H. H. Chattaway

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TROPICAL WOODS

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A technical magazine devoted to the furtherance of knowledge of tropical woods and forests and to the promotion of forestry in the Tropics.

The editor of this publication and the writer of any articles therein, the authorship of which is not otherwise indicated, is ROBERT W. HESS, *Associate Professor of Forest Products, Yale University School of Forestry.*

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STUDIES OF THE TREES OF BRITISH GUIANA*
III. WALLABA *(EPERUA* SPP.)

By D. B. FANSHAWE
Assistant Conservator of Forests, British Guiana

VERNACULAR NAMES

Soft Wallaba *Eperua falcata* Aubl.
Ituri Wallaba *Eperua grandiflora* (Aubl.) Bth.
Wallaba (trade); Yoboko (Arawak); Parewe (Carib).

BOTANY AND ECOLOGY

The Tree.–Semideciduous; canopy trees reach 32 inches in diameter and 100 feet in height, usually 16 to 24 inches in diameter and 80 to 90 feet high; bole 40 to 60 feet, basally

*For Part I see *Tropical Woods* 90: 30; Part II, *Tropical Woods* 92: 25.

swollen or with low buttresses; stem form good, cylindrical, with little taper; branches erect, slender, crown light, rounded or oval; bark grey-black or black-brown, faintly striated, smooth *(E. grandiflora* lighter colored and smoother than *E. falcata);* slash chestnut-brown to pink-brown, thickish, fibrous, tough.

Leaves.—Paripinnate, 2 to 5 paired; leaflets opposite, oblong, acuminate, chartaceous to leathery, finely reticulate or foveolate, smooth, 10 to 18 × 4 to 6 cm. *(E. falcata)*, 6 to 10 × 3 to 5 cm. *(E. grandiflora).*

Flowers.—*E. falcata:* Inflorescence ashy-brown, pubescent, on an elongated pendulous peduncle ½ to 2 meters long, bearing terminal raceme of pale pink to deep crimson flowers; receptacle campanulate; sepals 4, imbricate, 1.5 to 2 cm. long; petal sessile 3 × 2 cm. the other 4 wanting; 5 fertile stamens alternating with 5 sterile ones; filaments villose, 5 cm. long, ovary stipitate, pubescent.

E. grandiflora: Inflorescence short, erect, terminal or in upper axil, sericeous; receptacle campanulate; sepals 4, imbricate, leathery, 12 mm. long; petal sessile, mauve-purple, 2.5 cm. long; stamens 10, fertile, 9 obliquely connate, one free; ovary glabrous.

Fruit.—*E. falcata:* Falcate, oblong, compressed, brown, woody, 2 to 5 seeded, 20 to 30 × 6 to 8 cm., seed ovate, flat 4 × 2.5 cm., testa thin, fragile, brown; weight 17 gm., 24 to 28 per pound.

E. grandiflora: Rounded angular or oblong, compressed, brown, woody, 5 × 3 cm., seed one, flat, oblong 4.5 × 2.5 cm.

Habitat.—Gregarious and strongly dominant on the white sand relict peneplain of the near interior, separately or in association. *E. falcata* is the more mesophytic species, is dominant over *E. grandiflora* in the West and also occurs scattered throughout the rain forest, while *E. grandiflora* is more xerophytic, is restricted to the white sands but dominates *E. falcata* in the eastern districts. Other species occur as riparian trees and in the Mora forests of the far interior.

Stocking.—The stocking of sound, merchantable timber 16 inches in diameter and upwards, averaged over all types of forest in cubic feet per acre for the various districts, is as follows:

District	Cubic feet per acre
Barama-Waini	10
Cuyuni-Essequibo-Supenaam	110
Cuyuni-Mazaruni	170
Mazaruni-Essequibo	230
Essequibo-Demerara-upper	200
Essequibo-Demerara-lower	230
Mahaicony	30
Berbice-Corentyne	100

These figures should only be considered relative to each other. Where variations have been made in country largely covered by Wallaba forest the volume rises to 500 to 600 cubic feet per acre.

The volume in Wallaba forest cut over for firewood (timber down to 4 inches in diameter is included) runs from a minimum of 1100 to a maximum of 3600 cubic feet per acre.

Distribution.—Widely distributed throughout the Colony even in the extreme southern tip but more abundant in the near interior, following the white sand formation. They occur throughout the Guianas and *E. falcata* is found in Pará, Brazil.

Silviculture

Phenology.—General flowering takes place annually from mid-August to mid-December with a peak in October. *(E. falcata* usually commences flowering before *E. grandiflora.)* Occasionally general flowering may commence in June or July on a few trees and not finish till January of the following year or take place in two waves, an early one and a late one. Every 2 or 3 years casual flowering takes place from March to May. February is the only month without a flowering record.

Fruiting occurs annually from February to April, occasionally as early as January or as late as May or even June, with a heavier crop every 2 or 3 years. Casual fruiting in November is very rare.

Seed Dispersal.—The seeds are dispersed mechanically by the dehiscence of the fruit on the tree, and by animals which carry the fruit away to eat and leave a portion. Dehiscence of the fruit throws the seed into a zone two to three times the diameter of the crown.

Survival.—Seed remains viable for many months after it has dried out. Mortality among seedlings after germination is very low.

Germination.—Hypogeal. Germination takes place in 4 to 10 weeks, mostly in the fourth and fifth week. Percentage of germination in the nursery is good to very good, 50 to 100 percent with dibbled seed. In the field the percentage of germination is consistently high.

Seedlings.—(a) Nursery. Cotyledons open flat and turn green. First leaves are flaccid, drooping, but similar in shape to mature leaves, grey green *(E. grandiflora)*, crimson and one sided *(E. falcata)*. They harden up in 1 to 2 weeks. The leading shoot does not straighten up until well into the sapling stage. Growth is moderately slow, 4 to 6 inches in 2 weeks and 10 to 15 inches in 12 months for the shoot, and 7 to 8 and 8 to 9 inches respectively for the tap root. Branch roots are most numerous just below the root collar and are up to 4 inches long by 12 months *(E. falcata)*.

(b) Natural. Similar to the above but more vigorous. They can stand moderately heavy shade conditions. They are extremely tenacious of life. If the leading shoot is destoyed, another one will arise time after time to replace it.

Nursery Practice.—Dibbling of seed under shelterwood is the most satisfactory procedure. Dibbling without shelterwood is successful provided the seeds do not dry out completely.

Plantation Practice.—No information.

Silvicultural Characteristics.—Moderate shade bearer, coppicing freely at any stage from seedling to mature tree, extremely shallow rooted especially on the white sand peneplain, hence not wind-firm. Trees in Wallaba forest become hollow at an early age—large trese are often merely shells.

Sociability.—Strongly gregarious on the white sand peneplain because of its capacity to withstand the extreme conditions of that habitat. Wallaba forest carries as many as 60 stems of Wallaba to the acre (4 inches and upwards in diameter breast height). The number of trees of Wallaba per size class per acre is approximately as follows:

Diameter class, inches	<4	4-8	8-12	12-16	16-20	20-24	>24
Number of trees per acre	26	15	15	12	12	6	1

Rate of Growth.—In virgin forest the rate of growth of poles and trees is extremely slow, 0.17 (0.11 to 0.24) inches of girth per annum. This means that a tree will reach maturity (16 inches dbh.) in 300 years. In forest from which the larger trees have been removed for firewood, i.e. opened up, the remaining poles show a mean annual girth increment of 0.33 (0.28 to 0.40) inches. This means that a tree will reach the 16-inch dbh. size class in 150 years.

Regeneration.—Observations in natural Wallaba forest indicate that regeneration is present at the rate of approximately 3,000 seedling per acre, but with a tendency to erratic distribution, i.e. abundant in individual small patches but sparse or absent elsewhere. After exploitation stocking of seedlings may drop to approximately 2,000 per acre and, provided adequate overhead cover is retained, observations indicate that this stocking will be maintained for at least 6 years. After clear-felling however, soil degradation occurs so markedly that the ecological succession is altered to an extent which would appear to preclude the regeneration of Wallaba.

Response to Treatment.–Opening of the canopy and vine cutting has been tried on a small area of Wallaba forest exploited for firewood 6 years previously. The seedlings respond by faster, more vigorous growth in the early years but no growth data are available.

Pests.–The seed is eaten by rodents (acourie, labba, etc.) when there is a scarcity of other more palatable seed. Young fruit is occasionally destroyed by macaws and parrots.

Properties and Utilization

The Log.–As Wallaba is largely used in the riven state, maximum log sizes are immaterial. Transmission poles, however, can be obtained up to 60 feet long with butt diameters of 8 to 12 inches when fashioned. Trees acquire heart rot at an early age and many large trees are unsound. The percentage of unsoundness in trees of all sizes is from 15 to 20 percent.

The Wood.–(a) Macroscopic features. Sapwood dirty white, 1 to 2 inches thick, with resinous streaks, sharply defined from the dull red or reddish purple heartwood; surface streaked with gummy exudations in concentric rings; concentric zones of denser wood occur in the heartwood at irregular, radial intervals. Fresh sawn wood has an unpleasant odor of creosote or butyric acid; non-lustrous.

Growth rings distinct, marked by parenchyma. Concentric zones of denser, darker wood occur at irregular intervals. Pores distinct to naked eye, evenly distributed, 2 to 4 per sq. mm., occasionally containing gum. Parenchyma apparently terminal only. Rays 3 to 7 per mm., very distinct on radial surface. Intercellular canals filled with gum associated with the terminal parenchyma. Ripple marks absent.

(b) Microscopic features. Fiber length 1.4 (0.6 to 2.0) mm. Fiber diameter .015 (.005 to .028) mm.

Physical Properties.–Specific gravity 0.85 to 0.95 (0.75 to 1.04); weight 62 (57 to 66) lb. per cu. ft. air dry, 70 lb. per cu. ft. green. Odorless or mildly rancid, tasteless, dense, texture medium to coarse, grain even, straight. Very hard, stiff, heavy and strong. Contains a resinous mucilage of little known use. Durable, strongly resistant to termites and decay.

Working Properties.–Works easily with machine tools but hand tools give more trouble, especially hand planing. Radial splits and cup shakes may occur during conversion. A mixture of kerosene and water must be applied to saw teeth to keep them from clogging with the gum. Polishes reasonably well after filling, stains readily with both oil and spirit stains and turns well. Splits straight and clean normally but takes nails badly. *E. falcata* is easier to work and splits more freely than *E. grandiflora*.

Mechanical Properties.–The wood's hardness, bending strength and stiffness under gradually applied loads and its compressive strength along the grain are in proportion to its density. Its resistance to shock loads and splitting are proportionately not so high. Compared with Oak, Wallaba in the green state is 40 percent heavier, 40 percent harder, and 75 percent stronger and stiffer in bending under gradually applied loads.

Data on moduli of rupture and elasticity have been calculated by Plasschaert in Surinam in 1907 and Bell Laboratories Inc. in the U. S. A. in 1937.

	Surinam (68 lb./cu. ft.)	U. S. A. (73 lb./cu. ft.)
Modulus of Rupture	1050 kg./cm².	10,000 lb./sq. in.
Modulus of Elasticity	170,000 kg./cm².	2,400,000 lb./sq. in.

Complete mechanical data from the Forest Products Research Laboratory, Princes Risborough, England, are given below.

Static bending		
F.S. at L.P.	lb./sq. in.	9,860
Eq: F.S. at M.L.	lb./sq. in.	12,980
M. of E.	1000 lb./sq. in.	2,172
Work to L.P.	inch lb./cu. in.	2.52
Work to M.L.	inch lb./cu. in.	8.8
Total work	inch lb./cu. in.	11.3

Impact bending (50 lb. hammer)		
F.S. at L.P.	lb./sq. in.	16,470
M. of E.	1000 lb./sq. in.	2,988
Work to L.P.	inch lb./cu. in.	5.06
Maximum drop	inches	23
Compression parallel to grain		
F.S. at L.P.	lb./sq. in.	6,140
Eq: F.S. at M.L.	lb./sq. in.	8,220
M. of E.	1000 lb./sq. in.	2,561
Compression perpendicular to grain		
F.S. at L.P.	lb./sq. in.	–
Hardness		
Radial surface	lb.	1,551
Tangential surface	lb.	1,304
End surface	lb.	1,451
Shear		
Radial plane	lb./sq. in.	–
Tangential plane	lb./sq. in.	–
Cleavage		
Radial plane	lb./in. width	277
Tangential plane	lb./in. width	499
Tension perpendicular to grain		
Radial plane	lb./sq. in.	–
Tangential plane	lb./sq. in.	–
Specific gravity	O.D. weight / Volume at test	0.762
Moisture content, percent		57.9
Weight per cu. ft. at 50% moisture content	lb.	71.3

Abbreviations:
Eq:–Equivalent
F.S.–Fiber stress
L.P.–Limit of proportionality
M.L.–Maximum load
M. of E.–Modulus of elasticity (Young's)
O.D–Oven-dry

Seasoning Properties.–As the timber is used in the round or riven state, seasoning is rarely necessary. Air seasoned under cover, the timber dries very slowly with a slight tendency to split. Distortion, checking and honey-combing resulted while trying to dry the wood uniformly to center with kiln seasoning.

Uses.–Building construction: Foundations, pillar trees, sills, joists, framing, roofing and siding shingles, veranda posts, fence posts, paling staves, rustic building.

Land communications: Transmission poles, flag poles, sign posts, railway sleepers, bridge trestles, shoring.

Agricultural and Industrial: Vat staves for seasoning rum, mining timber.

Fuel: (a) Firewood. Oven-dry wood has a calorific value of 8,500 BTU per pound which compares favorably with coal (12,000 BTU per pound). In actual practice 2¾ tons of firewood are required to furnish the heating power of one ton of coal, the wood having a moisture content of 35 to 40 percent as used in the furnace.

(b) Charcoal. Calorific values of charcoal are: *E. falcata* 13,200 to 13,800 BTU (7,300 calories). *E. grandiflora* 11,600 BTU (6,450 calories). The results of using Wallaba charcoal in a portable Parker producer gas plant as fuel to drive a Ford ton truck are as follows:

E. falcata	2.11 ton miles per lb.	1.03 miles per lb.
E. grandiflora	1.935 ton miles per lb.	0.94 miles per lb.

Pulp: For many years the use of Wallaba for pulp and paper has been under consideration, but tests have been somewhat conflicting. Further investigations are now being carried out.

Service Tests.–The General Post Office in British Guiana reports that the average life of untreated transmission poles is 20 years but some are in good condition at the end of 30 years.

Minor Uses.–The bark contains 4 percent tannin, is bitter and used locally as an emetic and for curing diarrhoea and dysentery. For diarrhoea a half pound of bark should be boiled in 5 pints of water and a wineglassful of the infusion drunk three times daily. The inner bark is used to cure toothache.

The wood contains 8 to 25 percent resinous substance; it is more abundant in *E. grandiflora* than in *E. falcata*, in young trees than in old trees, and in heartwood than in sapwood. The resin is soluble in dilute solutions of caustic soda and sodium carbonate, in alcohol and acetone but not in other organic solvents. The extract from alcohol is dark, reddish-brown, soft and friable with an odor of butyric acid. It has no definite melting point but softens at 200° C. and partly melts at 250° C. It is highly acid and cannot be bleached satisfactorily. The high acidity and intensity of color render the gum valueless for most purposes for which similar gums are used commercially. The resin exerts some water-proofing action when mixed with loamy soil in the proportion of 4 percent by weight, but is not as effective as "Vinsol" in this respect. The resin has a low molecular weight (114 approx.) and at least one acidic hydrogen atom, as a result of which it can form alkali salts. Further investigations are currently being undertaken. The resin is used locally in place of Friar's balsam on cuts.

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IV. PURPLEHEART *(PELTOGYNE* SPP.)

NAMES

Peltogyne pubescens Bth. (*P. paniculata* Bth.)
Peltogyne venosa var. *densiflora* Amsh.

Purpleheart (trade); Koroboreli (Arawak); Maraka (Carib); Daba (Wapisiana).

BOTANY AND ECOLOGY

The Tree.—Semideciduous, dominant, to 4 feet in diameter and 170 feet high usually 1½ to 3 feet in diameter and 90 to 120 feet high; bole 60 to 90 feet with plank buttresses (2 to 3 feet *P. pubescens*, 6 to 12 feet *P. venosa* var.) sometimes spreading to 15-foot diameters, bole straight, with good cross section above the buttresses, tapering; branches flat-spreading, heavy; crown umbrella-shaped; bark reddish-brown to blackish-brown, granular or flaky, thin; slash brown, hard, compact.

Leaves.—Two-foliate; leaflets oblong, obtuse or acuminate, smooth, thinly leathery 5 to 10 × 2 to 5 cm.

Flowers.—In large, terminal, loosely pubescent (*P. pubescens*) corymbose panicles, subtended by deciduous orbicular bracts and bractlets; sepals 4, imbricate, 5 mm. long; receptable campanulate, 3 mm. long on a 3 to 5 mm. stalk; petals 5, pink, somewhat unequal; stamens 10 free with white filaments; ovary stipitate; style 2 times length of ovary; stigma dilated, lobed.

Fruit.—Flat-triangular, leathery, brown, veiny, unwinged (*P. pubescens*) or narrowly winged (*P. venosa* var.), dehiscent, shortly stalked 3 to 4.5 × 2 to 2.5 cm.; seed one, flat, obovate, black or brown with small arilus 3 × 1.5 cm. Mean weight of seed 0.3 gram, approximately 800 per pound.

Habitat.—Climax species, occasional to locally frequent in Wallaba forest on white sands and in marsh and swamp rain forest on river flood plains (*P. pubescens*) or occasional in rain and evergreen seasonal forest (*P. venosa* var.). The latter prefers mesophytic conditions, the former can stand xerophytic conditions where physiological drought prevails at certain seasons.

Stocking.—The stocking of sound, merchantable timber 16 inches in diameter and upwards in cubic feet per acre, averaged over all types of forest, is as follows for the various districts:

North West District	4.0
Cuyuni-Essequibo-Supenaam	19.0
Cuyuni-Mazaruni	5.0
Mazaruni-Essequibo	9.0
Essequibo-Demerara	7.0
Mahaicony	—
Berbice-Corentyne	1.0

Even on a limited area where the timber is more plentiful the volume reaches only 50 cubic feet per acre.

Distribution.—Purpleheart is generally distributed throughout the near interior, and is partly replaced by a third species (*P. porphyrocardia* Gris.) in the far interior. Some of the finest stands of *P. venosa* var. are along the Unabaruka, a branch of the Supenaam River and the Kaburi River, a branch of the Mazaruni River. Extra-territorially it is found from Mexico, Colombia and Venezuela (*P. pubescens* only) through Trinidad and the Guianas to Para, Amazonas and Rio Branco in Brazil.

Silviculture

Phenology.—*P. pubescens.* Flowering is annual and general in the near-interior, from mid-October to mid-December, occasionally as early as late September; in the Rupununi area, from June to August. Casual flowering occurs rarely in June. Individual trees flower for 6 to 10 days. Fruiting is probably annual and general during April and May. Casual fruiting occasionally takes place in November. Fruiting records are very scanty.

P. venosa var. General flowering takes place every 2 to 3 years, occasionally every year from mid-February through March. Casual flowering at any time from June to October in those years when there is no general flowering. Fruiting general in May to June corresponding to general flowering years.

Seed dispersal.—Fruits are light enough to be dispersed by wind over short distances from the parent tree (2 to 3 times the crown diameter). A certain amount is dispersed by birds and animals, as seedlings are usually found far from parent trees.

Survival.—Dry seed in an air-tight container will retain some viability for many months but the percentage of viable seed falls off steadily. The mortality percentage in the nursery after germination was nil. Mortality percentage in the forest whether as seed or after germination is apparently very high, as seedlings are extremely rare.

