South American Hardwoods and their Application
To North American Hardwood Markets

by
Ray L. Stewart

A Thesis
Presented to the Faculty
of the
School of Forestry
Oregon State College

In Partial Fulfillment
of the Requirements for the Degree
Bachelor of Science
June 1940

Approved:

Professor of Forestry
TABLE OF CONTENTS

Map of South America..............................Preface

Introduction.................................Page 1

Part I Location and Description of
Commercially Valuable Species........ Page 5

Part II The Trees and Their Woods.........Page 11

Part III Some By-products of South
American Woods...............................Page 34

Part IV A Future for South American
Hardwoods in Fulfilling the
Demand of North American
Hardwood Markets.......................Page 38

Bibliography.................................Page 41
INTRODUCTION

In 1920 the total estimated stand of hardwood timber in this country was 460 billion board feet. The annual drain for all purposes, including disease, fire, and insects is about 20 billion board feet. At this rate our hardwoods will be depleted in 23 years—twenty of these 23 years have already passed. It is true that hardwood lumber cut has gradually been decreasing, but this is probably due to the increasing industrial utilization of wood in other forms than lumber from commercial sawmills.

If our wood-using industries are to continue to grow with the population, or even approximately maintain their present status, they must begin to lay plans for securing raw materials.(1)

The history of mankind has been one of forest destruction. Long before man had learned to hew timbers, he had become the implacable enemy of the forests. First with puny weapons, and later with powerful machinery he has waged an everlasting war on tree growth. He has taken fire as his ally and laid vast areas to waste.

From man's first tribal beginning he has known the forests as only a place where dangers lurked. In legend and mythology most early races have woven a tale of mystery and fear about the forests. When they reached the agricultural stage it became an enemy of those who sought to till the soil and wrest from the forest's grasp the land on which to sow their grain or corn.
Within their little clearings, man found life if not easy, at least possible. He could raise crops, graze his animals, and live his allotted days. But there was always the fear of the black ominous forest close at hand. At times competition with tree growth became so hopeless that the places man had chosen for permanent occupation turned out to be only a kind of pioneer outpost that he was unable to hold.

With the passing of centuries man's power to conquer has increased. His numbers have augmented and he began to dominate the conditions that surrounded him. He found that with the help of tools he had invented he could conquer his old enemy and liberate land for cities and farms. He also found that he could make use of the felled trees for the ever increasing needs of his civilization. So exalting in his new found supremacy he hacked and cut and burned in an orgy of destruction.

Then something happened.

Those "inexhaustible forests" began to give out. In the more populous regions man began to wonder if he had not conquered his old enemy too completely. He looked on vast areas of denuded land so depleted of their valuable species that they were only straggling growths of underbrush and shrubs of little value in the markets of the world. He found that his population had increased and the demands of civilization multiplied. The nations of the temperate zone were using wood, for the most part, much faster than
they were replacing it.

None too promptly the North American people began the task of bringing back the forests. The United States had so taken her forest wealth for granted that when faced with the necessity for scientifically managing them she had no knowledge of how to begin the task. She found that it would take years to replace the forests she had used. Much too slow to fill her demands for the near future. She must search elsewhere for products to fill this gap.

In forest wealth the countries of the tropics have been favored above all others. Nature has given them trees of extremely rapid growth and great intrinsic value. They possess a climate in which rapid growth goes on day after day throughout the year, so that an acre near the equator can produce far more wood in a shorter time than can be grown on a northern acre.(3)

The hardwood consuming industries, and particularly those located along the Atlantic seaboard, are slowly beginning to appreciate that tropical hardwoods are becoming an important factor in the industry of the United States.(4)

When the American markets turned to the tropics for lumber and for woods for special purposes they encountered several formidable obstacles. All were the result of a woeful lack of knowledge concerning these forests and the woods they contain. It became immediately apparent that the wood using industries were not willing to accept some
unknown species in place of the oak, hickory, and ash with which they were familiar.

Thus the products of the tropics have languished on the American markets because so little was known of them.

It is the purpose of this thesis to gather authentic information regarding location, accessibility, and descriptions of hardwood species of South America and show how they can be adapted to North American hardwood markets.(3)
PART I

Location and Description of Commercially Valuable Species

This part presents a general view of the Tropical American countries where the more valuable species are found. Matters of population, topography, climate, and accessibility are emphasized because from the standpoint of utilization of timber, they are of even greater concern than the nature and extent of the forests themselves.

The forest resources of tropical America may be briefly summarized as follows:

Colombia has accessible forests on the Pacific side and in the drainage basins of the rivers flowing into the Caribbean Sea.

The best forests of Venezuela are in the lowlands at the head of Lake Maracaibo, the neighboring foothills of the Andes, and the remoter parts of the Guiana Highlands.

The Guianas as a whole are well timbered, and the British and Dutch colonies, especially, are advantageously situated for extensive development.

Ecuador has accessible forests on the Pacific slope of the Andes, but the eastern timberlands are in the upper reaches of the Amazon. Peru and Bolivia have vast forest resources in the lowlands of the Amazon headwaters, but their extensive exploitation will probably be long deferred. A part of Paraguay is heavily forested and the best markets for the products are in Argentina, Uruguay, and Southern Brazil. Southern Chile contains large quantities
of Antarctic beeches and certain conifers, but these will be needed for the agricultural region which is rapidly being developed farther north; the northern part of the country is desert. Argentina has great areas of Querbracho, but the stands of mixed hardwoods are limited. Uruguay is almost entirely dependent on outside sources for her lumber supply.

