	690	1,500
Ocotea rodiaei	GY	3	12	.83	--	--	--	14,940	2,650	2,830
Ocotea rubra	SU	3	15	.61	13,100	1,890	9.1	--	900	1,290
Ocotea rubra	SM	5	12	.51	10,210	1,790	6.4	5,620	640	960
Ocotea rodiaei	GY	2	15	.88	25,500	3,700	22.0	12,920	2,630	1,830
Parashorea plicata	AS	5	12	.43	10,355	1,380	9.8	6,336	590	1,074
Parashorea plicata	AS	5	12	.46	11,115	1,509	10.2	6,730	710	1,250
Parashorea plicata	AS	22	12	.49	13,400	1,860	--	7,000	880	1,370
Paratecoma peroba	BR	3	15	.63	16,000	--	--	7,520	--	--
Paratecoma peroba	BR	1	12	.67	15,400	1,760	10.2	8,920	1,600	2,140
Peltogyne densiflora	BR	3	13	.75	20,100	2,550	18.6	10,770	2,140	2,150
Peltogyne pubescens	GY	1	14	.92	25,100	3,640	24.9	13,270	3,640	2,070
Peltogyne venosa	SU	3	12	.67	19,220	2,270	17.6	10,320	1,860	2,220
Pentacme contorta	AS	18	12	.43	11,700	1,690	--	6,070	700	1,200
Pericopsis elata	AF	6	12	.66	18,430	1,937	18.5	9,936	1,560	2,086
Phoebe porosa	BR	3	12	.52	12,100	1,410	11.6	6,650	950	1,480
Pinus caribaea	CA	14	12	.68	15,230	2,030	15.3	8,000	1,150	1,870
Pinus elliottii	US	30	12	.56	15,900	2,060	12.6	9,100	1,010	1,730
Pinus oocarpa	HO	3	12	.55	14,870	2,250	10.9	7,680	910	1,720
Pinus palustris	US	44	12	.54	14,700	1,990	11.8	8,440	870	1,500
Pometia pinnata	AS	6	12	.57	15,400	2,080	--	8,670	1,470	1,950
Pometia tomentosa	AS	7	12	.56	13,900	2,090	--	7,700	1,240	2,040
Prioria copaifara	PA	4	12	.40	8,730	1,150	7.2	4,490	610	1,040
Pseudosindora palustris	AS	7	12	.59	17,195	1,969	13.4	8,880	1,410	2,033
Pterocarpus angolensis	AF	3	12	.59	13,015	1,305	11.1	7,949	1,480	1,998
Pterocarpus indicus	AS	8	12	.52	13,540	1,690	--	7,790	1,020	1,580
Pterocarpus indicus	AS	14	12	.53	13,800	1,770	--	8,450	1,060	1,630
Quercus aaata	CR	3	12	.71	18,140	2,920	16.2	--	2,390	--

Table 4. Strength properties of certain imported tropical woods and selected species, of the U.S. (Results based on small, clear specimens at a moisture content of 12 or as indicated.)

Botanical name	Origin	No. trees	Moisture content percent	Sp. gr[1]	Static bending: Modulus of rupture psi	Static bending: Modulus of elasticity 1,000 psi	Static bending: Work to maximum load In.-Lb./cu. in.	Compression parallel to grain: maximum crushing strength psi	Hardness side lbs.	Shear parallel to grain: Maximum shearing strength psi
Quercus alba	US	20	12	.60	15,200	1,780	14.8	7,440	1,360	2,000
Quercus costaricensis	CR	2	12	.61	17,560	2,640	16.8	--	1,570	--
Quercus eugeniaefolia	CR	1	12	.67	16,410	2,840	14.1	--	2,170	--
Quercus virginiana	US	5	12	.81	18,400	1,980	18.9	8,900	2,680	2,660
Quercus spp. (red)	US	70	12	.57	14,600	1,830	14.3	7,120	1,310	1,840
Quercus spp. (white)	US	55	12	.59	13,700	1,590	13.7	7,000	1,340	1,880
Shorea almon (lavan)	PH	12	12	.44	11,300	1,670	--	5,750	590	1,090
Shorea dasyphylla (meranti)	AS	2	12	.43	12,065	1,626	11.7	6,970	630	--
Shorea leptocladus (seraya)	AS	5	12	.39	9,310	1,295	8.4	5,155	510	1,162
Shorea negrosensis (lavan)	AS	15	12	.44	11,300	1,630	--	5,890	680	1,220
Shorea parvifolia (seraya)	AS	5	12	.39	9,500	1,220	8.5	5,923	460	968
Shorea pauciflora (seraya)	AS	5	12	.50	12,635	1,766	13.8	7,363	780	1,461
Shorea polyaperma (lavan)	PH	17	12	.46	12,900	1,810	--	6,580	770	1,290
Shorea smithiana (seraya)	AS	5	12	.40	10,260	1,412	8.8	6,307	540	--
Shorea squamata (lavan)	AS	12	12	.41	11,100	1,660	--	5,620	590	1,090
Shorea waltonii (seraya)	AS	4	12	.36	9,785	1,359	10.2	5,501	490	1,030
Simarouba amara	SU	3	15	.37	9,020	1,290	5.1	--	430	830
Simarouba amara	SU	2	12	.38	8,930	1,240	5.8	4,840	440	1,160
Spondias mombin	VE	3	12	.40	8,810	1,280	6.3	4,410	520	1,030
Sterculia oblonga	AF	5	12	.69	17,005	2,119	15.0	9,360	1,120	1,593
Swietenia macrophylla	CS	77	12	.45	11,640	1,510	7.9	6,630	810	1,290
Tabebuia guayacan	HO	3	12	.85	27,150	2,970	22.9	12,470	3,480	2,710
Tabebuia heterotricha	PA	3	12	.80	22,630	2,320	26.0	10,930	3,010	2,280
Tabebuia rosea	CA	9	12	.52	13,780	1,600	12.5	7,340	960	1,450
Tabebuia serratifolia	SM	3	12	.92	26,310	3,310	23.0	13,420	3,670	2,070
Tarrietia utilis	AF	7	12	.56	12,350	1,477	9.9	7,200	1,100	1,619
Tectona gradis	HO	3	12	.56	13,310	1,390	10.3	6,770	1,110	1,600
Tectona gradis	IN	56	12	.57	12,780	1,590	10.1	7,110	1,030	1,480
Terminalia ivorensis	AF	6+	12	.48	11,495	1,445	7.9	6,653	840	1,540
Tetraberlinia tubmaniana	AF	11	14	.60	16,750	2,210	--	9,010	--	--
Tieghemella heckelii	AF	4	12	.54	13,965	1,573	10.7	7,421	1,110	1,830
Tilia americana	US	8	12	.32	8,700	1,460	7.2	4,730	410	990
Triplochiton scleroxylon	AF	2	12	.33	7,505	856	6.9	3,926	430	986
Turraeanthus africanus	AF	3	12	.51	12,730	1,487	9.4	7,152	1,080	2,033
Virola koschnyi	CA	8	12	.44	10,800	1,720	8.1	5,720	640	1,300
Virola melinonii	SU	3	12	.42	10,070	1,980	7.8	5,280	600	1,220
Virola surinamensis	BR	2	12	.42	10,950	2,040	10.0	5,140	510	980
Vochysis hondurensis	CA	5	12	.35	7,980	1,200	7.1	4,420	770	1,070
Vouacapoua americana	SU	3	12	.79	21,640	2,530	17.0	11,480	1,730	1,090

[1]Specific gravity based on volume when green and weight when ovendry.

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