Germination.—Epigeal. *P. venosa* var. seeds germinate in 3 to 15 weeks (dibbled seeds faster than broadcast seeds), mostly in 3 to 8 weeks. The percentage germination is low to moderately high, 15 to 40 percent (tests in the forest nursery).

Seedlings.—(a) Nursery. Hypocotyl is weak and green, 2 to 5 inches tall. Seed leaves are whitish, withered, remain attached till first leaves begin to open, then fall. First leaves are somewhat oblique, green or purplish, similar to mature leaves and harden up in 4 to 5 weeks. The seedlings scarcely grow between 5 weeks when the first leaves are firm and 6 months, but are 9 inches tall by the end of the first year (*P. venosa* var.). Root growth is of the same order. The tap root is over 12 inches long by the end of the year with numerous branches up to 3 inches long.

(b) Natural. No information.

Nursery Practice.–Of the methods tried, dibbling under shelterwood seems to give more consistent results than broadcasting under shelterwood. Broadcast seed should be treated with red lead, otherwise small rodents carry it off.

Plantation Practice.–No information.

Silvicultural Characteristics.–Moderately good shade bearer for a dominant tree, coppicing powers limited, does not coppice at an advanced age, wind-firm although shallow to surface rooted. The leading shoot is not upright for the first few years. It has a strong, natural resistance against pests and diseases.

Sociability.–*P. venosa* var. has a tendency to be mildly gregarious in groups of 4 to 10 large trees especially on rocky sites with lateritic soils.

Rate of growth.–These are slow growing species but no growth data are available.

Regeneration.–Regeneration is sparse to rare, and scarcely ever found under the parent tree. The lower diameter classes appear to be poorly represented.

Response to Treatment.–Purpleheart seedlings along with other important species which occur in Greenheart forest are treated with the improvement fellings designed for that type of forest. No data on their response to the treatment have been collected.

Pests.–Small rodents feed on the seed. Young fruit is eaten by parrots and macaws, when there is a scarcity of other fruit. The sapwood is liable to attack by *Bostrychid* beetles. A commercial dusting powder containing 5 percent gammexane in one instance effectively controlled the attack.

Properties and Utilization

The Log.–Logs 75 feet long with a butt diameter of 3 feet are obtainable. More usual sizes for logs are 40 to 60 feet long and 1 to 2 feet in diameter at the butt. No data are available on unsoundness in standing trees, although the figure must be about 5 percent, as old trees are occasionally hollow at the base.

The Wood.–(a) Macroscopic characters. Sapwood off-white, 2 to 4 inches thick, sharply defined from the heartwood, non-durable, attacked by insects; heartwood brown when fresh, oxidizes slowly or quickly to violet-purple (*P. pubescens* turns purple sooner than *P. venosa* var.); purple color fugitive and the wood reverts after a few months to its original brown and to black-brown with age. Heating the wood also brings out the purple color; acid turns the purple color reddish, alkali turns it a dirty green. Soaking in water containing iron turns the wood black. Fresh sawn wood has an unpleasant smell. Luster "greasy"; cold to touch.

Growth rings variable in width (⅛ to ½ inch) and distinctness, but usually indistinct, initiated by a poreless zone of fibers and terminated by a fine line of parenchyma. Pores distinct to naked eye, surrounded by halo of aliform parenchyma, evenly distributed, 2 to 5 per square millimeter. Tyloses absent; dark gum plugs occur frequently. Aliform parenchyma sometimes confluent to form tangential bands. Terminal band of parenchyma prominent. Rays 2 to 4 per millimeter. Ripple marks and gum ducts absent. Timber of *P. venosa* var. can be distinguished from *P. pubescens* by the larger wood elements, especially the parenchyma which is markedly distinct to the naked eye, and the more open grain.

(b) Microscopic characters. Intervascular pits minute, with round to oval borders and slit-like apertures; fibers polygonal in section, pits simple, minute; rays 1 to 4 cells wide, 3 to 50 cells high, homogeneous, filled with red-brown gum; parenchyma 3 to 25 cells wide; pores, tangential diameter 0.09 (.07 to .12) mm.; vessel elements 0.33 (.2 to

.45) mm. long; fibers 1.36 (1.23 to 1.49) mm. long by 0.017 (.011 to .022) mm. wide; rays 0.61 (0.07 to 1.01) mm. high.

Physical Properties.—Specific gravity 0.8 to 1.0, 53 to 63 (49 to 65) pounds per cubic foot; odorless and tasteless when dry; texture medium to fine, grain usually straight, rarely interlocked with sufficient variation in shade, luster and feather striping to make panelling attractive; hard, heavy, compact, very tough (*P. pubescens* is tougher than *P. venosa* var.), strong and resilient; unplaned surface harsh to touch and finely splintery; very durable in contact with ground, highly resistant to wood destroying fungi, dry wood termites (*Cryptotermes*) and fire.

Working Properties.—The wood is moderately hard to work with hand and machine tools and needs to be run slowly through machines. Cutter tools must be of high speed steel. It saws and planes easily when straight grained; material with irregular grain requires care to prevent picking up, especially on radial surfaces. A 15° cutting angle is required for a smooth finish with interlocked grain. When the wood heats up in working, a gum exudes and clings to cutter teeth, causing over-heating of the cutting edges and a rather severe dulling effect on tool edges. It turns smoothly, requiring very little sanding to give a good finish, polishes well with wax or French Polish and takes stain well. Spirit polishes dissipate the purple color but a lacquer finish will probably hold it. It has a tendency to split when nailed. It can be veneered, using a hot glue. The wood holds its place very well when properly treated. Saw type D or E is recommended by the Forest Products Laboratory, Princes Risborough.

Mechanical Properties.—In strength Purpleheart is intermediate between Oak and Greenheart (*Ocotea*). Compared with Oak it is 100 precent harder, 50 percent stronger in bending and compression along the grain, 70 percent stiffer and more resistant to shock loads and 40 percent stronger in shear and resistance to splitting. Compared with Walnut it is stronger in bending and compression, stiffer, more

elastically tough, weaker in resistance to splitting, harder and heavier.

As a result of shock loading (e.g. use as shunting poles) thunder-shakes and cross-fractures develop.

The hardness as shown by tests at Duke University School of Forestry is 2,050 pounds at 5.6 percent moisture content. Tests on its screw-holding power by Duke University show that it is just superior to Greenheart in this respect. The forces in pounds necessary to withdraw No. 6 and No. 10 screws embedded to the limit of the thread on side and end grain are:

	Side	End
No. 6	870	800
No. 10	980	870

Tests in Surinam in 1907 by Plasschaert on material weighing 55 lb./cu. ft. show: Modulus of Rupture 1,300 kg./cm.², Modulus of Elasticity 180,000 kg./cm.²

Complete mechanical test data by the Forest Products Research Laboratories in (1) England and (2) Canada give the following results for Wallaba:

		(1)	(2)
Static bending			
F.S. at E.L.	lb./sq. in.	9,600	13,450
Eq: F.S. at M.L.	lb./sq. in.	14,980	23,070
M. of E.	1000 lb./sq. in.	2,257	3,154
Work to L.P.	in. lb./cu. in.	2.33	3.20
Work to M.L.	in. lb./cu. in.	12.8	—
Total work	in. lb./cu. in.	34.8	—
Impact bending (50 lb. hammer)			
F.S. at E.L.	lb./sq. in.	20,230	—
M. of E.	1000 lb./sq. in.	2,992	—
Work to L.P.	in. lb./sq. in	7.65	—
Maximum drop	inches	41	—
Compression parallel to grain			
F.S. at E.L.	lb./sq. in.	5,840	—
Eq: F.S. at M.L.	lb./sq. in.	7,890	13,210
M. of E.	1000 lb./sq. in.	2,369	—

Compression perpendicular to grain			
F.S. at L.P.	lb./sq. in	1,457	–
Hardness			
Radial surface	lb.	2,184	1,997
Tangential surface	lb.	2,022	2,182
End surface	lb.	2,080	2,250
Shear			
Radial plane	lb./sq. in.	1,764	–
Tangential plane	lb./sq. in.	1,966	–
Cleavage			
Radial plane	lb./in. width	487	378
Tangential plane	lb./in. width	563	
Tension perpendicular to grain			
Radial plane	lb./sq. in.	1,013	–
Tangential plane	lb./sq. in.	1,362	–
Moisture content	percent	50.0	14.2
Weight per cu. ft. at above moisture content	lb.	70	53

Abbreviations:
Eq.–Equivalent
F.S.–Fiber stress
E.L.–Elastic limit
L.P.–Limit of proportionality
M.L.–Maximum load
M. of E.–Modulus of elasticity
(1)–Forest Products Research Laboratory, England
(2)–Forest Products Research Laboratory, Canada

Seasoning Properties.–Air. Seasons easily and well but slowly with little or no degrade and very little end-splitting or checking.

Kiln. Thin lumber dries readily and well with little degrade but thicker lumber requires special handling as it is difficult to remove the moisture from the center of the plank. Kiln schedule V (F.P.R.L., England) is recommended.

Shrinkage in drying from green to 10 percent moisture content:

	F.P.R.L., (England)	Duke University
Tangential	9/16 inch per ft. or 4.8%	5.8%
Radial	¼ inch per ft. or 2.2%	3.8%

Uses.–Building construction: Sills, joists, framing, flooring, siding, doors, window sashes, window sills, door sills, partitions, panelling, moulding, hand-rails, parquet flooring.

Boat building: Interior work, corials (native dugout canoes), woodskin canoes.

Land communications: Bridging, coach building, wheel spokes, shunting poles, fresh water piling.

Furniture and ornamental work: Turnery, inlay, marquetry, cabinet work, furniture, trays, desks, bank counters, shop counters, billiard tables.

Agricultural and Industrial: Tool handles, mill beds, mortar beds, machine and engine bearers.

Miscellaneous: Bows, billiard cue butts, walking sticks, swagger sticks.

Veneer: Furniture, panelling.

Minor Uses.–The bark, which can be stripped off whole, is used for making woodskin canoes.

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V. MORA *(MORA EXCELSA* BTH.)

Vernacular Names

Mora (trade); Mora (Arawak); Mora-yek (Akawaio); Parakaua Carib).

Botany and Ecology

The Tree.—Evergreen to semideciduous, canopy tree to 160 feet (rarely 200 feet) high and 4 feet in diameter, usually 100 to 120 feet high and 2 to 3 feet in diameter; bole 50 to 60 feet above buttresses with plank buttresses spreading to 8 feet and 5 to 15 feet tall (sometimes 50 feet tall), occasionally elbowed; the larger trees are often hollow; bole form moderately good, straight but often flattened; branches erect, heavy; crown rounded, heavy; bark grey to brown, flaky; slash pink or pale brown, soft, thin; pale brown gum present in bark.

Leaves.—Simply pinnate, 3 to 4 paired, smooth; leaflets oblong, rounded, often emarginate at apex, leathery, finely reticulate on both sides, 8 to 20 × 3 to 9 cm.

Flowers.—White, sessile, in paniculate spikes 15 to 20 cm. long, subtended by small deciduous bracts; calyx campanulate, smooth, 4 mm. long, the 5 short lobes ciliate; petals spathulate, ciliate, 6 mm. long; 5 fertile stamens opposite the petals alternating with 5 free staminodes, clavate at apex without anthers; anthers with long, white, deciduous hairs; ovary stalked, smooth.

Fruit.—Pod usually 1-seeded, occasionally 2, rarely 3, oblong, chestnut brown, compressed, smooth, woody, 12 to 20 × 5 to 7 cm.; seeds reniform, brown, soft, exalbuminous, with thin, fragile testa, 7 to 12 × 4 to 7 cm.; 4 to 6 seeds per pound.

Habitat.—Climax species strongly dominant on river levees and river flood plains on alluvial clay or silt, widespread along stream courses on the heavier soils, invasive from such habitats and locally frequent in miscellaneous rain and seasonal forest on hill sides, mildly gregarious on low-lying sandy areas with a high water table due to clay pan; occasional in marsh forest.

Stocking.—The volume of sound, merchantable timber 16 inches in diameter and upwards in cubic feet per acre averaged over all types of forest is as follows:

North West District	270
Cuyuni-Essequibo-Supenaam	260
Cuyuni-Mazaruni	160
Mazaruni-Essequibo	95
Essequibo-Demerara-upper	60
Essequibo-Demerara-lower	30
Mahaicony	10
Berbice	10
Corentyne	200

On the Barema River the average is as high as 440 cubic feet per acre.

Mora forest in the Cuyuni River has a volume of Mora of 800 cubic feet per acre. Individual stands will run even higher, 10,000 to 15,000 board feet or 1,500 to 2,500 cubic feet per acre.

Distribution.—The species is widespread in the colony at least as far south as 3° north latitude with an apparent local center of distribution in the North West District. It also occurs in Trinidad, eastern Venezuela and the other Guianas.

Silviculture

Phenology.—General flowering February and March, occasionally as early as mid-January or as late as mid-April, normally every 2 years, sometimes annually or every 3 years. In alternate years either a casual flowering in February-March, a casual or general flowering from July to August (occasionally as late as mid-September), or a casual flowering at both periods. General flowering in July and August occurs every 5 to 7 years. Individual trees remain in flower 6 to 8 weeks.

Fruiting corresponds to the flowering period with the main crop usually in June and July, sometimes as early as mid-May, and the subsidiary crop in October or November, sometimes late September.

Mora reflushes wholly or partially every year. The young leaves are pink to red brown, soft and drooping. Flushing takes place in the off-flowering season. When general flowering occurs early in the year, flushing takes place in August and September (as early as mid-July and as late as mid-October, sometimes). When flowering is casual or absent in the early part of the year, flushing occurs in March.

Seed Dispersal.—Direct dispersal is mainly confined to the crown zone. On dry land animals help dispersal. On land liable to inundation the fruit are water borne. The rate of advance of Mora forest in Trinidad is estimated at 30 feet in 50 years.

Survival.—The survival percentage of shaded seedlings is high, although development after the seedling stage is slow. Seed does not remain viable long after becoming dried out.

Germination.—Hypogeal. Germination percentage almost 100 percent with dibbled seeds but only 40 to 50 percent with broadcast seeds in prepared nursery beds under shelterwood. Germination percentage in the forest is almost 100 percent. Germination mostly takes place in 2 to 3 weeks but may continue up to 12 weeks. The cotyledons open out almost flat on the soil surface, turn pinkish and send out shoots from 9 inches to 2 feet high.

Seedlings.—(a) Nursery. The first leaves are pinkish, similar in shape to mature leaves and harden up in a week. The shoot grows from 12 to 24 inches the first week, up to 30 inches in 6 months and up to 48 inches in 12 months. The tap root reaches 18 inches in a week, 24 (perhaps 30 inches) in 6 months but little more in 12 months. Branch

roots are 6 inches long at first. reduce to 2 inches by 6 months and disappear more or less by 12 months.

(b) Natural. As above.

Nursery Practice.—Dibbling of the seed under shelterwood is the most successful technique. Broadcast seed loses its viability as it dries out.

Plantation Practice.—No data locally. Experimentally satisfactory results have been obtained in Trinidad by direct sowing under shelterwood (a) with seed covered, (b) with seed exposed but with a ground cover.

Silvicultural Characteristics.—Mora is tolerant of shade. Trees will coppice at an advanced age but regeneration will not always do so. Root suckers are not produced. It regenerates freely under heavy shade. It is shallow rooted with abundant nodules on the roots; in spite of this it is windfirm because of its huge buttresses. Large trees tend to become hollow either wholly or partially. It is comparatively free from pests and diseases.

Sociability.—Strongly gregarious on alluvial sites liable to periodic inundation. Good Mora forest carries 100 to 150 stems per acre 4 inches dbh. and upwards.

Rate of Growth.—Height growth of 18 inches to 2 feet in the first fortnight, 4 feet in 12 months, 6 to 8 feet in 2 years is recorded from the forest nursery and confirmed by natural regeneration.

Regeneration.—Natural regeneration is abundant and vigorous with dense masses of seedling 6 to 8 feet high usually under the parent tree. The seedlings are able to stand heavy shade. Seedling density on the average is 13 per square meter; 11 from 32 to 60 inches, and 2 from 72 to 148 inches in height.

Response to Treatment.—Untried.

Pests.—A geometrid caterpillar is responsible for much of the leaf defoliation which occurs. Caterpillars of some of the migrant butterflies are also reputed to feed on Mora leaves.

Properties and Utilization

The Log.—Logs can be obtained up to 60 feet in length with a diameter of 3 feet at the butt but more usually 30 to 40 feet long and 1½ to 2½ feet in diameter at the butt. Unsoundness of the larger trees runs high, from an average of 20 percent in the North West District to 50 percent on the Corentyne River. Such trees are not always unsound throughout their length and even unsound trees will still furnish material for sleepers. Star shakes are frequent in the log. Sound logs will furnish as much as 400 cubic feet of timber (500 cubic feet including branchwood). Two timber varieties are recognized, white and black. White Mora has less heartwood, is lighter and less durable. Black Mora has more heartwood, is heavier and more durable.

The Wood.—(a) Macroscopic characters. Sapwood yellowish or pale brown, 2 to 6 inches broad, distinct from the heartwood. Heartwood dark brown, reddish brown, or deep dark red streaked with white or brown lines, darkening little on exposure to air; mealy in appearance, lustrous. Growth rings present but not always distinct, due to terminal parenchyma; pores numerous, evenly distributed, 3 to 6 per square millimeter, distinct to naked eye because of vasicentric parenchyma; parenchyma occasionally aliform and confluent. Ripple marks and gum ducts absent.

(b) Microscopic characters. Pores mostly solitary, sometimes in radial multiples, tangential diameter 0.14 (0.10 to 0.18) mm., elements 0.51 mm. long, intervascular pits minute, round, bordered; parenchyma distinct to naked eye, 6 to 10 cells wide, vasicentric, or confluent in tangential bands, dark brown deposits frequent; fibers polygonal, extremely thick walled, 1.19 mm. long (1.11 to 1.29), .016 mm. wide (.008 to .02); rays 10 to 14 per mm., 10 to 12 cells wide, 1 to 25 cells high, homogeneous, equidistant, cells filled with dark brown gum.

Physical Properties.—Specific gravity 1.00 (0.90 to 1.05); 62 (57 to 68) pounds per cubic foot air dry, 76 to 78 pounds green. Odorless when dry but Forest Products Research

Laboratory records an unpleasant smell when green, and with bitterly astringent taste. Texture coarse, rather harsh, grain straight or interlocked, very variable, sometimes with attractive wavy or bird's eye figure, very hard and heavy, tough, strong and durable. Highly resistant to dry rot (as durable as English Oak) and the dry wood termite *(Cryptotermes)*, fire-resistant, capable of withstanding prolonged wear and tear. Not resistant to *Teredo*, susceptible to attack by fungus and Lyctid beetles. Durability in contact with the ground variable, fails in 2 to 3 years (Trinidad) or lasts 20 years (British Guiana). Sapwood non-durable, in Trinidad susceptible to attack by pin hole beetles (Scolytids and Platypodids), powder-post beetles (Lyctids and Bostrychids) and longicorn beetles (Cerambycids).

Working Properties.—Requires careful sawing, planes well and finishes smooth to the plane when straight-grained, turns easily, requires little sanding, polishes well, does not splinter readily, splits with great difficulty, takes nails well and holds dog spikes extremely well. Tests on spike retaining properties showed driving force 7017 pounds and pulling force 7178 pounds.

Mechanical Properties.—It has great strength in static bending and in shear and tension either parallel or at right angles to the grain. Its resistance to crushing is high but it is not comparably tough. Test data for Modulus of Rupture and Modulus of Elasticity from British Guiana and Surinam are as follows:

	British Guiana (P.W.D. 1912) 61 lb./cu. ft.	Surinam (Plasschaert 1907) 70 lb./cu. ft.
Modulus of Rupture	14,640 lb./sq. in.	950 kg./cm².
Modulus of Elasticity	2,298,000 lb./sq. in.	180,000 kg./cm².