It is estimated that 40% of the area of Brazil is still in virgin forest. The bulk of this is in the great Amazon Basin in the north and most of this country has not been explored except along the water courses. There is also a valuable hardwood area along the east coast.

From the foregoing it will appear that the forests which offer the best opportunities, from the standpoint of supplying the United States in the early future, are located in northern South America chiefly in the Upper Amazon. Southern South America requires more timber than it can produce, while most of the timber stores of the Upper Amazon will await the needs of the distant future.

It would be impossible to cover adequately all the countries of South America in this thesis, so the following descriptions will be confined to that part where the greatest resources lie, namely, the Amazon Basin of Brazil.

Brazil with an area of 3,275,000 square miles, comprises about one-half of South America and borders on every other country on the continent except Chile. Its greatest length from north to south is about twenty six
hundred miles and its greatest width about twenty five hundred miles. The population, approximately 30 millions exceeds the combined population of all other South American countries. Brazil is divided into four natural regions, namely, the Guiana Highlands, the Amazon Basin, the Atlantic Littoral, and the Brazilian Highlands. Of these four regions the Amazon Basin contains the greatest treasure of hardwoods. It is a vast territory limited by the Guiana Highlands on the north, the Andes on the west and the Brazilian Highlands on the south and east. The total area drained by the Amazon has been estimated to be about two and three-quarter million square miles. The Amazon river system is the largest in the world; its gigantic tributaries, the Madeira, Xingu, and Tapajos from the south and west, and the Rio Negra from the north drain regions that have been only partially explored. The forests of the lower Amazon have been studied, but the accounts do not cover the elevated regions between the main tributaries farther to the west and away from the main channels of the Amazon. It is estimated that there are at least 2500 species of trees in this great basin, many of which will prove of great commercial value in the near future. (5) 

In order to visualize the timber resources of Brazil its territory can be divided into two compact portions, the one lying in the north, west, and upper center and comprising the states of Para, Amazonas, Goyaz and Matto Groso and the Territory of Acre and the other lying to
the east, lower center, and south and comprising all the other states. This southern portion as before stated consumes all the timber it can produce. (7)

The first portion constitutes about two-fifths of the whole territory of Brazil. It is crossed from east to west by the Amazon, into which run innumerable tributaries, some of them very large rivers. The land is almost entirely covered by virgin forest growth, mostly hardwoods, many of which are very beautiful when prepared for use. So far as known there are no large stands of any one variety, but all sorts of varieties grow side by side. In the true equatorial forest, which covers a very large part of this area, the trees grow close together and are surrounded at their base with an almost impenetrable jungle of undergrowth closely tied together by vines. Beyond the edges of the true equatorial forest, the trees grow in larger or smaller masses or bodies, with less jungle and separated by glades or wide open spaces.

The population of this vast territory is very meager and transportation facilities, except by water, do not exist.

Para, the third largest of the Brazilian states, embraces the drainage system of the lower Amazon, including the lower Tocantins. Its coast is exceedingly irregular. The chief city is Para or Belem which is situated on the south side of the Para river. Along the rivers and northward from the banks of the true Amazon Selva alternates with
savanna lands.

The area to the west of the Tocantins and south of the Amazon is not well known and considerable areas have probably never been visited by white man. Both the Xingu and Tapajos are navigable, but there is little known about what lies beyond the flood forests. That these rivers have their headwaters on the western slopes of the east Brazilian Highlands is evident, but just what forest conditions are beyond the Amazon selvas has not yet been determined.

Goyaz occupies a roughly wedge-shaped area about 290,000 square miles, situated wholly within the Brazilian Highlands. Little information is available concerning the forests of Goyaz, but for the most part the country is bare of trees.

Matto Groso, one of the largest and most backward states, occupies an area of over 500,000 square miles. The topography is not well understood and very little has been published about it. Many of the hills are entirely bare and while the river banks are forested farther south, the country is low and swampy.

To the north of the Matto Groso plateau is the vast Amazon Basin which is almost entirely unexplored. Naturalists have ascended all the large rivers discharging into the Amazon, but they have left no records of the character of the country. Most of these rivers periodically overflow their lower channels and flood the country for some 20 miles or more, making it almost impossible to traverse
the jungle.

Amazonas occupying about 750,000 square miles in the extreme northwest portion of the country is the largest state and one of the most sparsely populated. The majority of the people are Indians, many of whom are hostile. The entire state is relatively low and swampy. It lies wholly within the Amazon Basin and is traversed by many rivers.

Only the rivers have been explored. There are no roads or railroads and only a few towns, chief of which is Manaos. The forests are continuous throughout the basin and are said to be unsurpassed in density, rankness of growth, and wealth of species. The climate of this Amazon valley is tropical with year-around temperatures averaging approximately 80° Farenheit and a humid atmosphere with frequent rains totaling up to 98 inches.(5)

Out of more than 3,000,000 square miles of Brazilian territory approximately 1,500,000 square miles are forested and it is estimated that this area represents 5000 billion board feet of standing commercial timber. The Amazon valley has approximately 3000 billion and the southern portion some 2000 billion board feet.(6)
PART II

The Trees and Their Woods

The species in the country of Brazil with its vast areas of forested land are representative of all hardwoods in South America, so all species described herein will be from Brazil.

Brazilian woods are generally classified under two types, Madeira de Lei (hardwoods) and Madeira Branco (white wood or softwood). It is interesting to give the reason for these classifications. In Colonial days the Crown of Portugal reserved a monopoly on certain hardwoods particularly adapted to naval construction, and at one time it was a crime punishable by death, to cut certain woods without a license, hence Madeira de Lei or "Wood of the Law".