More complete test data for Mora have been furnished by the Forest Products Research Laboratory of Canada, Montreal, as follows:

Static bending		
F.S. at E.L.	lb./sq. in.	11,060
M. of R.	lb./sq. in.	17,920
M. of E.	1000 lb./sq. in.	3,583
Work to E.L.	inch lb./cu. in.	1.91
Compression parallel to grain		
C.S. at M.L.	lb./sq. in.	9,980
Hardness		
Radial surface	lb.	1,865
Tangential surface	lb.	1,909
End surface	lb.	1,925
Cleavage		
Radial/tangential plane	lb./in. width	416
Specific gravity	O.D. weight / Volume at test	0.867
Moisture content	percent	21.4
Weight per cubic foot as tested	lb.	67

Abbreviations:
F.S.–Fiber stress
E.L.–Elastic limit
M. of R. Modulus of rupture
M. of E.–Modulus of elasticity
O.D.–Oven dry
C.S.–Crushing strength
M.L.–Maximum load

Seasoning Properties.–Mora seasons well with very little checking if properly stacked. It kiln dries with little checking. Its shrinkage percentage is equivalent to yellow birch, one of the woods most amenable to kiln drying.

Preservative Treatment.–Mora heartwood sleepers are resistant to impregnation by creosote. Even under prolonged pressure treatment, the absorption is only 4 pounds per cubic foot. Penetration is reasonably uniform but the heart is only impregnated to a depth of about ⅜ inch.

Uses.–Building construction: Foundations, sills, joists, framing, flooring, siding, staircases, steps, partitions, ceilings, parquet flooring, fences, fence posts.

Boat building: A-1 rating at Lloyds. Stem and stern posts, ribs, knees, framing, decking.

Wharves, etc.: Decking, planking, capping, struts.

Land communications: Bridge runners, decking, rails, paving blocks, railway sleepers, shunting poles (possibly).

Ornamental work: Furniture, turnery.

Agricultural and Industrial: Mining timber, mill beds, engine bearers, heavy duty flooring, wagon building, tool handles (possibly).

Charcoal: It has a calorific value of 13,800 BTU, higher than both Ituri and Soft Wallaba *(Eperua* spp.), or Yaruru *(Aspidosperma* spp.) charcoal. Tests in England with a Parker Gas Producer attached to a Ford ton truck showed greater ton mileage with Mora charcoal than with any of these other species.

Pulp: Experimentally with the soda process Mora gives a fairly good yield of good quality pulp which furnishes a strong paper.

Service tests.–Some of the results from actual service tests are quoted below:

(1) Pennsylvania Railroad, U. S. A., the best sleepers lasted 15 years, untreated.

(2) Government Railway, British Guiana. Sleepers down for 25 years were taken up in 1928. Some were found to be still good enough for another year or two.

(3) Demerara Electric Co., British Guiana. Sleepers lasted 18 to 20 years in many cases.

(4) Untreated Mora sleeper on the Demerara railway lasted 9 years; treated mora sleeper still sound at 10 years.

Trade Substitutes.–The only timber for which Mora is likely to be substituted is Morabukea *(Mora gonggrijpii)* from which it can scarcely be distinguished, but which grows on totally different sites. As far as is known there are no appreciable differences in the qualities of these timbers.

Minor Uses.—The bark contains about 10 percent tannin which produces an exceptionally light colored leather. The bark and wood contain an alkaloid with a mildly toxic action which poisons fish but is not generally used as such. A decoction of the fresh bark is used locally to treat fever, dysentery, diarrhoea, worms, bladder and urethra diseases. The inner bark is used for cleaning and healing cuts. Young shoots, after being beaten out into fine strands and tied in bundles, can be used as torches. Seeds make good cattle food and in times of drought are mixed with cassava by the Indians.

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A NEW *LICANIA* FROM THE AMAZON BASIN

By BASSETT MAGUIRE
New York Botanical Garden

While reviewing recent collections of Guiana Rosaceae, a handsome unidentified specimen of *Licania*, collected and distributed by Dr. A. Ducke, came to my attention. Careful consideration of this Brazilian tree, along with Guiana species related to *L. microcarpa*, demonstrates it to be an undescribed member of the complex. It gives me pleasure to name this fine tree for Dr. Ducke, veteran dean of Amazonian botany.

Licania Duckei Maguire, sp. nov. Arbor magna; ramulis tenuis, glabris; foliis lanceolatis, acuminato-attenuatis, basibus acutis, supra glabris, venis inconspicuis, subtus albido-tomentosis, venis prominulis; petiolis tenuis, glabris; stipulis subulatis, puberulentis, caducis; inflorescentibus paniculatis, ramulis tenuis vel subcapillaris, glabris, bractiolis minute puberulentis; calycibus late campanulatis glabris, lobis triangularis, valde albido-puberulentis, dense intus; staminibus paucis, brevis; ovariis globosis, puberulentis; fructibus non visis.

A large tree, branchlets slender, glabrous, lenticels inconspicuous; leaf blades 4-6 cm. long, 1.2-2.5 cm. wide, lanceolate, the apex acuminate-attenuate, the base acute, primary veins 8-10 pairs, inconspicuous on the upper surface, prominulous on the lower, pale and glabrous above, closely but loosely whitish-tomentose beneath; petioles 5-7 mm. long, slender glabrous; stipules ca. 1.5 mm. long, subulate, puberulent, deciduous; inflorescence axillary and terminal, paniculate, the axes and branches slender, the ultimate branch subcapillary, 1.5-3.0 mm. long, glabrous, bracteoles minute, puberulent; flowers pedicellate, the pedicel subcapillary, 1.0-1.5 mm. long, the calyx broadly campanulate, ca. 1 mm. long, glabrous, drying reddish, the lobes ca. 0.5 mm. long, triangular, acute, strongly whitish-puberulent, densely so within, the tube puberulent within; the stamens

3 (4), filaments ca. 0.25 mm. long, anthers cordate-orbicular, ca. 0.3 mm. long; ovary globose, puberulent, the style ca. 1.25 mm. long, sublanate nearly to the apex; fruit not seen.

Type: "arbor magna flor. viridibus, silva ad ripam altam cataractae minoris, Manaós, Rio Tarumá, Amazonas, Brasil, July 24, 1936, *Ducke* 248." New York Botanical Garden. Known only by the type collection.

Licania Duckei is closely related to *L. microcarpa* Hook. f. In the isotype of the latter at the New York Botanical Garden, the leaves are broader, drying dark brown above, with a closer, thinner tomentum below, the petioles coarser and densely puberulent, the branches of the inflorescence and the calyx densely and uniformly puberulent.

DURABILITY OF BRAZILIAN CROSSTIES

By Eugene F. Horn
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The exportation of crossties from the lower Amazon valley was initiated about 25 years ago. Crossties were exported to Spain, Egypt, and Cuba as well as to central and south central Brazil. Other countries became interested and imported small quantities of Amazonian hardwood crossties for testing. In 1930 the Nederlandsche Spoorwegen, N. V. (Netherlands Railways) placed 84 Amazonian hardwood crossties in their track at Tilburg, Breda, Holland, along with 50 creosoted Oak and four Borneo Ironwood crossties. These crossties were inspected in 1938 and again in 1947 and the results are given in Table I.

It will be noted that untreated crossties of seven Amazonian species were equal or superior in durability to creosoted Oak crossties. The durability of four species—Acapurana, Sapucaia, Margonçalo, and Sucupira—was especially notable. Massaranduba and Mata-mata, which are regarded as first class timbers for crossties in Brazil, did not

Fig. 1—Photograph of Ducke 248, the type of *Licania Duckei* Maguire.

TABLE I

TEST TRIAL OF BRAZILIAN CROSSTIES IN HOLLAND

Species	No. ties, 1930	Cipher value* 1938	Cipher value* 1947	Observations in 1947
Sapucaia (*Lecythis paraensis*)	1	$8\frac{1}{2}$	$8\frac{1}{2}$	Sound
Araracanga (*Aspidosperma desmanthum*)	2	$7\frac{3}{4}$	7	One split and defective
Acapurana (*Campsiandra angustifolia*)	1	8	8	Small splits
Faveira (*Vatairea guianensis*)	3	$6\frac{1}{6}$	$5\frac{2}{3}$	Badly split
Pracuhuba (*Mora paraensis*)	3	$7\frac{5}{8}$	$6\frac{1}{3}$	Small tie still sound
Margonçalo (*Hieronyma alchorneoides*)	6	8	8	Small ones changed in 19
Axua (*Saccoglottis guianensis*)	2	$7\frac{1}{4}$	7	One split One sound
Jutai (*Hymenaea* sp.)	4	$6\frac{1}{4}$	$6\frac{1}{4}$	Split and beginning to decay
Sucupira (*Bowdichia* sp. & *Diplotropis* sp.)	6	$7\frac{7}{10}$	$8\frac{5}{12}$	All sound
Massaranduba (*Manilkara Huberi*)	50	$6\frac{7}{8}$	$6\frac{1}{5}$	Many split
Mata-mata (*Eschweilera odora*)	1		$7\frac{1}{2}$	No observation
Umiry (*Humiria floribunda*)	1	7	$6\frac{1}{2}$	Still sound
Creosoted Oak (*Quercus* sp.)	50	$8\frac{1}{2}$	7	Splits
Ironwood from Borneo	4	9	9	

*New crosstie cipher value is: 10

make as good a showing as expected owing to the tendency of these species to split. Only one species, Faveira, can be considered unsatisfactory. While the number of crossties of each species was too small to be conclusive, with the exception of Massaranduba, these tests did show that certain Amazonian hardwoods are suitable for use as crossties under average European climatic conditions. As a result of these tests Netherland Railways are now importing Amazonian hardwood crossties on a large scale.

In 1922 South African Railways became interested in Amazonian crossties and commenced durability tests, the results of which are shown in Table II.

It will be noted that three species—Cupiuba, Faveiro Amarelo, and Louro Vermelho—were of very low durability and cannot be considered as satisfactory for crossties in an untreated condition. The other six species had an average life of from 6½ to 18 years. Massaranduba gave a better showing than in Holland. It is to be regretted that some of the most durable Amazonian timbers such as Sapucaia, Sucupira and Margonçalo were not tested. These tests cannot be considered as conclusive owing to the small number of each species tested.

The Estrada de Ferro Bragança (Bragança Railroad) operate 220 kilometers of meter-gauge railroad between Belem and Bragança in the State of Pará. Only three woods are specified—Sapucaia, Massaranduba and Jarana *(Eschweilera jarana)*. Sapucaia is the outstanding wood for crossties having an average life of 10 years while Massaranduba and Jarana give 8 years service on an average. The Superintendent of the Maintenance of Way informed the writer that the life of a Massaranduba crosstie was only limited by its ability to retain spikes. Usually a Massaranduba crosstie is "spike-killed" after 8 years' service. He also stated that the durability of Massaranduba was greater in moist than in dry situations and that Maraparajuba *(Manilkara maraparajuba)*, which is frequently sold as Massaranduba, is only half as durable as true Masaranduba. Acapú is not considered to be satisfactory for crossties owing to the tendency of the spikes to become loose due to the corrosive action of the wood on metal.

The Pará Electric Company have used Amazonian hardwood crossties in their street car tracks in Belém during the past 30 years. The results of their experience is incorporated in Table III.

TABLE II

DURABILITY TESTS OF BRAZILIAN CROSSTIES IN SOUTH AFRICA

Species	No. ties	Locality	Zone	Placed In Track	Remarks
Acapú (*Vouacapoua americana*)	1	Capetown	Wet	Dec. 1922	Removed after 8 years, 7 months
do.	1	Karoo	Dry	Nov. 1922	Removed after 18 years
do.	3	Johannesburg	Dry	Feb. 1928	Removed after 12 years
Cupiuba (*Goupia glabra*)	1	Johannesburg	Dry	Sept. 1927	Removed after 1 year, 1 month
Taxi (*Tachigalia* sp. or Cupiuba ?)	10	Johannesburg	Dry	Oct. 1928	Average life 9 years
Massaranduba (*Manilkara Huberi*)	1	Capetown	Wet	Dec. 1922	Removed after 8 years, 7 months
do.	1	Karoo	Dry	Nov. 1922	Removed after 11 years, 8 months
do.	4	Johannesburg	Dry	Oct. 1928	Removed after 12 years
do.	10	Johannesburg	Dry	Oct. 1928	Average life 9 years
Faveiro Amarelo (*Vatairea guianensis*)	3	Johannesburg	Dry	Sept. 1927	Average life 2¾ years
Araracanga (*Aspidosperma desmanthum*)	10	Johannesburg	Dry	Sept. 1928	Average life 9 years
Louro Vermelho (*Ocotea rubra*)	1	Johannesburg	Dry	Feb. 1928	Average life 2⅓ years
Pracuhuba (*Mora paraensis*)	10	Johannesburg	Dry	Oct. 1928	Average life 9 years
Pracuhuba (?)	2	Johannesburg	Dry	Feb. 1928	Average life 2⅓ years
Abiurana (*Pouteria dissepala*)	1	Johannesburg	Dry	Feb. 1928	Average life 6 ½ years

TABLE III

DURABILITY OF AMAZONIAN HARDWOOD CROSSTIES USED BY THE PARA ELECTRIC CO., BELEM

Species	In poorly Drained soil, years	In well Drained soil, years
Acapú (*Vouacapoua americana*)	6 - 8	18 - 20
Jarana (*Eschweilera jarana*)	6 - 8	10 - 12
Massaranduba (*Manilkara Huberi*)	20 - 22	8 - 10
Tatajuba (*Bagassa guianensis*)	6 - 8	10 - 12
Pau d'arco (*Tabebuia serratifolia*)	10 - 12	18 - 20
Cumaru (*Coumarouna odorata*)	10 - 12	20 - 22
Jutai-assú (*Hymenaea courbaril*)	6 - 8	10 - 12
Faveiro Vermelho (? ?)	6 - 8	10 - 12
Mata-mata Preta (*Eschweilera odora*)	8 - 10	15 - 20
Sapucaia (*Lecythis paraensis*)	6 - 8	10 - 15

Only heartwood crossties were used. It will be noted that Massaranduba crossties last longer in moist than in dry situations. They reported that Massaranduba and Mata-mata crossties showed a marked tendency to split if exposed to the hot tropical sun for any length of time, while the woods which split less were Cumarú, Acapú and Pau d'arco. They also reported that the spikes soon became loose in Acapú crossties.

The three durability tests cited, while not conclusive, indicate that several Amazonian hardwoods are highly suitable for crossties under a wide variety of climatic conditions and are equal or superior in an untreated condition to creosoted Oak crossties. Crossties of the following species are now exported from the lower Amazon region:

Anani	*Symphonia globulifera* L.
Acapú	*Vouacapoua americana* Aubl.
Acapúrana de Varzea	*Campsiandra laurifolia* Benth.
Aipé, Apá, or Ipé	*Eperua bijuga* Mart.
Araracanga	*Aspidosperma desmanthum* Muell. Arg.
Copahibarana	*Copaifera Martii* Hayne
Cumarú	*Coumarouna odorata* Aubl.
Angelim Falso	*Dinizia excelsa* Ducke

Jarana	*Eschweilera jarana* (Huber) Ducke
Jutai	*Hymenaea courbaril* L. and *H. parvifolia* Hub.
Itauba	*Mezilaurus itauba* (Meissn.) Taub.
Mata-mata Preta	*Eschweilera odora* (Poepp.) Miers
Massaranduba	*Manilkara Huberi* (Ducke) Standl.
Margonçalo	*Hieronyma alchorneoides* Fr. All.
Mangue Vermelho	*Rhizophora mangle* L.
Pau d'arco	*Tabebuia serratifolia* (Vahl) Nich.
Pracuúba	*Mora paraensis* Ducke
Piquiá	*Caryocar villosum* (Aubl.) Pers.
Sucupira	*Diplotropis Martiusii* Benth. and *Bowdichia nitida* Benth.
Tatajuba	*Bagassa guianensis* Aubl.
Umiry	*Humiria floribunda* Mart.

TEREDO RESISTANT TIMBERS OF THE AMAZON VALLEY

By EUGENE F. HORN
Alto Tapajós, S. A., Brazil

Seven Amazonian timbers are said to resist the attack of teredo and other marine borers but not all of them are equally resistant to decay and the attack of wood-boring insects. Some of these species are not only resistant to decay, marine borers and insects but possess mechanical properties which recommend their use for piling, sheet piling, dock timbers, and under-water planking for boats and ships. The following timbers are teredo "proof" or have proven highly resistant to the attacks of marine borers: Anauera, Andiroba, Itauba, Mahuba, Mata-mata, Parinari, and Tapaiuna.

ANAUERA (*Licania macrophylla* Benth.)

This is a medium-sized tree found growing in the upland forests of the lower Amazon region. It is not abundant and it is doubtful if it could be obtained in sizes suitable for harbor works or in sufficient quantities. The reddish colored wood is hard, heavy, and strong. It is not resistant to decay. The resistance of this wood to the attacks of the teredo and other marine borers is due to the presence of silica particles (grit) in the wood which wear off or blunt the teeth of the boring apparatus of the mollusk so that the shipworm cannot penetrate the wood. Woods containing silica are very difficult to saw or plane but structural timbers can be shaped with an ax or adze. Anauera has an air-dry specific gravity of 1.00 and weighs about 62 lbs. per cubic foot, air-dry (15 percent moisture content).

ANDIROBA *(Carapa guianensis* Aubl.)

Andiroba occurs throughout the entire Amazon Valley from the foothills of the Andes Mountains in northeastern Peru to the islands in the estuary of the Amazon. It is called Crabwood in British Guiana; Crappo in Trinidad, Carapa in Venezuela, Masablo in Colombia, and Fragueroa in Ecuador. It is now marketed in the United States under the name of Cedro Macho. It is a lowland tree preferring marshy land or land which is periodically inundated. Andiroba is a tree of good timber form possessing a straight cylindrical bole and occasionally attaining a height of 170 feet and a diameter of six feet above the broad buttresses. In the lower Amazon region mature timber averages about 100 feet in height with a diameter of two or three feet. The heartwood varies in color from light to dark reddish brown and is not always readily distinguished from the pale brown sapwood. It is not as hard or heavy as many tropical woods having an air-dry specific gravity of 0.70 and weighing about 44 pounds per cubic foot. Straight-grained wood is easy to work but roe-grained material requires considerable sanding to produce a smooth finish. It takes paint and varnish well and glue-joints hold well. It is fairly resistant to decay and insect attacks, and dugout canoes in the lower Amazon estuary are said to resist the attacks of marine borers. Tests made on Crabwood at the Forest Products Research Laboratory, Princes Risborough, England, show that this wood compares favorably with Black Walnut *(Juglans nigra* L.) in strength properties. Seasoning must be done carefully to avoid warping and checking. In color and general appearance it is not unlike Mahogany, however, the grain is coarser and it lacks the high lustre and attractive figure of Mahogany. In Brazil it is used to some extent for furniture, fixtures, ceiling and interior trim. Andiroba logs and lumber are exported to England. Owing to its reputed resistance to marine borers as well as its strength properties it should be tested as a substitute for Mahogany plywood hulls for motor boats.

ITAUBA *(Mezilaurus itauba* [Meissn.] Taub.)