Today Madeira de Lei includes all of the principal hardwoods such as cabinet-woods, construction timbers, railroad ties, but curiously enough, cedar, while not a hardwood is classified as Madeira de Lei. Yet Urucurana, a wood hard enough to turn an axe is classified as Madeira Branco.

Of the two main forest districts of Brazil now open for regular lumbering operations and export of timber, the southern region is where the industry is better organized. Saw mills are operating along the existing railroads and lumber of good manufacture is now supplied in adequate quantities to the domestic market and for export. (6)

Considering, however, the case of an adequate supply of Brazilian hardwoods to the American market, the Amazon
valley is where such an enterprise can find great elements for success. Relatively close to the American ports, with facilities for inland navigation and of rapid communication with the United States, the Amazon valley, is bound to become the source of supply to which the lumber interests and technical associations of this country have been looking for the last few years.\(^{(5)}\)

The export of Amazonian woods started only with the outbreak of the World War. In the beginning only round logs were exported, but the industry has been progressing steadily since then and today there are quite a number of sawmills in operation along the main river and lumber is now being exported in increasing quantities to American and European markets.

Amazonian woods for construction and industrial purposes have been tried in the United States and have proved to satisfy the requirements of the trade. Shipments of those woods while still small, are coming regularly to the United States and little by little the ground is being prepared for the expansion that will take place when fully equipped and modern sawmills are installed in the Amazon valley for production of lumber on a large scale.\(^{(5)}\)

For the purpose of information and in order to give an idea of the main characteristics of the more important woods, a classification follows with an attempt to show the similarity of certain species to well known North American hardwoods which they closely resemble. Many of
these woods are available today in the United States, such lumber being graded in accordance with the National Hardwood Lumber Association.

The woods are suited to all classes of construction work, especially where materials unusually strong and resistant to deterioration are required. Many are suitable for decorative purposes, others because of their beautiful figurings and colorings are ideal for fine cabinet work. It would seem that in the growth and production of such cabinet woods that Brazil should assume a commanding position for that country offers an almost unlimited range—red, grey, brown, cream, white, purple and beautifully grained and figured, they offer new fields to workers in hardwood whose choice has been limited for the most part to conventional walnut, mahogany, and oak.

FAMILY: Lauraceae

GENUS: Nectandra

SPECIES: Nectandra sp. Can be substituted for walnut

The Laurel family consists of about 40 genera and over 1000 species of aromatic trees and shrubs. Many of the members of this family are rich in aromatic substances and are the source of such well-known products as camphor, cinnamon, and cloves. The alligator pear or avocado, is a tropical fruit of this family. The most important tree in this group from the standpoint of the United States is the embuia tree.
The Wood

Nectandra sp.  

**Embula**

Common Names: Embuia, embuia amarela, canella, Brazilian walnut.

**General Properties:** Color olive to chocolate-brown, depending upon exposure; lustrous- sapwood yellowish or yellowish-brown; line of demarcation not very sharp. Odor and taste spicy-resinous.

Moderately heavy and hard. Sp.gr. (air dry) 0.70 to 0.76

weight 43 to 47 lbs. per cu. ft. grain fairly straight;
sometimes curly. Texture medium to rather fine. Wood

strong, easy to work, finishes smoothly, appears durable.

**Growth Rings:** Distinct; due to somewhat denser and darker-
colored narrow layer of late wood.

**Parenchyma:** Sparingly developed about pores; scarcely

visible with lens.

**Pores:** Small but visible; fairly numerous but not crowded;

well distributed; occurring simply or more often in radial
groups of two or three.

**Vessel Lines:** Visible as fine dark lines.

**Vessel Contents:** Dark gummy substance very common.

**Rays:** Very fine; faintly visible on cross section; invisible

on tangential; visible, but low and inconspicuous, on the

radial, appearing of same color as background.

**Gum Ducts:** None observed. (§)
FAMILY: Lauraceae  
GENUS: Nectandra  
SPECIES: Nectandra Rodioei Schomb.

Another species of this family is the demrara green-heart; although it does not resemble any species grown in the United States it is highly valued in naval construction. It is a large evergreen tree, ranging from 70 to 120 feet in height and from two to three feet in diameter. The trunk is straight, cylindrical, and, unlike many of its associates, it is not buttressed. The trees are usually without branches for the first 50 feet and logs or timbers from 15 to 20 inches square, free of sap can be obtained. The bark of the trunk is thin, flinty brittle, smooth or somewhat scaley, and of a grayish white color that is very distinctive.

The chief uses of the wood are in the construction of ships and docks, especially for keelsons, beams, engine bearers, planking, dock and lock gates, piers and piling.

Greenheart tends to check and splinter in drying and requires great care in seasoning and in working. The logs often cleave at the ends into four segments, but the cracks usually do not extend deeper than two or three feet.

In tests made by the United States Forest Service greenheart was found to be 25% stiffer than black locust, the strongest and stiffest of North American woods. In resistance to shock it falls considerably below the hickories, and classes with beech, birch, ash and oak. The heartwood proved highly resistant and, in most cases,
practically immune to the action of 23 different wood destroying fungi.

The Wood

Nectandra rodioei Schomb.  

Greenheart

Common Names: Greenheart, demerara greenheart, bebeere, bibiru, torchwood, greenwood.

General Properties: Color light to dark olive or nearly black; often with intermingling of lighter and darker areas; lustrous. Thick sapwood pale yellow, becoming greenish upon exposure; not sharply defined. Odor and taste absent or not distinct.