This large tree, which occasionally attains a height of 100 feet or more and a diameter of 30 inches, belongs to the Laurel family (Lauraceae). It occurs in the upland forests (terra firme) from the Guianas southward through western Pará and eastern Amazonas to northwestern Matto Grosso. The freshly cut heartwood is of a yellowish brown color which fades upon exposure to a dull russet color which is distinct but not clearly defined from the greyish sapwood. The heartwood contains an oil and has an oily appearance and feel. It weighs from 57 to 59 pounds to the cubic foot in an air-dry condition. It is a rather fine-textured wood with an air-dry specific gravity of 0.93 to 0.96. The wood is only moderately hard and fairly strong. It is not a difficult wood to season and holds its shape well when manufactured. The grain varies from straight to somewhat roey. It is very difficult to saw, due perhaps to the presence of silica particles. It resists the attack of marine borers and insects and is durable in exposed situations. Tests made by the Instituto de Pesquizas Technologicas de São Paulo gave the following results: Specific gravity (15% moisture content), 0.95. Shrinkage: volumetric 12.1% radial 2.3%, tangential 6.6%. Compression parallel to grain: maximum crushing strength, green wood 7650 lbs. per sq. in.; air-dry wood (15% m.c.) 9,900 lbs. per sq. in. Modulus of rupture, green wood, 16,700 lbs. per sq. in., air-dry (15% m.c.), 18,300 lbs. per sq. in.

Modulus of elasticity, green wood, 2,104,000 lbs. per sq. in. The above tests indicate that this wood possesses about the same strength as Yellow Birch (*Betula lutea* Michx.) when used as a column or a beam; however, it is more brittle than Yellow Birch. On account of its resistance to marine borers this wood is preferred over all other Amazonian Hardwoods for the bottom planking of boats and ships. It is also used for general construction purposes, tight cooperage, and crossties. Large quantities of Itauba logs and staves are exported from Santarém to Portugal.

MAHUBA (*Licaria manhuba* [A. Sampaio] Kosterm.)

This is a medium-sized tree found growing in the lowland forests of the Island of the Amazon estuary. The yellowish brown wood is soft and easily worked and said to resist the attacks of marine borers. It has an air-dry specific of 0.66 and weighs 40 pounds per cubic foot air-dry. Not available for export on account of its scarcity.

MATA-MATA (*Eschweilera odora* [Poepp.] Miers = *E. matamata* Huber)

The name Mata-mata is applied to at least six species of *Eschweilera* in the Amazon basin. However, the above species is the most important commercially. It is a medium- to large-sized tree found in the upland rain forests of the Guianas and the lower Amazon region where it is very abundant. It is a very straight tree of good timber form, yielding piling 60 feet in length 6 to 8 inches in diameter (heartwood) at the small end or squared heart timbers 12 inches × 12 inches × 40 feet long. The wood is extremely hard, heavy, compact, tough, strong and heavy, weighing 72 lbs. per cu. foot (air-dry), and having an air-dry specific gravity of 1.15. It is extremely durable and highly resistant to the attacks of insects and marine borers. The grain is straight and crossties with sapwood on both sides split very badly when exposed to the hot tropical sun. This tendency to check and split is probably due to the high ratio between radial and tangential shrinkage. For piling and dock timbers

the sapwood should be removed as the resistance of the sapwood to marine borers is not known. In Brazil this timber is highly esteemed for foundation timbers for buildings, bridge timbers, mud sills, wharf timbers, piling and crossties.

PARINARI (*Parinarium Rodolphi* Huber)

This is a medium-sized tree found in the upland rain forests of the lower Amazon region. The dark yellow wood is extremely hard and strong. Parinari logs are almost impossible to saw on account of silica particles in the wood. It can, however, be shaped with an axe or adze and is widely employed for keels and keelsons in shipbuilding owing to its resistance to marine borers. Parinari is largely employed along with Mata-mata for piling and dock timbers in teredo-infested waters. Parinari has an air-dry specific gravity of 1.06 and weighs about 66 pounds per cubic foot air-dry (15% moisture content).

TAPAIUNA (*Dicorynia ingens* Ducke)

The range of this medium-sized tree is limited to moist sites in the upland forests of certain parts of the State of Pará, notably in the Municipio of Almerim between the flood plain of the Amazon and the Serras de Tucumanduba and Aramum. The heartwood, which comprises only one-third of the diameter of the trunk in this species, is dark reddish brown, rather sharply defined from the light brown sapwood. It is hard, heavy, tough and strong. Air-dry wood has a specific gravity of 0.90 and weighs 56 pounds per cubic foot. It is very durable and resistant to insect attacks. In Pará it is used for durable construction, piling, crossties and for heavy vehicles. A closely related species from Surinam called Basra Locus (*Dicorynia paraensis* Benth.) was recently used to replace the Greenheart timbers and planks used in the lock gates of the Panama Canal. This wood is resistant to marine borers because of the silica particles contained in the wood. However, in Surinam it is not considered as teredo resistant as Manbarklak (*Eschweilera* *longipes* [Poit.] Miers). In Brazil *D. paraensis* is one of the most common of the larger trees found along the entire course of the Rio Negro and its tributaries, with the exception of the Rio Branco, from Manaus to and beyond the frontiers. In spite of its abundance and large size it is little used and without a common name. Some of the earlier explorers described this tree under the name of Angelique do Pará which is no longer used. This wood is called Angelique in French Guiana where it is used for joinery, furniture, piling, posts, crossties, tight cooperage and for general construction purposes.

TESTS OF SOME CORKS FROM BRAZIL

By D. Guilherme de Almeida
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Interest in this subject was aroused by the "Note on Brazilian Cork" by P. L. Buttrick in *Tropical Woods* 68: 11. He stated that it has long been known that a kind of cork is available in south-central Brazil which is used locally for insulation, the major industrial use of cork. Not much has been published regarding either the tree, the character of the country in which it grows, or the quality of the cork. Mr. Buttrick stated that a good deal of money would have to be spent to increase Brazilian output to meet North American needs. He added that the species has been identified as *Kielmeyera coriacea* Mart. (family Guttiferae), but that more than one species may be involved.

Well known Brazilian authors, including F. J. C. Hoehne, E. T. Fonseca, J. G. Kuhlmann, M. P. Corrêa, A. Löfgren and others wrote about Brazilian cork-producing trees and the character of the region in which they grow. None, however, carried out laboratory tests on the material.

Material and Technique

Cork samples numbered 2777 to 2783 were furnished by Professor João Geraldo Kuhlmann, Director of the Botanical

Garden of Rio de Janeiro. Professor Mello Barreto supplied the samples of *Kielmeyera coriacea* Mart., No. 2949. All of these samples were collected from cork-producing trees growing in the State of Minas Gerais, Brazil; in most the genus and species has been authoritatively established by those botanists.

The author is especially indebted to Mrs. Eunice Pinto de Barros for the microtechnique and micrometric determinations involved and which were employed before with good results by J. V. Natividade, Portugal, to cork from Portugal.

The transverse, radial, and tangential sections for histological and cellular study were cut on a sliding microtome from small blocks infiltrated with paraffin. Sections 25 to 30μ thick were obtained. The sections were put in xylene to dissolve the paraffin; passed through a series of alcohols of decreasing strengths (absolute alcohol, 96%, 75%, 50%, and 20%); washed in distilled water; placed in iron aluminate solution for 10 minutes; washed in distilled water; placed in an aqueous solution of hematoxylin 5 to 10 minutes; washed repeatedly in distilled water; dehydrated (by passing through alcohols of increasing concentratons); xylene; mounted in Canada balsam.

Description of the Corks

Number 2777. *Aspidosperma tomentosum* Mart.
Apocynaceae.

Common name.—"pereiro do campo"

General appearance.—Samples 10 cm. long, 5 cm. broad, and 1 cm. thick. Color light yellow. Insect holes present in the outer face; depressions in the inner face. Growth layers visible on transverse and longitudinal surfaces.

Minute anatomy.—Transverse section. Cell wall deformation similar to that observed in the cork of *Quercus suber*. L. This deformation is said to result in a product that is too thin and hard.

Tangential section. Cell walls deformed as previously noted. In both sections some cells, isolated or not, were colored dark blue by the hematoxylin, probably because of tannic compounds.

Number 2778. *Enterolobium ellipticum Benth.* Leguminosae-Mimosaceae.

COMMON NAME.—"favela branca"

GENERAL APPEARANCE.—Samples 7 cm. long, 5 cm. broad, and 1 cm. thick. Yellowish brown; a few signs of borers; distinctive appearance caused by thin growth layers, conspicuous on transverse and longitudinal surfaces.

MINUTE ANATOMY.—Transverse section. Cylindrical cells radially elongated, colored intense blue by hematoxylin, disposed in pallisade tissue. Cells not elongated radially, disposed in concentric layers, generally two or three cells wide, colored yellowish brown by hematoxylin.

Tangential section. The cells of the concentric bands appear as sinuous lines in this section; other cells rounded and uniform.

Number 2779. *Fagara* sp. Rutaceae.

COMMON NAME.—"mamuda"

GENERAL APPEARANCE.—Samples 3 cm. long, 2 cm. broad, 1 cm. thick. Light yellow; inner surface with small depressions but without visible lenticular pores. Normal growth layers visible but not conspicuous.

MINUTE ANATOMY.—Transverse section. Walls of cork cells commonly wrinkled, giving a corrugated appearance to the tissue tangentially or as if radially stretched; colored blue by hematoxylin. Sclerotic cells isolated or in groups, also in layers two to four cells wide; distinctively yellow colored.

Tangential section. Cork cells polygonal; irregular in shape because of previously mentioned deformation. Thick-walled sclerotic cells yellow colored.

Number 2780. *Agonandra brasiliense* Miers. Olacaceae.

COMMON NAME.—"tatu," "pau marfim"

GENERAL APPEARANCE.—Samples of irregular size, 4 cm. long, 3 cm. broad, and 1.5 to 4 cm. thick; outer surface

very rough; inner surface irregular; yellow colored; with many insect holes. Growth layers thin and not easily observed.

MINUTE ANATOMY.—Transverse section. Deformed cell walls give a wrinkled appearance to the tissue.

Tangential section. Scattered blue stained cells conspicuous in the light-yellow colored tissue.

Number 2781. *Aegiphila* sp. Verbenaceae.

GENERAL APPEARANCE.—Pieces 5 cm. long, 3 cm. broad, 1 cm. thick. Outer surface corrugate, with some slits; insect holes present. Growth layers easily seen on the transverse and radial sections.

MINUTE ANATOMY.—Transverse section. The cells are larger than those of previously described corks; disposed in radial series. Cells in outer part of growth layers radially compressed.

Tangential section. Cells large, polygonal (mostly pentagonal to octagonal).

Number 2782. *Pisonia tomentosa* Casar. Nyctaginaceae.

COMMON NAME.—"pau lepra," "pau urubú"

GENERAL APPEARANCE.—Samples 3 cm. long, 2 cm. broad, 1 cm. thick. Dark brown; signs of insect borers frequent; inner surface with depressions but without lenticular pores. Growth layers visible on transverse and radial surfaces but not conspicuous because of the dark color of the suberose tissue.

MINUTE ANATOMY.—Transverse section. Six growth layers occupy 8 mm. of radial width. Sclerotic cells with varying wall thicknesses are present, some irregularly disposed, others forming bands one to four cells thick near the growth layer margins.

Tangential section. Cells large, nearly isodiametric.

Number 2783. Not identified.

GENERAL APPEARANCE.—Samples 3 cm. long, 2 cm. broad, 1 to 2 cm. thick. Color dark, appearing burned; surface rough; very hard, lacking elasticity.

Number 2949. *Kielmeyera coriacea* Mart. Guttiferae.

COMMON NAME.—"pau santo"

GENERAL APPEARANCE.—Samples 5 cm. long, 5 cm. broad, and 1 cm. thick. Color yellow. The outer surface has light gray longitudinal wrinkles and some insect holes; the inner surface has depressions and a few lenticular "pores" (from the canals). Growth layers visible on transverse surface.

MINUTE ANATOMY.—Transverse section. Cell walls greatly deformed, making measurement of cell dimensions difficult. Deeply colored cells scattered or in groups of two to many in radial disposition.

Tangential section. Cells irregular in size, shape and color.

TABLE I
SIZE OF CELLS (MICRONS)

	Transverse section						Tangential section	
	Radial direction (length)			Tangential direction (width)			(diameter)	
Specimen number	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Average
2777	37	18	28	31	17	18	31	25
2778	90	—	—	—	—	27	—	26
2779	62	25	45	50	25	34	50	25
2780	50	—	27	50	—	37	62	50
2781	87	25	50	87	32	62	75	25
2782	87	—	53	87	—	75	87	84
2949	37	—	20	50	—	38	50	45

Note: Cork No.'s 2778, 2780, 2781, 2782, and 2949 could not be measured exactly because of cell deformation.

THE TESTS

The limited number of cork samples of each kind and their small size limited the tests and did not permit desired repetitions. This study must be regarded as preliminary in character only. The purpose was not, at this stage, to establish final figures on any of the corks in question. It was, rather, to bring forward a moderate amount of data on a number of Brazilian corks and thus furnish information which would

give a general indication of the character of each and permit comparisons with the cork from Portugal, this latter being taken as the paradigm of good quality for the product.

Permeability Tests

To test the soak resistance and prove the floating ability some of the cork specimens were forced by means of glass weights to the bottom of Borel flasks filled with distilled water. They were submerged thus for four years. At the end of this period of immersion all specimens of cork floated promptly.

During the permeability and floating test it was noted that some of the corks changed the color of the water in which they were soaked, as follows:

Species	Color of infusion
Aspidosperma tomentosum Mart.	yellowish
Enterolobium ellipticum Benth.	yellow
Fagara sp.	no color
Agonandra brasiliense Miers	no color
Aegiphila sp.	no color
Pisonia tomentosa Casar	deep yellow
No. 2783 (not identified)	light yellow
Kielmeyera coriacea Mart.	no color

To determinte the amount of water absorbed during the period of four years' soaking, the specimens were put on a glass surface in a dry place with enough air circulation to remove the excess of water that dampened their surfaces. As soon as they became free of surface water, they were weighed with an analytical balance to the nearest 0.005 gr., then transferred to an oven and dried at a temperature of 100° C to constant weight, and again weighed. Moisture content was calculated as percentages of oven-dry weight of the cork.

From the results tabulated below it may be seen that only the corks of *Enterolobium ellipticum*, and of *Aegiphila* showed a moisture content percentage very high as compared with that of *Quercus suber* selected for comparison.

TABLE II

MOISTURE CONTENT

Scientific name	Weight before drying (gr.)	Oven dry weight (gr.)	Moisture content (Percent of oven-dry weight)
Quercus suber	3.920	1.005	289
Aspidosperma tomentosum	2.990	1.540	94
Enterolobium ellipticum	4.140	0.600	590
Fagara sp.	1.020	0.400	155
Agonandra brasiliense	7.020	1.940	262
Aegiphila sp.	3.020	0.425	610
Pisonia tomentosa	2.070	0.470	340
Kielmeyera coriacea	2.175	0.755	188

Density Determinations

The samples were weighed as previously described. This weight was then divided by the volume of the sample measured to the nearest hundredth of a cubic centimeter (0.010 cm^3) in a Breuil Volume-meter (mercury displacement).

TABLE III

DENSITY OF CORKS

Scientific name	Weight (gr.)	Volume (cm^3)	Density
Quercus suber	1.210	8.55	0.14
Aspidosperma tomentosum	3.725	12.62	0.29
Enterolobium ellipticum	2.930	7.29	0.40
Fagara sp.	0.265	3.63	0.07
Agonandra brasiliense	1.335	5.09	0.26
Aegiphila sp.	0.505	4.44	0.11
Pisonia tomentosa	0.835	7.12	0.12
No. 2783 (not identified)	3.115	7.05	0.44
Kielmeyera coriacea	3.130	9.21	0.34

The sample of *Fagara* was of very low density, indicating possible use of this cork for life-saver and other floating devices. The sample of *Enterolobium ellipticum* and that of No. 2783 (not identified) were comparatively of very high density; the former contained "resin pockets," the latter contained distinctive granulose masses unlike any other cork studied.

Compression Tests

The crushing strength in kilograms at maximum load was divided by the area of specimen in square centimeters to determine "unit stress." The tests were conducted on a universal testing machine designed for use with wood by Amsler & Co., Switzerland.

TABLE IV

COMPRESSIVE STRENGTH OF CORKS

Scientific name	Load (Kg.)	Area ($cm.^2$)	Unit stress (Kg. $cm.^2$)
Quercus suber	1,520	7.07	214.992
Aspidosperma tomentosum	466	7.07	65.912
Enterolobium ellipticum	320	7.07	45.260
Fagara sp.	200	2.25	88.880
Agonandra brasiliense	240	5.30	45.280
Aegiphila sp.	420	4.00	105.000
Pisonia tomentosa	130	3.75	34.660
Kielmeyera coriacea	240	7.07	33.946

Note: Cork No. 2783 (not identified) was rough and brittle making it impossible to test its crushing strength in the same manner as the others.

The "unit strain" was determined dividing the total strain of the cork sample under the maximum load by its total thickness. The result shows the strain per unit of linear thickness. All measurements were in millimeters.

TABLE V

COMPRESSIVE STRAIN IN CORKS

Scientific name	Cork thickness (mm.)	Total strain (mm.)	Unit strain (mm.)
Quercus suber	6.8	6.0	0.88
Aspidosperma tomentosum	8.5	6.0	0.70
Enterolobium ellipticum	9.6	7.0	0.72
Fagara sp.	8.5	6.0	0.70
Agonandra brasiliense	10.8	6.5	0.60
Aegiphila sp.	9.0	7.5	0.83
Pisonia tomentosa	10.8	8.5	0.78
Kielmeyera coriacea	9.6	6.0	0.62

RESULTS

The salient feature brought out by this investigation of the properties of certain Brazilian corks was the wide variation of the results. For this reason, although none of them are as good as the best Portuguese cork, it would be possible to select from among the different kinds of Brazilian corks the one best suited for each specific use.

EXPLANATION OF FIGURES

Photomicrographs of Brazilian corks. × 80.

Fig. 1. *Aspidosperma tomentosum*. No. 2777. Transverse section.
Fig. 2. *Aspidosperma tomentosum*, No. 2777. Tangential section.
Fig. 3. *Fagara sp.*, No. 2779. Transverse section.
Fig. 4. *Fagara* sp., No. 2779. Tangential section.
Fig. 5. *Agonandra brasiliense*, No. 2780. Transverse section.
Fig. 6. *Agonandra brasiliense*, No. 2780. Tangential section.
Fig. 7. *Kielmeyera coriacea*, No. 2949. Transverse section.
Fig. 8. *Aegiphila* sp., No. 2781. Tangential section.
Fig. 9. *Pisonia tomentosa*, No. 2782. Transverse section.
Fig. 10. *Pisonia tomentosa*, No. 2782. Tangential section.

NOTES ON A TIMBER SURVEY IN EASTERN NICARAGUA

By PAUL SHANK
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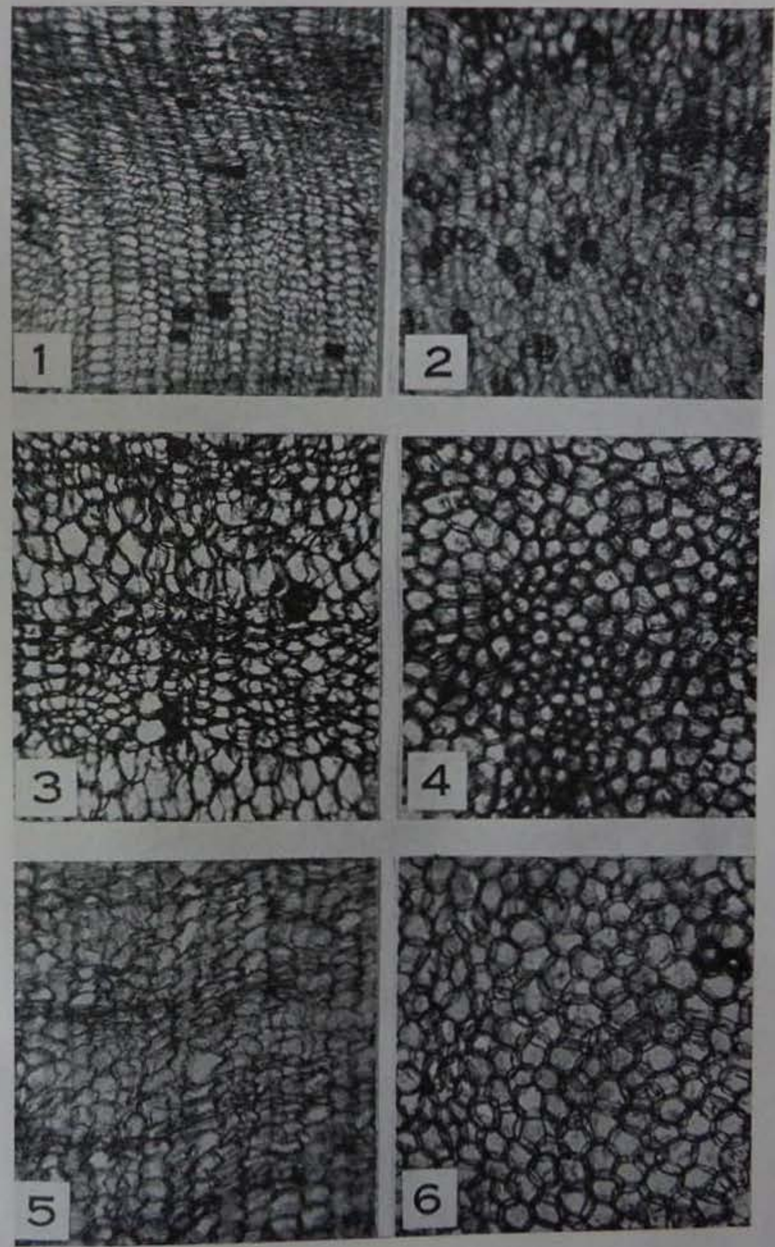
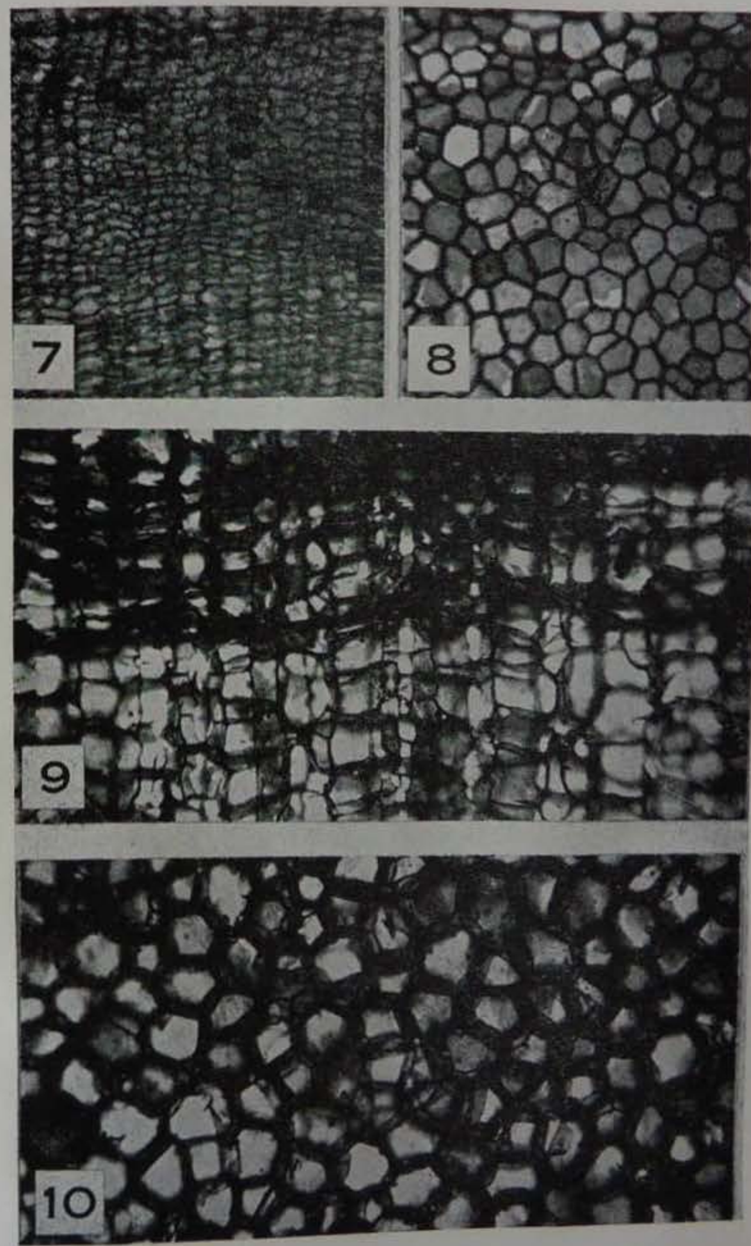
Purpose of Survey

The United Fruit Company is developing plans for utilizing forest products from its lands in the Central American Republics. A survey of the Punta Gorda tract of Eastern Nicaragua was made for the purpose of determining the amount of usable woods in a virgin stand of Company timber on land heretofore undeveloped for banana production.

Description of Area

The Punta Gorda River flows into the Caribbean at a point about forty-five miles south of Bluefields, Nicaragua.

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The area surveyed lies on both sides of the river beginning at a point thirty miles inland from the coast and extending upstream fifteen miles. Natural units are formed by tributaries of the Punta Gorda, all of which are navigable with small boats or flat bottom power barges. The topography varies from flat swamp lands on the downstream side to hilly land in the upstream section where a maximum elevation of 600 feet is reached. The flora is typically rain-forest with uniformity in composition. The average annual precipitation is 116 inches and the mean annual temperature is 82° F. There is a season of lessened rainfall during the months of February, March and April but rains never cease entirely at any season. The soil is always wet but will support logging machinery.

Soil varies from sandy loam along the river vegas to clay loam in the hilly sections. Pure clay is found on steep slopes where organic matter seems to be carried away by rains as rapidly as it is formed. The soil in swamp areas is composed of deep layers of matted vegetative material sometimes having the appearance of peat. The slow rate of decomposition appears to result from the land being submerged under water several months of the year.

The net area or productive timberland cruised is 11,622 hectares. The gross area of the tract is approximately 32,000 hectares. The difference is made up of waste land in inaccessible swamps, abandoned banana plantations and waterways.

Survey Methods Used

The cruise was made by the strip method. Parallel lines were cut at one kilometer intervals and perpendicular to the river or its main tributaries. These lines were about a meter in width to permit passage of a man afoot. They were cut in advance of the cruising party in order that their accuracy might be determined. Bearings of the lines were established by compass. The native bushman has a system of running straight lines once a bearing is fixed which about equals the accuracy of a compass. He uses stakes set in the ground in a straight line so that at least three are always visible on a backsight. The chopper looks back and lines himself in on the stakes, establishing a new one when the third one back is almost out of sight. The crew that chopped the lines also measured the distance and set stations at 100 meter intervals. Cross lines were cut to connect cruise lines and allow progressive travel.

Strip width was fixed at 60 meters, 30 meters on either side of the center line. This width, at kilometer intervals, thus gave a 6% cruise of the area.

A few days were spent training native bushmen to take tree measurements, pace distance to strip limits and allow the chief of the survey to become familiar with tree species of the region. More reliance was placed in identification by bark and outer wood characteristics than by floral characteristics. Often it is impossible to see the crown of a tree and one is never certain from which tree leaves or fruit have fallen. Trees are often barren of flowers and fruit for a considerable part of the year thus adding to the difficulty of identification with floral specimens. Examination of wood and bark by chopped specimens offered the most reliable means of identification on this job. Odor, taste, density of wood, sap characteristics, color of wood and a multiplicity of bark characteristics were used. All of the native ability of the bushman was utilized in identifying species. Twenty-one log specimens were cut and brought out to a mill and sawed up into billets for later checking with previously determined specimens.

Cruising was done by a five man party consisting of chief, recorder, two machete men and a tree measurement man. The chief estimated approximately 80 percent of the trees and the tree measurement man measured the other 20 percent for diameter and height. This enabled the estimator to continually check his estimates with measured trees. Trees were measured with diameter tape and abney hand level. The recorder was necessary to protect notes from rain and allow the tree measurement man and estimator to concentrate on their work.

A merchantability standard was established which required that a tree contain a log having minimum dimensions of 12 inches diameter inside bark at the small end and 16 feet of length. The following data were taken on all trees: Diameter breast high or diameter above buttresses; the number of 16 foot logs to a 12-inch minimum top diameter. Bark thickness was studied to determine deductions necessary to give the inside bark dimensions. In the absence of volume tables applicable to this class of timber, each tree was reduced to logs and each log scale recorded separately. The summation of the logs thus gave the tree volume. Taper was found to be of sufficient uniformity to permit use of this method of determining tree volumes. The International ¼-inch log rule was used for determining volumes. A 5 percent cull factor was used to cover unseen defects.

The net area of productive timberland cruised was 11,622 hectares. A total of 116.23 kilometers of strip were cruised with a net area of 697.32 hectares inventoried. An average of four kilometers of strip were run per day with approximately 29 effective field days of cruising time. In all, 11.5 days were required to compile the data.

Summary

The following table is a condensation of data collected on the survey. This table gives three factors essential to planning an operation in tropical forests. There are other physical factors that are important also but these three cover the silvical conditions.

1. Frequency of merchantable stems per hectare by species.
2. Board foot volume per hectare by species.
3. Board foot volume of the average tree by species.

Volumes were totaled by strips and a hectare factor worked out for each strip and applied to the area for which that strip was the sample. For example, Santa María (*Calophyllum* sp.) was found only on two strips having a total 11.7 kilometers and a strip area of 70.2 hectares. Thus the figure 70 (rounded off to the nearest hectare) in column 5.

This column is a comparative scale of the distribution of species in the net area cruised. A theoretically perfect distribution would be 697 for any given species in column 5 of the table. The lower the scale, the poorer the distribution. It is noted that Cedro Macho *(Carapa nicaraguensis)* has the best distribution with 655 out of a possible 697.

VOLUME SUMMARY AND SPECIES DISTRIBUTION

Species	Average Volume Per Hectare (MFBM)	Average No. Stems Per Hectare	Average Volume of Tree (MFBM)	Number of Trees, Basis	Number of Hectares, Basis
Cedro Macho *Carapa nicaraguensis*	.620	1.01	.562	723	655
Ebo *Coumarouna oleifera*	.675	.35	1.910	197	557
Aceituno Negrito *Simaruba glauca*	.300	.06	.490	15	244
Laurel Negro *Cordia alliodora*	.255	.60	.425	391	646
Laurel, dead* *Cordia alliodora*	.130	.34	.380	180	523
Guava colorada *Ravenia* sp.	.280	.47	.605	251	536
Barba Chele *Vochysia ferruginea*	.205	.18	1.240	100	548
Nancito *Hieronyma alchorneoides*	.150	.34	.435	180	521
Nispero *Achras Zapota*	.120	.03	3.505	2	60
Pan Subá *Lecythis costaricensis*	.165	.09	1.825	21	229
Campano *Guarea* sp.	.075	.12	.595	40	328
Guapinol *Hymenaea* sp.	.075	.04	1.710	3	67
Cedro Real *Cedrela odorata*	.070	.10	.700	52	536
Cortez *Tecoma chrysantha*	.060	.06	.940	7	108
Balsa *Ochroma* sp.	.025	.09	.315	27	309
Zapote *Calocarpum viride*	.025	.07	.345	5	72
Santa María *Calophyllum* sp.	.025	.07	.360	5	70
Cola de Pava *Cupania asperula*	.025	.09	.295	22	242
Manwood *Minquartia guianensis*	.020	.06	.270	17	263
Lagarto *Zanthoxylum microcarpum*	.020	.06	.380	14	242

*Dead Laurel was tabulated because examination showed that most of the material could be salvaged and fully utilized. Natives relate that there was a hurricane in 1933 which blew down thousands of Laurel trees. The blown down trees are very much in evidence today and are in a well preserved condition. The sapwood has long since rotted away leaving the sound heartwood.

A METHOD OF DETERMINING THE SPECIFIC GRAVITY OF SMALL WOOD SAMPLES

By J. S. BETHEL and E. S. HARRAR

During the course of a recent investigation it was necessary for the authors to determine the specific gravity of a large number of short sections of increment borings. The use of the standard volume displacement method to obtain these measurements with proper accuracy proved to be both difficult and time consuming. As an alternative the "volumeter" illustrated in Figure 1 was developed.

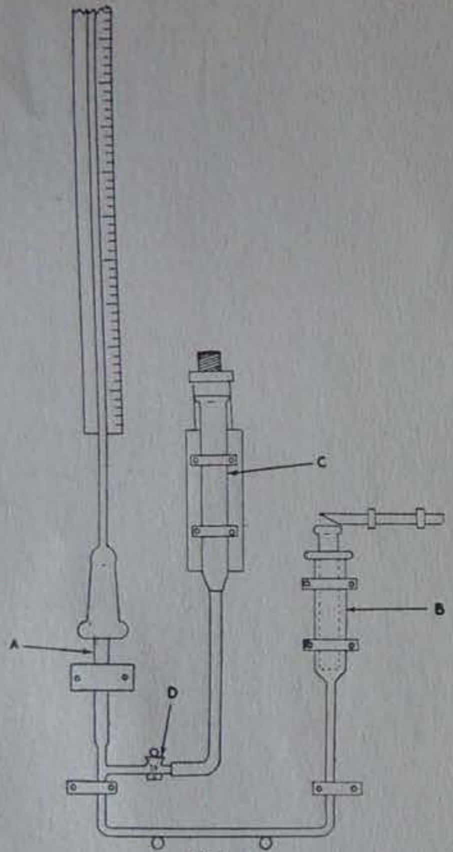

FIG. I
VOLUMETER USED TO DETERMINE THE GREEN VOLUMES OF INCREMENT CORES

In use, the whole instrument, exclusive of the capillary tube, is filled with mercury. The capillary tube is placed on receptacle *A* and the hypodermic syringe *B* is depressed. Stopcock *D* is opened and the height of mercury reservoir *C* is adjusted until the level of the meniscus of the mercury in the capillary tube coincides with the zero mark on the gauge. The stopcock *D* is then closed and the instrument is ready to use. To measure the volume of an increment core the syringe is released and the core is placed in receptacle

A. The capillary tube is positioned on the receptacle and the syringe depressed. The volume of the core is read on the guage. To improve the accuracy of the instrument several capillaries of various bores were prepared for tests with specimens of different sizes. A tube with an inside diameter of 3 millimeters was found satisfactory.

The gauge was calibrated by filling the system with mercury and adjusting it to zero as previously described. Small increments of mercury were weighed and dropped in the receptacle and the syringe depressed. The height of the mercury column above zero was measured and recorded. Several series of such measurements were completed covering the entire length of the tube. From the known specific gravity of mercury and the measured weight, the volume of each increment of mercury was obtained. Using these data a regression of the form $\hat{Y} = b\,X$, was computed with Y equaling height above zero and X equaling volume. The constant b was determined by the method of least squares and having made the determination, the height above zero for even increments of volume was calculated. A separate regression was required for each size capillary tube.

After calibration of the instrument it was felt that it would be desirable to compare its accuracy in the determination of volumes with another standard method. Accordingly a standard volume displacement set-up, of the kind described in Army-Navy Aeronautical Specification AN-W-4a,* was made using a Chainomatic analytical balance and a very thin suspension wire. The green volumes of twenty-six loblolly pine increment cores were obtained by this standard water displacement method and also using the "volumeter." The oven dry weights of the borings were obtained and specific gravities calculated using both sets of volumes. A statistical analysis was made to test the hypothesis that the two groups of specific gravity values were from the same population. A "*t*" of 0.1206 was obtained. This "*t*" value was not signifi-

*Army-Navy aeronautical specification. Wood, determination of specific gravity of,. 1942. Army Air Forces, Wright Field, Dayton, Ohio.

cant and therefore the null hypothesis must be considered to be valid.

	Test to determine whether specific gravity values obtained by the water displacement method and by the mercury volumeter method could be assumed to be from the same population
Number of comparisons	26
Sum of the differences	−1
Sum of the squared deviations from the mean	66.18
Standard deviation	1.63
Standard error	0.320
t	0.1206

Since no significant difference between the methods of obtaining the specific gravity of increment cores was demonstrable it was assumed that the use of the volumeter as a substitute for the usual volume displacement technique in specific gravity determinations was justified.

After establishing the utility of this method for determining specific gravity when applied to increment borings it was also tried with small samples of veneer and small blocks of the size frequently used in sectioning wood samples. It was found to be equally applicable to these.

THE YALE WOOD COLLECTIONS

Accessions

At the end of the calendar year 1947 the total number of catalogued wood samples in the Yale wood collection amounted to 44,579, representing 12,582 named species and 2,866 genera of 236 families. There were 1,065 accessions during the year. The three largest single contributions were from (1) the New York Botanical Garden (394 duplicates of woods collected in British and Dutch Guiana); (2) the

Conservator of Forests, British Guiana (343 duplicate wood specimens from the Forest Station in Mazaruni); and (3) from the Comisión de Botanica del Valle del Cauca, Colombia (134 duplicates of woods collected by Dr. José Cuatrecasas). The sources of all the wood samples accessioned are as follows:

Africa: Mr. W. F. Opdyke, Cleveland Heights, Ohio (wood of South Africa); Mr. F. Peche, Brussels, Belgium (woods of the Belgian Congo).

Australia: The Bernice P. Bishop Museum, Honolulu; Council for Scientific and Industrial Research, Melbourne, Australia.

Brazil: Dr. D. G. de Almeida, Serviço Florestal, Rio de Janeiro; Dr. A. Ducke, Instituto Agronomico do Norte, Belém, Pará; Museu Comercial do Pará, Belém, Pará. Dr. W. Andrew Archer, U. S. Bureau of Plant Industry, Beltsville, Md.; Mr. Herbert Mead, Long Island City, New York (trade sample).

Colombia: Dr. José Cuatrecasas, Comisión de Botánica del Valle del Cauca, Calí.

Cuba: Mr. Alberto J. Fors, Havana.

British Guiana: Conservator of Forests (Georgetown); The New York Botanical Garden.

Dutch Guiana (Surinam): The New York Botanical Garden.

Hawaii: The Bernice P. Bishop Museum, Honolulu.

Honduras: Chicago Natural History Museum; Dr. V. C. Dunlap, The United Fruit Company, Lancetilla.

Mexico: Mr. T. MacDougall, New York, N. Y.

New Zealand: Mr. W. F. Opdyke, Cleveland Heights, Ohio.

Panama: Mr. W. R. Barbour, Hampton, South Carolina.

Solomon Islands: Mr. A. R. Entrican, Director of Forestry, State Forest Service, New Zealand.

U. S. A.: Mr. Francis R. Moulds, Melbourne, Australia; Mr. H. Nogle, Port Arthur, Texas; Mr. W. F. Opdyke, Cleveland Heights, Ohio; Rancho Santa Ana Botanic Garden, Anaheim, California.

Tropical America, Miscellaneous: Dr. Louis B. Wise, Institute of Paper Chemistry, Appleton, Wisconsin.

Miscellaneous: Dr. Erling Christophersen, Norwegian Embassy, Washington, D. C. (wood from the island of Tristan da Cunha).

Sections for Microscopic Study

During 1947 there were added to the slide collection cross, radial and tangential sections of 40 specimens, which, allowing for changes in species classification, makes a total of 30,431 slides of 11,621 specimens of 6,863 named species, 2,682 genera, and 220 families.

Specimens Distributed

There were distributed during the year 160 wood specimens to the following scientists and institutions:

To Prof. I. W. Bailey, Institute for Research in General Plant Morphology, 64 woods of 9 families.