Very hard and heavy Sp.gr. 1.06 to 1.23 weight 66 to 77 lbs. per cu.ft. Texture medium. Hard to cut, easy to split, finishes smoothly, is extremely durable. Statements that the wood is poisonous to workmen are apparently untrue.

Growth Rings: Absent or vaguely defined

Parenchyma: In very narrow circles about the pores; readily visible; not in lines.

Pores: Rather small but very distinct on account of parenchyma; uniform; mostly oval in shape; numerous but not crowded; well distributed occurring slightly or sometimes subdivided radially.

Vessel Lines: Rather fine; distinct, but not conspicuous, in proper light due to parenchyma; mostly long and straight.

Vessel Contents: Some gum deposits in darker portions.

Rays: Invisible or nearly so on cross and tangential sections; fine and inconspicuous though distinct in proper
light, on radial surface where they may appear either lighter or darker than background.

Ripple Marks: Absent

Gum Ducts: None observed (s)

FAMILY: Bignoniaceae

GENUS: Peroba

SPECIES: Tecoma peroba

Can be substituted for oak

This family consists of about 100 genera and several hundred species. The "Ipe Peroba" group is the most important to us and closely resembles our oaks.

The tree attains a height of about 130 feet with a slender symmetrical trunk about 95 feet long and 30 inches in diameter, covered with a distinctly rigid, yellowish bark. The leaves are digitate, opposite, glabrous.

This is one of the most important woods in the market of Rio de Janeiro. Nearly all of the better class of houses, banks, and stores are finished with it and much of the best quality of furniture is of this wood. It has recently entered the market in New York in limited amounts and a cabinetmaker there says of it: "Peroba wood is a yellowish, moderately hard wood resembling oak." If not properly dried it it likely to check when exposed to warm temperature.

The Wood

Tecoma Peroba Record

Ipe Peroba

Common Names: Peroba, peroba ammella, peroba branco, peroba do campo.
General Properties: Light olive-brown with a yellowish, greenish, or reddish hue; fairly lustrous. Sapwood grayish or pale yellowish; sharply defined. Odor and taste absent or not distinctive.
Rather hard and heavy. Sp. gr. (air dry) 0.70 to 0.83 weight 43 to 52 lbs. per cu. ft. Grain fairly straight to finely roey; sometimes beautifully figured. Texture medium. Wood fairly easy to work, takes a smooth finish, is tough and strong, appears durable.

Growth Rings: Present; fairly distinct on all sections; due to some difference in color and in density; also to fine line of parenchyma, which often is not continuous.

Parenchyma: Associated with pores, but not distinct; sometimes also visible with lens, in very fine lines, terminating growth rings.

Pores: Small but visible; numerous to very numerous; occurring singly or more often in short radial groups and with tendency to formation of diagonal and wavy lines; closed.

Vessel Lines: Rather fine and inconspicuous.

Vessel Contents: Tylosis abundant; yellow substance sparingly present.

Rays: Present, but irregular; barely visible without lens; invisible on tangential; visible, but inconspicuous, on radial, being of same color as background.

Ripple Marks: Present, but irregular; barely visible without lens and not very distinct with it; all elements in seriation. Number per inch 90 to 95.

Gum Ducts: None observed.
FAMILY: Simarubaceae

GENUS: Simaruba

SPECIES: Simaruba

Can be substituted for yellow poplar

This species is common throughout Brazil, and attains a height of 60 to 65 feet and a diameter of 6 to 24 inches. The simaruba is a tree of rapid growth, yielding a wood that is light, soft, easy to work, and immune from attack of insects, presumably on account of the bitter taste. It is used principally for house sheathing, boxes, etc. Lumber from this species is now entering the New York market in considerable quantities and is being used in the manufacture of organ pipes, piano keys, patterns, and for interior trim that is to be painted. The stock is subject to blue stain in transit, but this does not affect its strength and can be prevented. It is said that the logs are likely to split open in sawing and boards may also split from end to end in drying.

The Wood

Simaruba amara Aubl.

Common Names: Simaruba, maruba, aruba, paradise tree, bitter wood.

General Properties: Color yellowish-white or straw colored; uniform except for occasional oily streaks; is subject to blue stain. Sapwood not clearly defined.

Odorless; taste bitter.

Light but firm. Sp.Gr. (air dry) 0.40 weight about 25 lbs. per cu.ft. Grain usually straight. Texture rather course to medium. Wood as easy to work as white pine.
Does not warp or check, holds its place, glues up well, and is easy to stain, paint, or varnish; resistant to insects but not to decay.

**Growth Rings:** Absent or indistinctly marked by parenchyma lines and sometimes by gum ducts.

**Parenchyma:** Fine, irregular, white lines connecting pores; sometimes more or less concentric, fairly abundant and distinct, sometimes only as wings to pores and much less distinct, scarcely visible on longitudinal surface.

**Pores:** Variable from rather small to rather large; distinct; open, fairly numerous to comparatively few; evenly distributed; solitary or subdivided radially.

**Vessel Lines:** Usually long, straight, and very distinct, appearing darker than background.

**Vessel Contents:** Some contents of a gummy nature noted.

**Rays:** Fine and inconspicuous, but visible with lens on all sections; storied.

**Gum Ducts:** Usually present. Few to many vertical ducts of normal occurrence in narrow tangential series; sometimes widely spaced, and may be absent in small specimens. Oily contents produce prominent streaks on surface of wood.