To Prof. D. A. Kribs, Department of Botany, Pennsylvania State College, 12 woods of 8 families.

To Miss Jeannette M. Kryn, Department of Botany, University of Michigan (Ann Arbor) 4 woods of 4 families.

To Prof. R. Salgues, Institut de Pathologie, Fondation Salgues de Brignoles, France, 17 samples of 10 species of the genus *Pittosporum*.

To Dr. Oswald Tippo, Department of Botany, University of Illinois, 28 woods of 3 families.

CURRENT LITERATURE

Indigenous palms of Trinidad and Tobago. By L. H. BAILEY. *Gentes Herbarum* (Ithaca, N. Y.) 7: 4: 353-445; figs. 143-210; December 1947.

The species, some new, are described and illustrated in excellent drawings and photographs. Keys to the genera and species are included.

Riqueza forestal Dominicana. Tomo III. By José SCHIFFINO. Pub. by Sec. Estado de Agri. y Riego (Ciudad Trujillo, Dom. Rep.). Pp. 186, ill.; 1947.

This volume completes the set describing the trees and woods of the Dominican Republic. Each species is listed under the preferred common name with the scientific and other common names given.

Los *Cupressus* de Mexico. By MAXIMINO MARTÍNEZ. *An. Inst. Bol. Mexico* 18: 1: 71-149; 48 figs.; 1947.

The six Mexican species of *Cupressus* are described and illustrated. Some revision of the nomenclature was involved.

Leguminosas nuevas de Colombia. By LORENZ URIBE-URIBE. *Caldasia* (Bogotá) 4: 20: 405-409; September 1947.

Included in the article are descriptions of three new species of *Inga* by the author and also the new *Machaerium indutum* Killip.

Observaciones taxonomicas sobre las *Lecythis* del norte de Colombia. By ARMANDO DUGAND. *Caldasia* 4: 20: 427-430; September 1947.

The characteristics of the three species are discussed and *Lecythis magdalenica* Dugand sp. nov. is described.

Noticias botanicas Colombianas, IX. By ARMANDO DUGAND. *Caldasia* 4: 20: 427-430; September 1947.

Two new species of *Coccoloba* and *Mastichodendron colombianum* (Standl.) Dugand, comb. nov., are presented.

Vistazo a la vegatacion natural del bajo Calima. By José Cuatrecasas. *Rev. Acad. Col. Cienc. Fís & Nat.* (Bogotá) 7: 27: 306-312; 6 plates; July 1947.

The composition of the forests and other plant associations adjacent to the river are described.

Verbenáceas del centro de Antioquia. By H. Daniel. Pub. by Sociedad de Ciencias Naturales Caldas (Medellin, Colombia), (?) 1947. Pp. 8.

The species are discussed and the correct common names given.

Catalogo de la flora Venezolana. Tomo II. By H. Pittier, T. Lasser, L. Schnee, Zoraida Luces de Febres, and V. Badillo. Pub. by Third Conference of Interamerican Agriculture (Caracas), 1947. Pp. 577.

Contained in this valuable reference are species listings, specimen numbers and occasional notes, keys to the species, and indexes to scientific and vernacular names.

A study of *Hevea* (with its economic aspects) in the Republic of Peru. By R. J. Seibert. *Ann. Missouri Bot. Gard.* (St. Louis) 34: 3: 261-353; pl. 32-44, 1 folded map; September 1947.

A detailed study of the species, with particular emphasis upon field conditions and habitat, is presented.

Two new leguminous trees of British Guiana. By N. Y. Sandwith. *Contr. Gray Herb.* (Cambridge, Mass.) No. 165: 25-29; 1947.

Sweetia praeclara Sandwith and *Swartzia Bannia* Sandwith are described as new. The former is known as Blackheart, the latter as Bannia.

Arvores e plantas uteis. Amazonia Brasileira III. By Paul Le Cointe. *Brasiliana* (Rio de Janeiro) Volume 251: Series 5. Second edition; illustrated. Pp. 506. In Portuguese.

Vernacular and common names, botanical classification, habitat, principal uses and proprieties are given for the native and acclimated useful trees and plants of Brazil. There are 18 photographs.

Le pin du Parana—Source possible d'approvisionnement en bois pour la reconstruction de l'Europe. By Tom Gill. *Unasylva*, (F.A.O., United Nations Org., Washington, D. C.) 1: 2; September-October 1947.

The author believes that Parana Pine offers more possibilities than any other construction wood for the reconstruction of Europe.

There is wood on hand now in the Parana Pine region. Needed are equipment and proper methods of transport. If the Brazilian Government cooperates, as is expected, there remain two problems to be solved: evaluation of the needs of Europe in the next three to five years, and the procurement of necessary equipment.

Parana Pine is found "in the high mountain regions of the states of Rio de Janeiro, Minas Geraes and São Paulo and on the plateaux of the states of Parana, Santa Catharina and Rio Grande do Sul, at an altitude of 550 to 1,100 meters above sea level." "It is estimated that at present the pine covers more than 10 million hectares of land in Parana, Santa Catharina and Rio Grande do Sul; it extends for a considerable less distance in the state of Minas Geraes and São Paulo. The forests in the northern part of Rio Grande do Sul are apparently virgin . . ."—*Mary Record.*

Industria madeireira. By Paulo Ferreira de Souza. Imprensa Nacional, Rio de Janeiro, Brazil, 1947. Pp. 344; illus. In Portuguese.

This is a complete book of the primary wood-using industries, as applied to Brazilian timbers and conditions. The subjects covered include logging, lumbering, seasoning, wood preservation, lumber grading, the names and distribution (by states) of the principal timbers, veneers and plywood, and several lesser products.

Tecnologia de produtos florestais. By Paulo Ferreira de Souza. Imprensa Nacional, Rio de Janeiro, Brazil, 1947. Pp. 409; illus. In Portuguese.

The subject matter of this volume is an extension of that covered in the book reviewed above. Included are the use of wood as fuel, charcoal, railway cross-ties, for tannin, naval stores (resin, turpentine), cork, rubber, paper and other products.

O gênero *Eucalyptus* no Brasil. By J. G. Kuhlmann. Arquivos Serviço. Florestal (Rio de Janeiro) 2: 2: 1-37; 22 plates; November 1946.

Detail sketches and keys are presented for the identification of about 100 species.

Forest products of Paraguay. By Lyall E. Peterson. *Jour. Forestry* (Washington, D. C.) 46: 1: 20-26; January 1948.

"The main forest wealth is found in the region to the east of the Paraguay River, in a country that is wild, roadless, and sparsely inhabited by Indians. Sixty percent of the land is under forest, much of which is virgin in character. To the west, more than 40 percent of the Chaco region is covered by a scrubby forest growth of little value except for palm logs and the quebracho (mainly *Schinopsis lorentzii*) . . ."

Los incendios de bosques en la Argentina. By Lucas A. Tortorelli. Ministerio de Agricultura, Buenos Aires, 1947. Pp. 239; 32 plates, 5 maps.

The author discusses the causes and effects of forest fires in each of the main forest regions of Argentina. Methods of prevention are presented in detail.

Arid southeast Oahu vegetation, Hawaii. By Frank E. Egler. *Ecological Monographs* 17: 4: 383-435; 41 figs.

"Specifically, this paper is a report on the composition, structure, and other features of the vegetation of arid southeastern Oahu. These communities differ only in minor ways from those which occur in all other arid parts of the island of Oahu. Furthermore, the botanical literature indicates that this vegetation is similar to that which is developed in the other Hawaiian islands."

Official common names of trees and other plants. *Philippine Jour. Forestry* (Manila) 5: 1: 75-135; 1947.

Over 900 species are listed first alphabetically by common names and then according to scientific names.

Richesses forestières des Iles Philippines. By Arthur F. Fischer. *Rev. Internat. Bois* (Paris) No. 124: 178-184; October 1947.

The forests and forestry of the Philippines are briefly described and the useful timbers classified. Brief descriptive notes accompany a list of 33 important species.

The timbers of North Borneo. By H. G. Keith. North Borneo (Sandakan) Forest Records No. 3; 1947. Pp. 156. Price $7.00 or 16 s. 4 d.

Part I is a brief description of the forests; Part II consists of descriptions of the commercial (export) timbers; Part III deals briefly with the less well-known timbers of local utility.

Australian tea trees of economic value. Part I. By A. R. Penfield and F. R. Morrison. Technological Museum (Sydney) Bul. No. 14; 1946. Pp. 16; 7 figs. Price 6 d.

"For the purpose of this series of publications, we propose to confine the word 'Tea Tree' to a selection of species of *Leptospermum* and *Melaleuca* which are becoming widely known on account of their economic value."

"This Part I issue will treat of two species, *Melaleuca linariifolia* and *M. alternifolia*."

Forest resources, regions and trees of New South Wales—in brief. Pub. by Forestry Commission of New South Wales, 1947. Pp. 16; 1 folded map; cover illus.

The forests, forest types, and commercial forest trees are briefly described. The map delimits the forest types, state and other land ownerships.

New genera and species of Bambusaceae from eastern Asia. By F. A. Clure. Lingnan Univ. Sci. Bul. No. 9: 1-67; 1940.

"The bamboos treated herein fall into 14 genera, of which three are new. Fifty-six species and six varieties presumed to be new to science are described, and six transfers are made."

Die fossilen Floren Ägyptens. IV. By Richard Kräusel. Ab. Bayerischen Akademie der Wissenschaften (Munich) No. 47 (New Series), 1939. Pp. 140; 23 plates; 33 text figs.

This work describes the fossil woods in detail and presents a key for their identification. The excellent drawings and superb photomicrographs are an important feature.

Caractéristiques de quelques bois des Comores. By Didier Normand and Alice Besson. *L'Agronomie Tropicale* (Nogent-sur-Marne, France) Nos. 7 & 8: 399-405; July-August 1947.

This study of some commercial woods of the Island of Comores, a dependent of Madagascar, includes a key for their identification, preliminary physical properties tests, and chemical analyses.

Les bois, richesse permanente de la Cote d'Ivoire et du Cameroun. By A. Aubréville. *L'Agronomie Tropicale* Nos. 9 & 10: 463-489; 15 figs.; September-October 1947.

The exploitation of the forests and the forestry methods required to improve their value are discussed. The species to be favored are briefly reviewed separately.

Notes on the forests of Uganda and their products. By W. J. Eggling and I. R. Dale. Pub. by Uganda Forest Department, 1947. Pp. 18; 1 folded map.

A general description of the country, its geology, soils and climate, is followed by information on each of the main forest types. Brief descriptive notes about the principal timbers and utilization statistics are also given. The map shows the forest areas.

Uganda, her forests and timber industry. By Ivan R. Dale. *Wood* (London) 12: 12: 338-341: 4 figs.; 1 text map; December 1947.

The general type of forests and their distribution are described briefly. Both the historical and present aspects of administration, together with the future prospects, are outlined.

Botanica Nigerica. By A. P. D. Jones. *Farm and Forest* (Ibadan, Nigeria) 8: 1: 10-16; 1 text map; January-June 1947. Price 3 s. 6 d. (or 12 s. yearly).

The history of botanical collections is outlined and depicted on an outline map. It is estimated that the flora of the eastern province is not more than 65 percent known and that in no part of the remainder is it more than 90 percent known.

Notes on the vegetation of Old Oyo Forest Reserve. By R. W. J. Keay. *Farm and Forest* 8: 1: 36-47; 4 plates; January-June 1947.

A preliminary account of the vegetation and forest associations in a part of this 200 square mile forest reserve.

New or noteworthy plants from west tropical Africa. By A. C. Hoyle and J. P. M. Brenan. *Kew Bul.* (London) 1: 67-74; 1947.

Among the new species described is the large tree *Brachystegia nigerica* Hoyle & A. P. D. Jones, common in southern Nigeria where it is known as Achi.

Contribution à l'étude de la végetation du Sénégal. By JEAN TROCHAIN. Mém. Inst. Français d'Afrique Noire (Libraire Larose, Paris) No. 2, 1940. Pp. 433, 30 plates.

This comprehensive publication deals with the plant ecology of Senegal in French West Africa. Information on plant succession is correlated with that on climate and soils as far as the steppes and savannahs are concerned. These areas occupy most of the colony with the exception of a relatively small district in the south which is occupied by remnants of a closed monsoon forest similar to that of the Gold Coast and Central Nigeria. The author does not attempt to give the southern forest area more than cursory attention although the species composition is discussed briefly.—DAVID M. SMITH.

On the relationships of *Lannea barteri* (Oliv.) Engl. By A. C. HOYLE and A. P. D. JONES. *Kew. Bul.* No. 1: 75-86; 4 plates; 1947.

The name *Lannea barteri* (Oliv.) Engl. is rejected as nomen confusum and the components of the original mixture assigned to other species. Other mixed material is identified, collections cited, and a key for identification presented.

The families Illiciaceae and Schisandraceae. By A. C. SMITH. *Sargentia* (Jamaica Plain, Mass.) 7: 1-224; 41 figs.; 1947.

"The present paper is directed toward a systematic revision of the Illiciaceae and Schizandraceae, which may serve as a framework for subsequent morphological and anatomical studies by Prof. Bailey and Dr. Nast." "In selecting the genera *Illicium*, *Schizandra*, and *Kadsura* for our next studies, we turn to a very important group of ranalian genera—important for the primitive aspects of certain of its organs and also for the implications of its distributional patterns."

"As a result of our collaborative studies of the three genera concerned, my colleagues and I have concluded to keep *Illicium* apart in a separate family, the Illiciaceae."

The extension of the card-sorting method to war-time problems in timber identification. By H. E. DADSWELL, FLORENCE V. GRIFFIN, and H. D. INGLE. *Jour. Council Sci. & Ind. Res.* (Melbourne) 20: 3: 321-337; 5 figs., August 1947.

The war-time applications of the card-sorting identification key for field use is discussed. The development of keys for the south-west Pacific area, New Guinea, Philippines, Malaya, and East Indies timbers is described in detail.

The mahoganies. By H. E. DESCH. Wood (London) 12: 10: 288-290; 8 figs.; October 1947.

The teaks. By H. E. DESCH. *Wood* (London) 12: 11: 324-325; 5 figs.; November 1947.

The walnuts. By H. E. DESCH. *Wood* (London) 12: 12: 358-360; 8 figs.; December 1947.

Each of the above three articles contains brief descriptions of the woods, their origin, and their applications. A photomicrograph of the cross-section accompanies each wood description.

Histology of barks of *Chinchona* and some related genera occurring in Columbia. By RUBY R. LITTLE. *Rev. Acad. Col. Cienc. & Nat.* 7: 27: 404-425; 2 plates, 19 figs.; July 1947.

A detailed study of the anatomy of the bark of *Cinchona* and related genera. Keys for identification are included. (See review in *Tropical Woods* 84: 29.)

Foreign woods. By GEORGE N. LAMB. *Wood Products* 52: 12: 26; December 1947.

Sub-titled "Origin, Use, Properties and Nomenclature." This is the ninth of a series of short notes on imported woods.

The fine structure of the fibres of normal and tension wood in beech (*Fagus sylvatica* L.) as revealed by x-rays. By R. D. PRESTON and V. RANGANTHAN. *Forestry* (London) 21: 1: 92-98; 1 plate; 1947.

"In a recent contribution to this journal Chow [K. Y. Chow] has presented the results of detailed chemical and microscopical analyses of normal and tension wood in beech. At the request of the Officer-in-charge, Chemistry Section, Forest Products Research Laboratory, Princes Risborough, we have now examined his material in the X-ray spectrometer in the hope that it might thereby prove possible to supplement the work already published. It is the purpose of this paper to present the results of this examination and to discuss some of the implications in terms of the general picture presented by Chow."

Timber, its structure and properties. By H. E. DESCH. MacMilland & Co., Ltd., London, 1947. Pp. 299; 55 plates. Price 18 s. net.

The second edition of this well-known book is considerably enlarged and more comprehensive than the first. Those who are familiar with the author's other technical writings, need no further description to appreciate the excellence and comprehensive treatment of this significant contribution to the literature on the subject of wood.

The growth of the World's forests. By the Staff of the Div. of Forestry and Forest Products. *Unasylva* (F.A.O., Washington, D. C.) 1: 1: 27-36; 6 figs.; July and August 1947.

Preliminary estimates and a discussion of factors involved accompanies a request for detailed information from all countries.

M. M. Chattaway.

Price 25 cents

Yale University School of Forestry

TROPICAL WOODS

NUMBER 94 JUNE 1, 1948

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Yale University	School of Forestry

TROPICAL WOODS

NUMBER 94 June 1, 1948

A technical magazine devoted to the furtherance of knowledge of tropical woods and forests and to the promotion of forestry in the Tropics.

The editor of this publication and the writer of any articles therein, the authorship of which is not otherwise indicated, is ROBERT W. HESS, *Associate Professor of Forest Products, Yale University School of Forestry.*

Address all communications to the editor, 205 Prospect Street, New Haven 11, Connecticut, U. S. A.

THE ARGENTINE *PIPTADENIA* TIMBERS

By LUCAS A. TORTORELLI[1]

The genus *Piptadenia* is of great importance in the Argentine forest economy of today and will be even more so in the future, because the woods of the species which make up the genus are very valuable and also because the tree can be reproduced easily, either naturally or artificially.

According to Arturo Burkart, this genus comprises about 40 species, almost all of which are American (Brazil)[2]; Professors Samuel J. Record and Robert W. Hess report, on the other hand, that the genus *Piptadenia* is formed by about 80 species of thorny and unarmed trees and by straight bushes represented abundantly in the tropical part of South

[1]Director of Forest Service, Department of Agriculture (Argentina).
[2]Las leguminosas argentinas. p.144. 1943.

America and scarcely in tropical Africa, Asia and New Guinea.[3]

In our forest flora, the principal species of this genus grow in the northern stands. They are:

I. *Piptadenia macrocarpa* Benth.
II. *Piptadenia excelsa* (Gris.) Lillo
III. *Piptadenia rigida* Benth.
IV. *Piptadenia paraguayensis* (Benth.) Lindm.

In this work, they are all studied in their xylo-technologic and forestry aspects. In this way, biological and quasi-economic data of importance may be added. For example, those relating to the existence per hectare of trees larger and smaller than 30 cm. in diameter constitute an index of the present and future stocking of the species within the forest. This is necessary in the case of plans for management which would secure the perpetuity of the more economically valuable species. The wood samples and their corresponding herbarium material were obtained by Arturo Ragonese and Julio A. Castiglioni and the identifications of the herbarium material were made by Burkart, all being placed in the herbarium of the Dirección Forestal of the Argentine Department of Agriculture. In addition, the wood samples named in each particular case have been studied.

The macroscopic study was made with unaided eye or with an 8× lens. A 100× magnification has generally been used for the microscopic study. For more detailed observations, greater magnifications have been used as specified in each case.

The terms used in the anatomical description are included in the official nomenclature of the International Association of Wood Anatomists[4] and in the recommendations of the first meeting of Wood Anatomists held in Rio de Janeiro between the 21 and 28 of September 1936.[5] We have also

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[3]Timbers of the New World. p.307. 1943.
[4]Tortorelli, Lucas A. Spanish translation of the Glossary of Terms Used in Wood Anatomy. *Rev. Arg. de Agronomia* 4(1):51-66; 1937.
[5]*Rev. Arg. de Agronomia* 4(2):124-29; 1937.

been aware of the suggestions of our Brazilian friend Fernando Milanez.[6]

The analyses of the exotic woods similar to the studied native species refers only to the aesthetic characteristics, specific gravity and approximate hardness. This has been done with the material obtained by exchange up to the 20th of June 1947, available in the collection of American woods created recently at the Dirección Forestal of the Argentine Department of Agriculture. Also used were samples obtained from some European countries and Africa, especially from the French West Africa Colonies, which just before the war were the principal suppliers of a great part of the woods used in our country for interior decoration of modern homes, show cases, etc.