**FAMILY:** Euphorbiaceae

**GENUS:** Hura

**SPECIES:** Hura crepitans L. Can be substituted for yellow poplar

The tree is very common throughout Brazil and is sometimes 100 feet high, with a large-limbed, wide spreading crown and a trunk that is sometimes six feet or even as
much as nine feet in diameter. The bark is rather smooth, except for the multitude of conical prickles which usually beset the lower portion of the trunk, particularly of the young trees. The leaves are about the size and shape of those of our cottonwood, but are dull on both surfaces and show numerous prominent ribs on the under side. The dark red flowers are borne in the form of a cone, and while not large, are fairly conspicuous on account of their profusion.

The wood is not yet established in the American market, though attempts to that end are being made. The soft and light but firm wood is very uniform, easy to work, and can probably be employed successfully as a substitute for many of our soft woods. It has a high, silky luster and enough figure to make it suitable for certain classes of furniture, cabinetwork, and interior trim, being readily stained any desired color. It takes glue well and can be used for plywood and corestock for veneering.

The Wood

Hura crepitans L.                Possum wood

**Common Names:** Hura wood, possum wood, rakuda (U.S. trade), sandbox, haba.

**General Properties:** Color pale yellow, creamy white, or grayish yellow to yellowish-brown, often streaked; lustrous. Sapwood white.

Odor and taste absent or not distinctive.

Light and soft but firm; of about the consistency of basswood.
Sp. gr. (air dry) 0.36 to 0.44. Weight 23 to 27 lbs. per cu. ft. Somewhat roe or ribbon grained. Texture medium; more or less woolly; wood easy to cut, holds its place, takes stains and glue well; dark colored wood fairly resistant to decay; attacked by shipworms.

**Growth Rings**: Indistinct to distinct; when present, due to slight difference in color and to relative abundance of parenchyma.

**Parenchyma**: In very fine and extremely numerous lines, extending from ray to ray and producing a very fine wavy pattern (invisible or very indistinct without lens).

**Pores**: Rather large and distinct; not very numerous, well distributed, occurring singly or more often subdivided radially two to several times.

**Vessel Lines**: Very distinct as coarse lines, usually darker than background; variable from long to short; appearing rather waxy or resinous.

**Vessel Contents**: Tyloses fairly abundant; lustrous. Light colored gum deposits common.

**Rays**: Very fine and only faintly visible on cross and tangential sections; visible, but fine and inconspicuous, on radial, where they are of same color as background.

**Ripple Marks**: Absent; local tendency noted in some species.

**Gum Ducts**: None observed.

**FAMILY**: Papilionatae

**GENUS**: Vouacapoua

**SPECIES**: Acapu
The acapu is a tall slender, smooth-barked tree, yielding a hard, heavy, strong, and very durable timber highly prized for certain kinds of construction and particularly for flooring in conjunction with some light colored wood. It makes an extremely durable post timber and, where abundant, is the principal material used for this purpose. Limited quantities of timber are now coming into the markets of the United States. It makes beautiful interior trim, but should be thoroughly kiln-dried before manufacture to prevent shrinkage and warping.

The Wood

Vouacapoua americana Aubl.  

Acapu

Common Names: Acapu, vacapou, bruinhart, blackheart.

General Properties: Color chocolate-brown with prominent pencil striping (vessel lines) of lighter brown. Sapwood light colored; sharply defined. Odor and taste absent or not distinctive.

Hard and heavy; rather horn-like. Sp.gr. (air dry) 0.87 to 0.92. Weight 54 to 57 lbs. per cu.ft. Grain fairly straight to somewhat roey. Texture moderately coarse; rather harsh. Not very easy to work, splits easily, takes good polish, finishes smoothly; is very strong and durable.

Growth Rings: Present or absent; sometimes distinct, due to narrow, poorly defined zones, deficient in pores and sometimes with fine broken lines of limiting parenchyma.

Parenchyma: In conspicuous patches about pores and often connecting them into irregular patterns; sometimes in short fine lines at apparent limits of growth rings.
Pores: Of medium size, but appearing large and conspicuous on account of halo of wood parenchyma; numerous, well distributed; no definite arrangement, except when connected by parenchyma into irregular diagonal rows or festoons.

Vessel Lines: Conspicuous because of parenchyma, producing light-colored stripes on dark background.

Vessel Contents: Vessels mostly open; some gum and occasional white deposits noted.

Rays: Very fine; not distinct on cross and tangential sections without lens. Distinct on radial, being lighter-colored than background. (5)

Ripple Marks: Absent.

Gum Ducts: None observed.

FAMILY: Anacardiaceae

GENUS: Astronium

SPECIES: Astronium fraxinifolium Schott.

One of the first trees in Brazil is the "goncalo alves" commonly referred to as Astronium fraxinifolium Schott. This is a well-known, though comparatively rare, tree scattered through the coastal mountain forests where it attains a height of 100 feet and a diameter of two or three feet. It is beautifully figured and is highly esteemed for the manufacture of fine furniture. The darker and heavier grades make good railway ties and are useful for any purpose requiring a strong durable wood. It is often mixed in shipments of Brazilian rosewood and is known in the furniture trade as Zebra wood and sometimes as kingwood.
The Wood

Astronium fraxinifolium Schott.  Goncalo Alves

Common Names: Goncalo alves, zebra wood, kingwood.

General Properties: Color light to dark brown or reddish, with black stripes which may predominate; dark areas look oily, light portions deepen upon exposure. Sapwood grayish; sharply defined.

Odor and taste not distinctive.

Mostly hard and heavy. Sp.gr. (air dry) 0.85 to 1.00.

Weight 53 to 62 lbs. per cu.ft. Grain straight or roey.

Texture rather fine. Wood takes high polish; some specimens are hard to cut, others comparatively easy; dark specimens very durable; has striking and often beautiful figure.

Growth Rings: Bands of black, usually of variable width and continuity; are sometimes disposed regularly enough to form growth rings. These dark areas, which are denser than the light portions, appear to begin rather than end the growth rings, since the inner edge is more sharply defined than the outer.

Parenchyma: Not distinct even with lens.

Pores: Small, but usually distinct, especially in dark bands. Usually well distributed; occurring singly or more often in small groups.

Vessel Lines: Fine; visible without lens, at least in darker areas; low, but distinct, on radial surface, appearing either lighter or darker than background, depending upon its color.

Ripple Marks: Absent.
Gum Ducts: Present in some of the rays; showing as small black dots on tangential surface; contents oily. (s)

FAMILY: Papilionatae
GENUS: Dalbergia
SPECIES: Dalbergia nigra Fr. Allem.

This wood, one of the best known from the Brazilian forests, has been an important article of export from northeastern coastal forests for over 300 years.

Brazilian rosewood attains a height of 125 feet or more, with a rather short, irregular, often buttressed bole, often three or four feet in diameter. The ultimate branches are fine; the leaves are pinnate with numerous small leaflets; and the pods are small, thin and few seeded. The trees are deciduous or nearly so. The bark is brown in color and slightly ridged or scaly. Only the heartwood is commercial and when the thick sapwood is hewn off the logs are rarely more than 18 inches in diameter. These are frequently decayed in places and it is not an uncommon practice to whip-saw the logs through the middle and hew out the defective portions. The heartwood of the young trees is brown and not attractive and, in fact, it is only from old defective trees that the highly fragrant wood with rich purplish-black marking is obtained. The natives often refer to the young second growth timber as white rosewood ("jacaranda branco"), but investigation has shown that it is botanically the same as the species yielding the commercial timber.
Brazilian rosewood has been extensively used for furniture and cabinet making, but at present there is little demand for it for these purposes in the United States, the principal use here being for spirit levels, butcher-knife handles, and to a minor extent for billiard tables and phonograph cabinets. It is probable that with changing styles in furniture there will be a larger demand for rosewood.

The Wood

**Dalbergia nigra** Fr. Allem.  
**Brazilian Rosewood**

**Common Names:** Brazilian rosewood, palisander wood, jacaranda wood.

**General Properties:** Color chocolate or violet-brown, irregularly and conspicuously streaked with black; rather oily looking. Sapwood nearly white; sharply, but irregularly defined.

Has a mild but distinct fragrant odor which gives rise to the name rosewood; very characteristic; may not be present in wood from young tree.

Taste distinctive, but not definable.

Hard to heavy. **Sp.gr.** (air dry) 0.85. Weight about 53 lbs. per cu.ft. Grain mostly straight; sometimes wavy. Texture medium. Wood has excellent cabinet qualities, easy to work, holds its place, is durable; some specimens too oily to take a high polish.

**Growth Rings:** Present or absent; often distinct; when present due to differences in color or to narrow poreless zones, or to more pronounced and regular parenchyma lines.
Parenchyma: Inconspicuously about pores and in very irregular concentric and tangential lines; some continuous and apparently limiting seasonal growths, while between them are few to many irregularly spaced, broken lines, often poorly defined; sometimes visible without lens and sometimes scarcely visible with it.

Pores: Variable in size; most of them rather large and distinct; not very numerous; irregularly distributed; single or subdivided radially; round or oval in shape; mostly open.

Vessel Lines: Distinct, but not conspicuous, being of about the same color as the background; mostly long. Under lens the empty vessels show distinct and regular segmentation.

Vessel Contents: Dark gum deposits very common, often filling vessels completely, especially in darker portions of the wood.

Rays: Very fine; not visible on cross and tangential sections without lens; visible, but fine and not very distinct, on radial.

Ripple Marks: Present; all elements storied; fairly regular; sometimes faintly visible without lens; 125 to 130 per inch.

Gum Ducts: None observed.

FAMILY: Caesalpinioideae

GENUS: Caesalpinia

SPECIES: Caesalpinia echinata Lam.

This species is common in the coastal forests of eastern Brazil from the vicinity of Bahia southward.
The forest grown tree attains a height of more than 100 feet, with a slender symmetrical bole upward of three feet in diameter, clear of branches for 50 or 60 feet and covered with a thin, rough bark. The leaves are doubly compounded, with many small leaflets somewhat like those of the honey locust.

The early demand for this wood was so great that the business was made a royal monopoly, and private exploitation was strictly prohibited. The methods of exploitation were wasteful and without any regard to the future of the forests. It is said that many of the early planters felled trees on their estates and used the wood for fuel in order to avoid governmental regulations. Such practices resulted in the extermination of this tree in the accessible regions along the coast, and the continuance of the industry has been dependent on extension of operations into regions where accessibility is difficult.

The wood which now enters the market is in the form of short logs often small and irregular. The lots are usually picked over in the search for straight-grained, fine-textured pieces for making violin bows. The remainder is usually ground up and used to make dyestuffs. The dye is similar to that obtained from cochineal and alizarin, and are used chiefly in dyeing and printing calico.

The Wood

*Caesalpinia echinata* Lam.  
**Brazilwood**

**Common Names:** Brazilwood, pernambuco, Para wood, peachwood.
General Properties: Color bright orange, fairly uniform except for occasional darker striping; lustrous; turns deep red or reddish-brown upon exposure. Sapwood thin; white or yellowish.

Odor and taste absent or not distinctive.

Very hard, heavy, compact. Sp.gr. (air dry) 1.24; (oven dry 1.21. Weight (air dry), about 78 lbs. per cu.ft.