The pictures of Plate I, were taken by O. Giacobbi (a and b) D. Panelati (c) and Jorge Lippold (d); the photomicrographs of the other plates, were taken by J. A. Castiglioni and E. Di Lella in the laboratory of the Dirección Forestal.

Key to Argentine Piptadenia Species

I. Wood with incomplete paratracheal parenchyma; rays three or more cells wide, and up to 550μ high.
  A. Wood fibers with very thick walls; pore multiples predominate. Heartwood light brown or reddish. *P. macrocarpa.*
  B. Wood fibers with thin walls; solitary pores in greater numbers. Heartwood light brown or reddish with longitudinal violet stripes............ *P.* aff. *macrocarpa.*
II. Wood with definite paratracheal-vasicentric parenchyma; rays uniseriate or biseriate, and up to 350μ high.
  C. Wood parenchyma scarce to abundant. Heartwood light brown to reddish.
    a. Pores 50 to 90μ in diameter. Vascular elements

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[6]Nota sobre a classificacao do parenquima do leno. *Rodriguesia.* VIII(17):2; (Rio de Janeiro) 1944.

(macroscopic) follow a straight line, indicating straight grain; texture soft .... *P. excelsa.*

b. Pores 100 to 200μ in diameter. Vascular elements in distinctive angular alignment as seen on tangential surface (macroscopic), due to interlocked grain; texture uniform .... *P. rigida.*

D. Wood parenchyma very abundant. Heartwood yellowish white not well differentiated from the sapwood .... *P. paraguayensis.*

1. *Piptadenia macrocarpa* (Cebil Colorado)

This is one of the characteristic species of the Tucuman-Bolivian Subtropical Forest and is also present, but rather scarce, in the north and northeast of Corrientes and southern the territory of Misiones. Its habitat comprises also part of the territory of Misiones. Its habitat comprises also the transition zone between the Subtropical Salteña Forest (Selva Subtropical Salteña) and the Western Chaqueña Forest (Bosque Chaqueño Occidental). It is also present in the southeast of the territory of Formosa. We have found it in the northeastern part of the territory of Chaco (Selva Rio de Oro).

It was observed in the Salteña portion of the Tucuman-Bolivian Forest (Selva Tucumano-Boliviana), near the borders of the Pescado, Iruya, Bermejo, Tarija and Itau rivers, and on slopes, especially eastern, of the numerous brooks of the Salta mountain region (parallel 22° South) on the floor between 340 and 900 meters above sea level, but the principal elevated stands were found between 400 and 700 meters above sea level.

The best conditions for its natural regeneration and development among the studied stations were found along the brook of San Telmo (in the mountains of Itau), province of Salta. It shows a decided preference for sites with warm and humid climate.

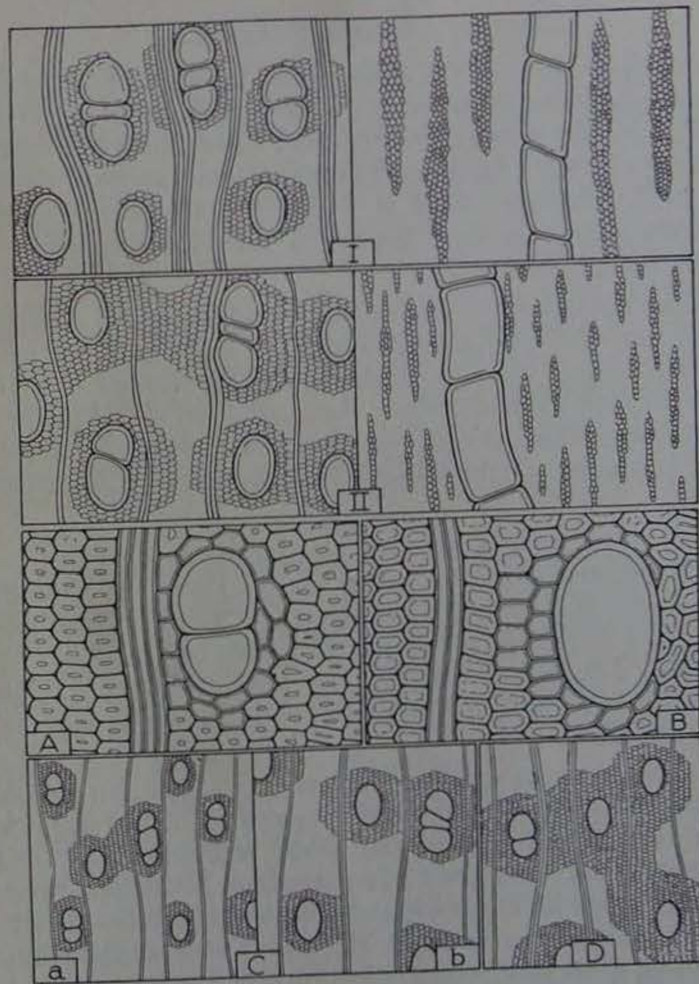

Plate I. ANATOMICAL CHARACTERS OF WOOD REFERRED TO IN THE IDENTIFICATION KEY.

Fig. I. Wood parenchyma and rays of Group I. ×50
Fig. II. Wood parenchyma and rays of Group II. ×50
Fig. A. Cross section of *Piptadenia macrocarpa.* ×200
Fig. B. Cross section of *P.* aff. *macrocarpa.* ×200
Fig. C.a. Cross section of *P. excelsa.* ×25
Fig. C.b. Cross section of *P. rigida.* ×25
Fig. D. Cross section of *P. paraguayensis.* ×25

COMMON NAMES AND MATERIAL

In the provinces of Tucuman, Salta, Jujuy and Catamarca, *Piptadenia macrocarpa* has the common name of Cebil or Cebil Colorado, while in the territory of Misiones it is called Curupay. In the Chaco and Formosa territories both names are used, although there is a slight preference for the Guaraní name, the best known in the Paraguayan chaco where the tree also grows.

In our opinion the common name which must be popularized is that of Cebil Colorado because it is the only one used in Salta, Jujuy and Tucuman, where the species is more abundant and the place where the Argentine[7] wood marketed in Buenos Aires is obtained. For that reason it is the one to be proposed for the Official Nomenclature of Argentine Woods.

The wood material studied belongs to specimens from which herbarium samples were taken (Dirección Forestal Herbarium No. 2631). They were collected at Saucelito (Salta) by Ragonese and Domingo Cozzo and identified by Burkart. The wood material we have collected at Rio Pescado (Salta) and at Presidencia de la Plaza (Chaco) has also been studied.

Besides the above mentioned material, we have also studied samples of woods with the common name Cebil Moro, collected near Oran (Salta) and wood samples having this common name with their corresponding herbarium specimens collected by Ragonese and Cozzo at Saucelito (Dirección Forestal Herbarium No. 2627, 2695 and 2629), identified in all cases as *Piptadenia macrocarpa* by Burkart. It is possible to say that according to this circumstance Cebil Moro and Cebil Colorado would be synonyms of the same species. However, they have some different characteristics which we shall mention in the discussion of Cebil Colorado.

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[7] *P. macrocarpa* from Paraguay is also marketed in Buenos Aires under the common name of Curupay.

THE TREE

P. macrocarpa is one of the species that form the arborescent stratum of the subtropical Tucumano-Boliviana formation. This species reaches 25 meters in height and 90 centimeters in diameter; more typical diameters are 35 to 50 centimeters. Its trunk is rather erect, yielding logs of 4 to 8 meters in length. The bark has a thickness of 2 to 5 cm.; it is smooth, grayish and has small longitudinal fissures.

The leaves are bipinnated, with 14 to 20 pairs of pinnae and 50 to 60 pairs of leaflets 5 millimeters long and 1 millimeter wide. The flowers are small, clustered in yellowish rounded heads of about 1½ to 2 cm. in diameter and have a peduncle 2 cm. long. The fruits are flattened legumes which measure 15 to 20 cm. long and 3 cm. wide; they are bright reddish brown and have several flattened oblong seeds of 14 to 19 mm. in length.

In the sample plots made at the Quebrada San Pedro (Salta) *P. macrocarpa* was found among fifty-five other forest species, from which number, about 10 associated species stand out because of their economic importance. Arranged in a decreasing scale of proportional abundance, quantity of timber per hectare and quantity of trees bigger and smaller than 30 cm. in diameter, they are:

Piptadenia excelsa	Horco Cebil
Ruprechtia polystachya	Lanza Blanca
Tipuana tipu	Tipa Blanca
Astronium urundeuva	Urundel
Prosopis alba	Algarrobo Blanco
Prosopis nigra	Algarrobo Negro
Schinopsis Lorentzii var. *marginata*	Horco Quebracho
Pterogyne nitens	Viraró
Calycophyllum multiflorum	Palo Blanco
Fagara naranjillo	Naranjillo
Phyllostylon rhamnoides	Palo Amarillo
Acanthosyris falcata	Sacha Pera

Myroxylon peruiferum	Quina Colorada
Gleditschia amorphoides	Espina de Corona
Cedrela Lilloi	Cedro
Tabebuia Avellanedae	Lapacho Rosado
Juglans australis	Nogal del Pais

The same sample plots yielded the following figures for the Cebil Colorado:[8]

Average occurrence of exploitable logs per hectare	16 m.³
Average diameter	48 cm.
Maximum diameter found	90 cm.
Percentage of disease	25 percent
Average number of trees larger than 30 cm. in diameter per hectare	7
Average number of trees smaller than 30 cm. in diameter per hectare	3
Maximum number of trees larger than 30 cm. in diameter per hectare	50
Maximum number of trees smaller than 30 cm. in diameter per hectare	14

DESCRIPTION OF THE WOOD

The sapwood is yellowish white with a tinge of pink; the heartwood is light brown when freshly cut but after being exposed to the air for some time, it acquires a reddish brown color. On both longitudinal walls, there are smooth stripes formed by different shades of brown. When the wood is exposed to the air, the stripes disappear and the entire surface becomes reddish brown. Only a slight stripe remains then, derived from the markedly interlocked grain; a feathery pattern may be present in some portions. The wood is hard and heavy to very heavy; specific gravity, 0.980 kg./dm.³ to 1.080 kg./dm.³.

[8]The corresponding values for Cebil Moro are considered separately.

Gross Anatomy

The pores are small and numerous, appearing as small whitish dots; as seen with a lens, the pores are empty and their whitish color is due to parenchyma tissue which embraces the pore. The growth rings are lightly marked and rather irregular. On the longitudinal walls the vascular elements appear as fine lines, more or less slanted, and of a deep ochre color.

Minute Anatomy

Vessels numerous, from 12 to 20 per sq. mm.; tangential diameter from 40 to 110μ; with multiples of 2, 3, 4 and 5, also solitary with roundish to elliptic shape. Walls marked with canals of the visible pits.

Vascular elements with a rather sinuous alignment and up to 400μ in length; the end walls are generally slanted. Pits somewhat lenticular, in alternate arrangement.

Wood fibers from 8 to 12μ in diameter and with very thick walls. Closely and radially arranged although this arrangement is frequently not perfect. They have a sinuous alignment.

Wood rays bend around the wider pores; tri- and multiseriate, few biseriate and seldom uniseriate; multiseriate rays 40 to 50μ wide; pits visible. The rays are all homogeneous being formed by procumbent cells; very rarely acro-heterogeneous. There are from 6 to 8 per mm.; their height is between 100 and 480μ (300 average). Sometimes wood rays may be observed vertically joined; these do not, however, have upright cells in the joined portion.

Wood parenchyma paratracheal, generally incomplete, sometimes vasicentric, composed of polygonal cells measuring from 18 to 25μ in width. In a tangential section, cell series 500μ long may be observed with more or less sharpened ends and subdivided into cells 100 to 180μ tall. Pit canals may be observed in the walls.

Cell contents. In transverse section numerous cells containing calcium oxalate crystals may be seen, usually solitary and sometimes in uniseriated tangential bands, while in a longitudinal tangential section it may be noticed that the crystalliferous strands are on the margins of the wood parenchyma aggregates. The cells are generally about 30μ high and 20μ wide, but sometimes they are smaller, from 15 to 20μ and they have one crystal in each cell.

In a radial section, no other important characteristics are observed, with the exception of the horizontal walls of the procumbent ray cells, which are rather long, generally exceeding 2 mm.

The growth rings are lightly marked.

USES OF THE WOOD

The wood of the Cebil Colorado or Curupay is the most extensively used of the four species which constitute the genus. It is used locally for several rural purposes such as posts, gates, rods, troughs, pounds, dips, etc.

Out of its geographical area, including Buenos Aires, it is marketed as logs and beams of a special and good quality and as boards and planks of special and first quality.

The wood of Cebil Colorado is successfully used in naval construction; at the Delta of the Paraná river it is extensively used for piles and piers. It is also used for window and door frames, frameworks, floors and platforms of railway carriage chassis and cars. It has been recommended for railway ties.

It has been discovered that this wood has great possibilities in the cooperage industry. Tests made at the Institute of Oenology of the School of Agriculture and Veterinary of the University of Buenos Aires by Julia Martinez de Billard, with my collaboration showed that wine bottled with shavings and with chips of Cebil Colorado for two years had a darker color than the control specimen, especially in the bottle containing the wood shavings. No differences were noticed in the odor; the taste was slightly bitter.

It is more intensely exploited in the provinces of Salta and Tucuman than in the northern Territories, because of its greater abundance in those provinces.

There is no extraction data on Cebil Colorado before 1946 when 5 tons were removed from public forests and 962 tons from private forests, especially in Misiones.

The bark of Cebil Colorado like the one of Horco Cebil contains a considerable amount of tannin, which due to its quality might be used mixed with the tannin of the heartwood of *Schinopsis balansae*, Quebracho Colorado Chaqueño. Up until a short time ago, tanneries located in Salta used to add waste of the bark of Cebil Colorado to the tanning tanks that contained the hides, leaving them for several months, till the end of the tanning process. This procedure is now being abandoned because of its slowness. Dr. Luis Pardo of the Dirección Forestal believes that it would be feasible to extract the tannin contained in the bark of the Cebil Colorado and Horco Cebil thus making the tanning operation easier; it could be used to improve the extract of Quebracho through its high percentage of non-tannic substances. Pardo's analysis of the bark of Cebil Colorado gave the following results:

Moisture content	9.6 percent
Tannins	13.64 percent
Non-tannic compounds	8.46 percent
Insoluble residue	68.1 percent
	100.00 percent

EXOTIC WOODS SIMILAR TO CEBIL COLORADO

Among the exotic woods whose color, texture, grain, specific gravity and hardness are similar to Cebil Colorado are:

Astronium spp. (Anacardiaceae) from Brazil, commonly called Aroeira Vermelha.

Cercocarpus ledifolius Nutt. (Rosaceae) from California, commonly named Curl Leaf Mountain Mahogany.

Dialium guianense Willd. (Leguminosae) from Gabon, French West Africa, where it is called Onvon.

Elizabetha paraensis Ducke (Leguminosae) from Brazil, known as Arapary Roxo.

2. *Piptadenia* aff. *macrocarpa* (Cebil Moro)

This species may be considered a synonym of Cebil Colorado according with the determination of the herbarium material by Burkart, who classified both species as *Piptadenia macrocarpa.* Nevertheless, between the Cebil Colorado described above, and the Cebil Moro there are some differences that should be mentioned.

The bark of the Cebil Moro generally has numerous (2 cm. apart) to very few[9] conical spurs up to 2.5 cm. in height. The bark has a slightly grayish to a greenish color and longitudinal fissures, but less marked than those of the Cebil Colorado.

The timber cruise previously mentioned for the Cebil Colorado gave the following information with reference to the standing timber and other forest characteristics:

Merchantable volumes in cubic meters per hectare (in logs)	9 m.^{3}
Average diameter	46 cm.
Maximum diameter found	1 m.
Percentage of disease	40 percent
Average number of trees smaller than 30 cm. in diameter per hectare	1
Average number of trees bigger than 30 cm. in diameter per hectare	1.4
Maximum number of trees smaller than 30 cm. in diameter per hectare	10
Maximum number of trees bigger than 30 cm. in diameter per hectare	12

DESCRIPTION OF THE WOOD

The sapwood has a thickness of 3 to 7 cm. and a pinkish yellow color. The heartwood is light brown with characteristic stripes of violet to deep brown.

This striped effect is due to the different colors of the heartwood and is very distinctive, especially on the longitudinal sections, when the wood is freshly polished. After being exposed to the air these clear brown portions become slightly darker but the characteristic violet stripes remain, permitting quick identification with the unaided eye. These violet stripes are the most outstanding difference to be found between this wood and the wood of Cebil Colorado. On the longitudinal surfaces the wood has a soft luster. The wood is hard and heavy; its specific gravity is .950 kg./dm.^{3}.

[9]In the Cebil Colorado the spurs are rather rare.

Minute Anatomy

Vessels numerous, 18 to 22 per sq. mm.; tangential diameter mostly 90μ, but many reach 120μ (sometimes pores of 45μ can be observed, particularly in the late wood); solitary, also in multiples of 2 or 3, seldom 4 or 5, few clustered; with very distinctive walls in which pit canals may be observed.

Vascular elements up to 300μ in length; slanted end walls, alternate lenticular pits.

Wood fibers with thin to very thin walls, thinner and fewer than in Cebil Colorado; irregularly arranged with a tendency to the radial arrangement. The radial arrangement is interrupted by the triangular, squarish and irregular hexagonal shape of the fibers; they are not very close together and have thicker walls in the late wood; 12 to 18μ in diameter. The fiber arrangement is rectilinear.

Wood rays with a slightly sinuous arrangement in the vicinity of the wider pores; uniseriate to triseriate. The end walls and pits are only barely visible with this magnification. In tangential section the wood rays number 4 to 10 per mm.; the multiseriate rays are elongated fusiform, the longest ones are up to 550μ and the shorter from 100 to 150μ high. The elongated fusiform rays are sometimes vertically joined with erect cells in the contact zone.

The wood parenchyma is paratracheal, incomplete, sometimes vasicentric and even confluent. Polygonal cells of 18 to 25μ are more abundant than in Cebil Colorado.

The vascular elements are bordered by the wood parenchyma strands with cells 100 to 120μ in height.

Cell contents. Numerous cells containing calcium oxalate crystals are observed (fewer than in Cebil Colorado), mostly solitary and scattered among the fibers. At greater magnification (450×), rhomboidal crystals of calcium oxalate are also seen in the parenchyma cells bordering the pores.

USES OF THE WOOD

Cebil Moro has been marketed out of its geographical area the same as Cebil Colorado. This wood, generally from Salta, is sold in Buenos Aires. Its value is always less than that of Cebil Colorado. For example, the beams of Cebil Moro of special quality were quoted in May, 1947 at 210 to 215 pesos and at 195 to 205 pesos for those of good quality, while the beams of Cebil Colorado had a quotation of 225 to 230 pesos and 210 to 220 pesos respectively for each type. Besides this, the Cebil Moro has no quotation for logs, while the special logs of Cebil Colorado are quoted at 120 to 125 pesos per ton.

The uses of Cebil Moro are, however, similar to those of Cebil Colorado. It requires cutting in the proper season and a more careful seasoning than the Cebil Colorado because, according to our observations, it warps and splits more easily. Despite these deficiencies, we consider the wood of Cebil Moro much more useful than others of the genus for ornamental purposes; being particularly apt for interiors of parlors, rooms, show cases, etc., and specially in the form of veneer.

EXOTIC WOODS SIMILAR TO CEBIL MORO

Colubrina rufa Reiss. (Rhamnaceae) Brazilian wood, named Saguaragy; very similar to Cebil Moro in its color, stripes, texture, grain, hardness and specific gravity.

Dalbergia nigra Allem. (Leguminosae) Also from Brazil and similar to our wood in color, texture, grain, hardness and specific gravity.