Grain variable from straight to more or less interwoven. Texture fine. Wood takes a high polish, is strong and resilient, very durable.

Growth Rings: Usually present, but not always distinct, even with lens; limited by fine line of parenchyma.

Parenchyma: Inconspicuous about pores, sometimes connecting them irregularly; also limiting growth rings and sometimes in two or more very fine and often poorly defined concentric lines within each ring, mostly independent of the pores; produces faint patterns on tangential surface.

Pores: Very small, but visible on account of narrow halo of parenchyma; numerous to abundant, fairly well distributed; mostly singly, but often in radial groups of two to five, sometimes linked by parenchyma into short tangential or diagonal rows.

Vessel Lines: Very fine, numerous, inconspicuous.

Vessel Contents: Sometimes reddish gum deposits occur.

Rays: Very fine; invisible or at limit of vision on cross and tangential sections; visible, but inconspicuous, on radial, where they appear darker than background.

Ripple Marks: Present; all elements storied; rather ir-
regular; varying from faintly visible without lens to fairly distinct; about 90 per inch.

Gum Ducts: None observed. (5)

In addition to the above detailed descriptions there are certain species that are being imported into the United States to a certain extent at the present time which should be mentioned. (6)

Their names and some of their uses follow:

Louro: (Cordia excelsa, D. C.) Cardiaceae. Used in furniture and cabinet making, window frames, barrels, and waterworks etc. (4)

Oleo Vermelho: (Myrospernum erythroxylum, Fr. All.) Leguminosae. Applied in furniture, railway ties, cabinet making, flooring, etc. It is known as "Balsamo" in Minas Geraes and as "Pau sangue" (blood wood) in Parana. (4)

Pau Mulato: (Calycophyllum spruceanum Benth) Rubiaceae. Shipbuilding, outdoor woodwork, furniture, cabinet making, etc. Known in Para as "Pau Red". (4)

Pau Setim: (Aspidosperma eburuem, Fr. All.) Apocynaceae. Commonly employed in high grade furniture, owing to its pale yellow color. It is fine for flooring alternated with other darker woods. It is also known as "Pau amarello" (yellow wood). (4)

Pequia: (Caryocar brasiliensis, St. Hil.) Caryocaraceae. A tough wood though porous. Applies in shipbuilding, house construction, furniture, canoe ribs, pestles, etc. (4)

Mura: (Muiracotiara) Because of the striking effects presented in both the striped and mottled varieties, is
especially adaptable for paneling of rooms where variation of color is desired; also for cedarlined chests and flooring.

**Andiroba:** Andiroba is of the mahogany family. Some of the purposes for which it has already been found particularly advantageous are radio cabinets, embellishment of automobile bodies, for models and forms used in automobile and other factory work, caskets and show cases. Andiroba is being sold on the New York market to some extent at the present time as a substitute for Phillipine mahogany.

**Brazil Nut:** (Castanheira) has characteristics suitable for general carpentry; its walnut-like appearance also suggests many uses where one of the walnut species are ordinarily called for in general cabinet work.

**Sucupira:** Sucupira in its unusual blend of color, is much like the old English weathered or fumed oak; it lends itself to treatment in the Gothic period, especially for church work.

**Arc Wood:** (Pau d'arco) while suitable for structural work (already used for piling and general construction work) has also been found so easily workable that its attractive dark coloring has appealed to many for cabinet purposes.

**Massaranduba:** Massaranduba is essentially a structural wood and, as such, has been known. Its unusual strength promises its ultimate use on a large scale for dock construction, for railroad work, piling, dance floors, picker sticks, etc.

In addition to the cabinet trades, use for one or another of these woods has already suggested itself in
sixty different industries, many of which have actually proceeded so far in their experimental use that many orders in commercial quantities are being received. (4)

It is interesting to note the recent increase in Brazil's exports of woods. Present export trade does not begin to indicate the country's possibilities, as Brazil has some of the most extensive forests in the World and scores of types of beautiful and useful woods. From 1934 to 1937, shipments abroad were as follows: 1934-136,188 tons; 1935-167,177 tons; 1936-191,087 tons; 1937-261,057 tons. (e)

In view of the heavy orders received in recent months from foreign buyers, it is expected that shipments in 1938 will exceed 1937 and earlier years. (4)
PART III

Some By-products of South American Woods

So far no mention has been made of the hundreds of by-products produced in South America. Some of these by-products are of great importance in the industries of the world. (1)

Rubber: North Brazil may be correctly cited as the first home of rubber, one of the world's most necessary and useful commodities, although Brazil, since the advent of the Far Eastern plantations, no longer furnishes, as she once did, the overwhelming proportion of the world's output of this product, the name Para, taken from the state of that name in North Brazil and descriptive of the highest quality rubber, still retains its fame on the world markets.

Cocoa: Cocoa is another of the numerous Brazilian commodities, which, when its development is traced, gives evidence of having originated in the fertile basin of the Amazon. (2)

The state of Bahia contributes approximately 98% of Brazil's total cocoa output and about 10,000,000 acres of land in this state are devoted to its cultivation.

Oilseeds and Nuts: The uses of oilseeds and nuts, like their origins, are innumerable and widespread. They go into the making of a great and increasing number of industrial products, such as soap, paint, cosmetics, lubricants, linoleum, oilcloth and insulating materials, while they are indispensable and basic as a constituent
of foods.

Babassu: The commercial discovery of the Brazilian babassu nut during the world war opened up a promising field of vegetable oil exploitation that has as yet been scarcely entered upon. Conservative estimates of the Brazilian resources of this nut indicate that hundreds of millions of babassu palm grow in the territory stretching from Bahia to Amazonas. (9)

The babassu tree, a tall, fan-shaped palm botanically classified as the Orbignya speciosa, bears from 200 to 600 nuts on a bunch and yields three or four of these bunches, or heads a year. The nut resembles a large lemon in size and shape.

Oiticica: Another of the numerous Brazilian oil trees that has attracted commercial interest, is the oiticica, a native of northeastern Brazil.

The tree, which may attain a height of fifty feet, is found principally in the states of Ceara, Bahia, and Paraiba. The oil that comes from the seeds of the oiticica has excellent drying properties and is classed with linseed and tung for its suitableness in making paints and varnishes. (9)

Brazil Nuts: The Brazil nut, known in Brazil as the Castanha do Para from the name of the state in which it is most abundantly found, is familiar to everyone in the United States as a choice eating nut, commonly called "nigger toes". In Great Britain and the United States, the two principal buyers, the nuts are sold for use in making confectionery.
Cashew Nuts: Vying with the Brazil nut in popularity as a delicacy is the cashew nut or caju. The cashew nut is small and kidney-shaped and is borne at the end of a fleshy fruit produced by the tree Anacardium occidentale. This tree is found growing wild in several of the states of north Brazil, particularly in Pernambuco. (9)

Mamona: Castor oil, or mamona oil, as it is called in Brazil, is derived from the seeds of the castor plant, Ricinus communis, a tropical and sub-tropical growth varying in size from six to thirty-five feet and occurring in a wild state throughout northeastern Brazil. In addition to its well-known proficiency as a medicine, castor oil has a wide variety of other uses, such as in the manufacture of soaps, inks, and imitation leather, in the dyeing of fabrics, and as lubricants, perfume fixatives and illuminants. (9)

Coconut Palm: The coconut palm, (Cocos nucifera) which today furnishes a great proportion of the world's soap oils, grows abundantly in north Brazil, particularly along the coast. (9)

Carnauba Wax: Carnauba wax, derived from the leaves of the carnauba palm, (Copernicia cerifera), is a valuable raw material for the manufacture of automobile, floor, furniture, and shoe polishes, phonograph records, carbon paper, varnishes, candles, insulation material for cables and numerous other articles. In volume, it is the most important vegetable wax brought into the United States from abroad. (9)
The carnauba palm grows to a height of 50 or 60 feet and has a crown of broad, webbed leaves. The wax, a natural protective covering against moisture evaporation, forms on the leaves and eyes, which are cut off with a pruning knife attached to a long pole. They are sun-dried for 2 or 3 days and the wax is then removed by any of various methods. A common one is beating, or whipping, which causes the wax to fall in dust particles onto a collecting sheet from which it is gathered and placed in pots and either boiled with water or heated alone. The method of heating and the origin of the wax, that is, whether it comes from the leaves or the eyes, partially determines its export classification and price.
PART IV

A Future For South American Hardwoods in Fulfilling The Demands of North American Hardwood Markets

The hardwood consuming industries, particularly those along the Atlantic seaboard, are beginning to appreciate that tropical hardwoods are becoming an important factor in the industry of the United States, and are destined to take an important part in the near future.

The American manufacturer will not always be able to obtain an unlimited quantity of any one species and grade. He will soon be compelled to readjust his manufacturing and marketing methods to meet a new condition. The days will soon be past when the furniture manufacturer can continue to produce the same identical furniture from the same wood.

His problem will then be to change over his plant and marketing and use the new woods efficiently.

A very large percentage of hardwoods used in the United States can be grouped in ten or so industrial classes without regard for their botanical relationship. Tropical hardwoods would naturally fall into these major divisions along with the domestic species.

The plywood industry is a very large user of the best of American hardwoods, and an industry that is progressing very rapidly. In regard to face stock, a partial abandonment of standardized finish would make an immediate market for a large number of very beautiful tropical hardwoods.
There are a great many woods that can be used interchangeably for cores.

Fortunately this industry is best located to take immediate advantage of the opportunity of importing hardwoods, can take the stock in the log, and has the greatest need for clear high grade logs.

Tropical hardwood logs have all the qualities that are most desirable. These logs are straight, clear, of good size, cylindrical and cut to a high percentage of clear lumber. The plywood industry can well afford to pay for these qualities.

The inevitable result will be that the manufacturing of furniture, flooring, finish, etc., will, out of necessity lay aside their old standards, and we shall see a great deal more diversity in finished wood products than we have in the past. Now, almost all furniture is made of oak, walnut, gum, or mahogany. Public taste and industrial necessity both demand a change. The automotive industry is already abandoning the standardized finish, particularly regarding color.

Standardized parts require not only shape and dimension, but also standardization of physical characteristics. The obvious solution to this problem is to classify the woods according to their physical characteristics, rather than their botanical families.

The greatest bug bear of the American wood-using industry that tropical competition will ruin their business
is without foundation. These interests will naturally acquire tropical holdings, logs will be exported, manufactured by American plants, and flow through the existing channels to the ultimate consumer. (2)

The greatest danger to our wood-using industries is a sudden cutting off of an adequate supply of high-grade material, resulting in the use of substitutes.

Tropical hardwoods are to be a potential factor in the markets of the future. The trade must accept this phase of the situation, and it will be wise for them to cooperate at this time in all measures which will protect their industries and enable them to profit through their use rather than wage a losing fight to retard their introduction.
BIBLIOGRAPHY

5. Samuel J. Record--"Timbers of Tropical America."