Juglans nigra L. (Juglandaceae) Black Walnut or Nogal Americano, from U. S. A.; similar in its texture, grain and hardness, but with a more homogeneous violet color in the North American wood.

Ctenolophon Englerianus Mildbr. (Linaceae) from Gabon (French West Africa), commonly named Okip; similar in color, stripes, texture, grain, hardness and specific gravity.

3. *Piptadenia excelsa* (Horco Cebil)

This species is found with *P. macrocarpa* in the superior arborescent stratum of the Subtropical Tucuman-Bolivian Formation (Formación Subtropical Tucumano-Boliviana) and has similiar climatic, biological and social requirements.

COMMON NAMES AND MATERIAL

Within its geographical area the species has three common names: Horco Cebil, Cebil Blanco and Sacha Cebil. We prefer the first name because it is the most extensively used, and for that reason it is the one to be proposed for the Official Nomenclature of Argentine Woods.

The herbarium material and its corresponding wood samples were found at Sausalito in Salta and collected by Ragonese and Cozzo, being incorporated in the Dirección Forestal Herbarium under the number 2690.

THE TREE

The tree is commonly 15 meters tall and 60 cm. in diameter, although it may reach up to 25 meters in height and 90 cm. in diameter. Its trunk frequently supplies straight logs up to 5 meters long. The bark is rugose having longitudinal fissures and transversal cracks.

The leaves are bipinnate, 3 to 6 pairs of pinnae with 20 to 30 pairs of leaflets measuring 6 to 8 mm. by 1.5 to 3 mm., with the midrib near the upper edge; small yellowish green flowers with cylindrical spikes; the fruit is a flat legume about 1 cm. wide and 10 to 20 cm. long.

Piptadenia excelsa occurs in the same superior stratum of the association where *P. macrocarpa* prevails. For that reason it is found associated with the same forest species mentioned for the latter.

Referring to forest economy, the census revealed the following values:

Average quantity of wood per hectare	13 m.^{3}
Average diameter	44 cm.
Maximum diameter found	90 cm.
Average percentage of disease	20 percent
Average number of trees smaller than 30 cm. in diameter per hectare	5

DESCRIPTION OF THE WOOD

Sapwood and heartwood pink colored, barely distinguishable by the slightly darker color of the heartwood. Eventually the heartwood becomes darker, and is then easier to distinguish from the sapwood which remains unchanged in color. When freshly planed it has a mild silver luster which is more visible in the exterior portion of the trunk (sapwood).

Horco Cebil is a wood of fine texture and slightly roe grain. The radial surface is not more outstanding than the tangential because the wood has very tenuous stripe. It is hard and heavy; specific gravity, .978 kg./dm.^{3}.

Gross Anatomy

The pores are small and appear as little whitish points, very numerous and scattered throughout all the tissue (diffuse porous). The vessel lines are rectilinear, very thin and of darker brown color than the rest of the tissue. On the radial section, the wood rays can be observed with the unaided eye, in spite of which it cannot be said that this wood has very conspicuous rays. It has slightly marked growth rings but always of an irregular width.

Minute Anatomy

Vessels, 15 to 20 per sq. mm.; tangential diameter from 50 to 90μ. Pores often elliptic and generally in multiples of two; there are also multiples of three and occasionally four and five. The walls are moderately marked and the pit canals are distinct. Vascular elements up to 250μ long; generally with slanted end-walls. Pits alternate, lenticular.

Fibers thin- to very thin-walled, with a decided tendency to radial arrangement; they are of a polygonal section and with a diameter of between 10 and 15μ. They have a slightly wavy alignment.

Wood rays follow a wavy pattern near the larger pores; 15 to 20μ wide by 80 to 450μ high. They are mostly biseriate and in minor amount uniseriate or uniseriate with aggregate cells; fusiform elongated; 7 to 10 per mm. Homogeneous, constituted by conspicuous ray cells; rarely acro-heterogeneous.

Wood parenchyma of a definite vasicentric type and frequently aliform, seldom unilateral. Square to polygonal cells, 18 to 20μ tangential diameter. The vessels are bordered by strands of wood parenchyma cells of 280μ in length, generally divided into two cells of 130 to 160μ in length by 15μ in width; the ends are pointed. The parenchyma cells can be seen on radial section.

Growth rings are not very marked. At the margins of the growth rings are uniseriate bands of calcium oxalate crystals.

Cell contents. Besides the already mentioned uniseriate bands, solitary crystalliferous cells can be observed in the entire field, irregularly scattered through the fiber tissue. The crystalliferous parenchyma strands can be observed on longitudinal sections.

USES OF THE WOOD

The quality of Horco Cebil wood is inferior to that of Cebil Colorado, but it may have the same uses whenever the maximum physical or mechanical characteristics are not required.

It is also known on the market of Buenos Aires where the beams of special class are quoted at 55 to 65 pesos m./n. the cubic meter and those of good quality at 42 to 50 pesos per cubic meter (May 1947 quotations).

EXOTIC WOODS SIMILAR TO HORCO CEBIL

Clarisia racemosa R. et Pav. (Moraceae). This Brazilian wood is commonly named Oiticica; it is similar in color, texture, brightness and grain.

Astronium urundeuva (Fr. Allem.) Engl. A Brazilian wood from São Paulo, known as Urunday, is similar in color, texture, grain, hardness and specific gravity.

Piptadenia africana Hook.f. (Leguminosae). A wood from the Ivory Coast in French Africa, called Dabéma. It is similar to Horco Cebil in color, texture and grain, but its specific gravity is somewhat higher.

4. *Piptadenia rigida* (Anchico Colorado)

This is one of the species which forms the upper arborescent stratum of the subtropical forest of Misiones, which is outstanding for its stability and permanence. It grows in Corrientes also. The characteristics of its wood makes it very valuable and for that reason it is now marketed in Buenos Aires.

COMMON NAMES AND MATERIAL

In Misiones it is called by the common name of Anchico Colorado, Curupay-ra, or Curupay-na. We prefer the first name as it is the most widely used and also because it is the only one used outside of the native territory, in places where it is marketed and used by industry. It is the one which will be proposed for the Official Nomenclature of Argentine Woods.

The herbarium material (Herbarium Dirección Forestal No. 2061, 2054 and 2710) and wood samples came from Campo Viera (Misiones). Samples originally from Misiones, included in the same collection under number 163, have also been studied.

THE TREE

Piptadenia rigida is one of the constituent species of the arborescent strata of the Misionera forest; its preferred station is the one determined by warm and humid climate. It

requires fairly deep to deep soils; preferring sites that are flat to very slightly sloped. Sample plots taken by two experts of the Dirección Forestal, Juan R. Araujo and Jose Antonio Valentini, in Colonia Aristobulo del Valle, in the middle of the territory of Misiones, showed the following figures for the average quantities of exploitable wood per hectare, varying with the soils: In fairly deep soils and mild slopes, 5.6 $m.^3$ per hectare; in deep and uniform soils, 3.6 $m.^3$ per hectare; and in the forests of rolling countries having shallow soils, only 1.4 $m.^3$ per hectare. Besides this decrease, Araujo and Valentini found in this last case the highest percentage of trees with clear signs of disease: 15.8 percent.

It is a tall tree varying in height from 18 to 25 meters, the principal diameters being between 50 and 80 cm. This tree is generally erect and gives a clear bole of 10 to 12 meters because its branches come out naturally at that height. The bark is 2 to 5 cm. thick, presenting little rhytidomas of light to dark brown coloration and so lightly attached that they fall off in irregular plates. The inner bark is of a reddish brown color.

The leaves are bipinnate with 3 to 6 pairs of pinnae, many leaflets about 1 cm. long and 2 mm. wide, slightly falcated, with 2 to 5 veins of which the midrib is very near to the upper edge. The flowers form long axillary spikes. The fruit is flattened, coriaceous, about 12 cm. long and 20 mm. wide.

Besides the *Piptadenia rigida*, the superior and inferior arborescent strata of the misionera forest also includes the following species:[10]

Nectandra membranacea var. *saligna*, (Laurel Negro)	11.49 percent
Balfourodendron Riedelianum, (Guatambu Blanco)	5.90 percent
Ocotea suaveolens, (Laurel Amarillo)	5.62 percent
Piptadenia rigida, (Anchico Colorado)	3.17 percent

[10] The species are in order according to the total percentage of the species found in the forest, up to one percent, and to the average of the forest types studied.

Cedrela fissilis, var. *macrocarpa*, (Cedro)	2.37 percent
Apuleia leiocarpa, (Grapia)	2.02 percent
Cabralea oblongifoliola, (Cancharana)	2.02 percent
Aspidosperma olivaceum, (Guatambu amarillo)	1.86 percent
Helietta cuspidata, (Canela de Venado)	1.72 percent
Myrocarpus frondosus, (Inciensо)	1.06 percent

The following species are represented less than one percent: *Cordia trichotoma*, (Peterebí); *Machaerium brasiliense*, (Canela do Breyo); *Jacaranda semiserrata*, (Caroba); *Chlorophora tinctoria*, (Mora); *Bastardiopsis densiflora*, (Loro Blanco); *Ocotea puberula*, (Canela Guaica); *Pithecellobium Hassleri*, (Anchico Blanco); *Enterolobium contortisiliquum*, (Timbó Colorado); etc., forming an association of more than 150 species.

From the economic point of view, the average figures for the forest types studied corresponding to Anchico Colorado are as follows:

Average stand of exploitable logs per hectare	5.6	$m.^3$
Average diameter	60	cm.
Maximum diameter found	1.20	m.
Percentage of disease	8	percent
Average number of trees smaller than 30 cm. in diameter per hectare	3	percent
Maximum number of trees smaller than 30 cm. in diameter per hectare	5.5	percent
Average number of trees larger than 30 cm. in diameter per hectare	5	percent
Maximum number of trees larger than 30 cm. in diameter per hectare	5.8	percent

DESCRIPTION OF THE WOOD

The sapwood is rose brown color and the heartwood is light brown. When freshly planed there is little difference between them, but exposed to the air the heartwood becomes darker brown. On the longitudinal walls it has mildly violaceous stripes but when exposed to the air the color tends to darken, becoming more uniform. Only then is the slight stripe evident, formed by the interlocked or feathery grain which makes this wood more valuable than the *Piptadenia macrocarpa* for decorative purposes. Like the other *Piptadenia* species, it has a fine texture.

Gross Anatomy

Against the brownish background numerous pores appear to the unaided eye as white dots, as in the Horco Cebil. Under the 8× lens it may be observed that their whitish aspect is due to the parenchyma which envelops the commonly empty pores. On the longitudinal walls the vessel members appear as numerous small lines of a darker color. The alignment of these small lines is generally very irregular and in some portions angles are formed, which determine the type of grain either interlocked or spiked grain. The growth rings are lightly marked and of irregular thickness.

Minute Anatomy

Pores are few (6 to 10 per sq. mm.), solitary, elliptic to roundish, sometimes found in multiples of 2, and more rarely of three and four. Sometimes clusters appear in which two or three pores are smaller than others. Vascular walls are marked prominently with pit canals particularly visible in the intervascular walls. The vessel in irregular alignment, being composed of rectangular elements with or without appendix 160 to 280μ high and 100 to 200μ wide; the smaller ones are 150μ high by 60 to 80μ wide. The perforations are usually simple and the pits very numerous. Under observation at 400× the pits have a lenticular form, opposite, with a tendency to alternate.

The fibers are very close together and radially arranged, with thin to thick walls and, as observed at 600× they are polygonal. The counts made indicate than 70 percent are 1 mm. long by 10μ wide and the rest are 500 to 800μ long by 5μ wide or 1100 to 1400μ high by 15μ wide. They seldom have pits, but when these pits are present they have a lenticular form and are slanted.

Rays are numerous (6 to 10 per mm.), generally uniseriate and biseriate, rarely triseriate; sometimes uniseriate and biseriate rays have aggregated cells, very rarely acro-heterogeneous may be observed. They have an average height of 200μ with a maximum of 350 and a minimum of 80μ; 12 to 20μ wide. Most are fusiform elongated and are formed by conspicuous ray cells which generally leave interstitial spaces (200×). In cross section they have simple pits and conspicuous end walls.

The wood parenchyma is paratracheal, usually vasicentric and sometimes incomplete; sometimes also terminal, rather irregular. The cells are polygonal, radially arranged, others are square 20 to 40μ by 20 to 40μ.

Growth rings are lightly marked, due to the flattening of the fibers. In the boundary there are sometimes uniseriate bands of cells with calcium oxalate crystals (rhomboidal).

Cell Contents. Besides the mentioned bands of cells with oxalate crystals, very conspicuous solitary cells containing rhomboidal crystals of calcium oxalate, one to each cell, may also be observed. In a longitudinal section and in separated material, the cells are arranged in strands. The series of crystalliferous cells appear as crystalliferous fibers and as crystalliferous parenchyma. In the first case among the strands of fibers it is possible to see some cells wider than the rest of the fiber divided by numerous septa into rectangular compartments 20μ long by 15μ wide and in number up to 15, every one containing an oxalate crystal.

USES OF THE WOOD

The wood of Anchico Colorado is used locally a great deal, for rural construction work, carpentry, shingles, beams and posts. In addition because of its favorable characteristics, it is used for wheels and car axles. The Institute of Silviculture of the School of Agriculture and Veterinary of the University of Buenos Aires, has a parquet floor of Anchico Colorado which was laid eight years ago, that is still in perfect condition.

The Anchico Colorado is a wood of very good characteristics which could have great commercial importance

in our country. As an index of its good quality we can take the fact that in Misiones the extractions of this species have been increasing steadily since 1941 when in state owned forests 304 tons were extracted and in private owned forests 1992 tons were extracted, as compared with the year 1946 in which 1188 and 5448 tons respectively were extracted. It should be recommended for reforestation work undertaken within its geographical area which includes also the province of Corrientes.

EXOTIC WOODS SIMILAR TO ANCHICO COLORADO

Besides the same species which exists also in Brazil, known under the common name of Angico Vermelho, there are in that country other species which have wood similar to our Anchico Colorado. Their use can be a definite guide for new uses of the Argentine wood. The following are outstanding among them:

Lecythis Pisonis Cambess. (Lecythidaceae), Sapucaia Vermelha, with rather similar texture, grain, color, structure, weight and hardness. It is used in heavy construction bridges, crossties, posts, carpentry and cabinet work.

Pterodon pubescens Benth. (Leguminosae), Faveiro, has the same characteristics as the preceding. It is exotic in Brazil where it has acclimated itself very well and is used for crossties, bridges and other durable construction. It is also used for tools, door and window frames and spokes of car wheels.

Calophyllum brasiliense Camb. (Guttiferae), Jacareuba, has color, luster, texture and grain rather similar to our Anchico Colorado, although it is somewhat lighter (specific gravity .700).

There is a great resemblance between our wood and *Khaya senegalensis* A. Juss., Cail Cedrat, native of French West Africa, used in France for decorative purposes.

5. *Piptadenia paraguayensis* (Ibirá-né)

This species grows in the northeastern part of the territory of Formosa. It generally has the typical form of a bush or coppice tree; the different suckers, which come out of the same stump reach 3 to 5 meters in height and 20 cm. in diameter. It has no economic importance.

COMMON NAME AND MATERIAL

The best known common name is Ibirá-né and means in Guaraní "stinking tree."

The wood sample studied belongs to herbarium specimen number 2655 collected by Ragonese at Mojan de Fierro (Formosa). We have also studied wood samples sent by Jorge Lippold from Formosa which were added to the wood sample number 2655, having the same characteristics.

THE TREE

As was said before the *P. paraguayensis* is a large bush, seldom reaching the size of a tree. It grows as a globe-shaped plant, with a clear green foliage, covering areas of about 4 meters in diameter. It is found spread throughout the forest savannas and islets. This species is heliophyte, is found on plain sites or in stands located in the proximity of the Paraguay river and up to about 30 kilometers into the interior of the territory.

The trunk has a thin bark, rather rough with shallow longitudinal fissures. In the specimens of smaller diameter, which are the most common, the bark is smooth, about 2 mm. thick and of a greenish gray color with darker spots.

The leaves are bipinnate, unijugate, with four leaflets 1 to 5 cm. long by 5 to 25 mm. wide; abundantly flowering, in elongated spikes; black sheaths slightly curved, 4 to 6 cm. long between ends by 1 cm. wide. The sheaths remain a long time on the trees, giving them a beautiful aspect. They have 4 to 10 (frequently 8), light, bony and 4 cm. in diameter.

P. paraguayensis is found in the islets among the following species:

Tabebuia nodosa	Palo Cruz
Diplokeleba floribunda	Palo Piedra
Astronium Balansae	Urunday
Aspidosperma chacoensis	Quebracho Blanco
Peltophorum dubium	Virá Pitá
Crataeva Tapia	Paraguáyá Naranjo
Tabebuia Ipe	Lapacho Negro
Gleditschia amorphoides	Espina Corona
Caesalpinia melanocarpa	Guayacán

DESCRIPTION OF THE WOOD

The heartwood is not clearly differentiated from the sapwood; the wood is slightly greenish yellow in color with very mild striping and with little luster. It has fine texture and slanting to interlocked grain.

The wood of Ibirá-né has a strong and disagreeable odor when sawed; to this is due the native name of the species. It is heavy and hard.

Gross Anatomy

In transverse section the pores are very small and cannot be distinguished without lens. Bands of very abundant wood parenchyma of a whitish color can be noticed instead, against the yellowish background of the rest of the fiber tissues.

The growth rings are very irregular and slightly demarcated due to the greater density of the fibers in the late wood and to the more yellowish color of the same portion of the ring. They are easily confused with the confluent parenchyma bands, which are whitish and are present in the early wood. No important distinguishing characteristics are seen in either the tangential or the radial sections.

Minute Anatomy

Vessels numerous to very numerous (12 to 30 per sq. mm.); tangential diameter 42 to 110μ, more frequently 80 to 100μ. Solitary, round to elliptic and multiple, usually in radial three's and four's and clustered. Pit canals distinctively mark the vessel walls. Vascular elements have a smooth, sinuous alignment and a length of 170 to 300μ; end walls horizontal or slanted. Lenticular pits more abundantly alternate than opposite and frequently coalescent. By observing with greater magnifications (600× to 1300×) a tenuous coalescent pit border can be seen. The pits between vessel members and wood parenchyma cells are horizontal, lenticular and slightly bordered.

Wood fibers thin- to thick-walled, triangular to polygonal shape; irregular arrangement and of two different diameters, 8 to 12μ and 18 to 25μ, compact. They follow a rectilinear arrangement and in a radial section they alternate with wood parenchyma bands and vascular elements.

Wood rays of a mild rectilinear arrangement, uniseriate and biseriate; pits visible at this magnification (100×). Elliptic procumbent cells 8 to 10μ in width, up to 1000μ in length; more frequently 500 to 800μ long. The end walls of the ray cells are visible.

Wood parenchyma definitely vasicentric, aliform and frequently in confluent bands. Square cells of 20 to 30μ and also round or elliptic of 18 to 30μ leaving interstitial spaces which can be well observed with a 400× magnification. The cells are radially arranged, simple pits scattered and frequently visible. Wood parenchyma strands divided into cells 800 to 1500μ in length; the pits can only be seen occasionally. In a radial section, the horizontal walls of the wood parenchyma cells can be well observed, divided into almost rectangular compartments. Simple and very scattered pits, can be observed with greater magnification than 150×.

Growth rings, marked by flattened fibers, are not very distinct.

Cell contents. Calcium oxalate crystals may be observed in much smaller amounts than those of the other species belonging to the genus *Piptadenia*. On the radial section it can be observed that the crystal cell rows are usually located in the fibrous areas.

USES OF THE WOOD

This wood has no actual uses. It is not even used as firewood because of its disagreeable odor.

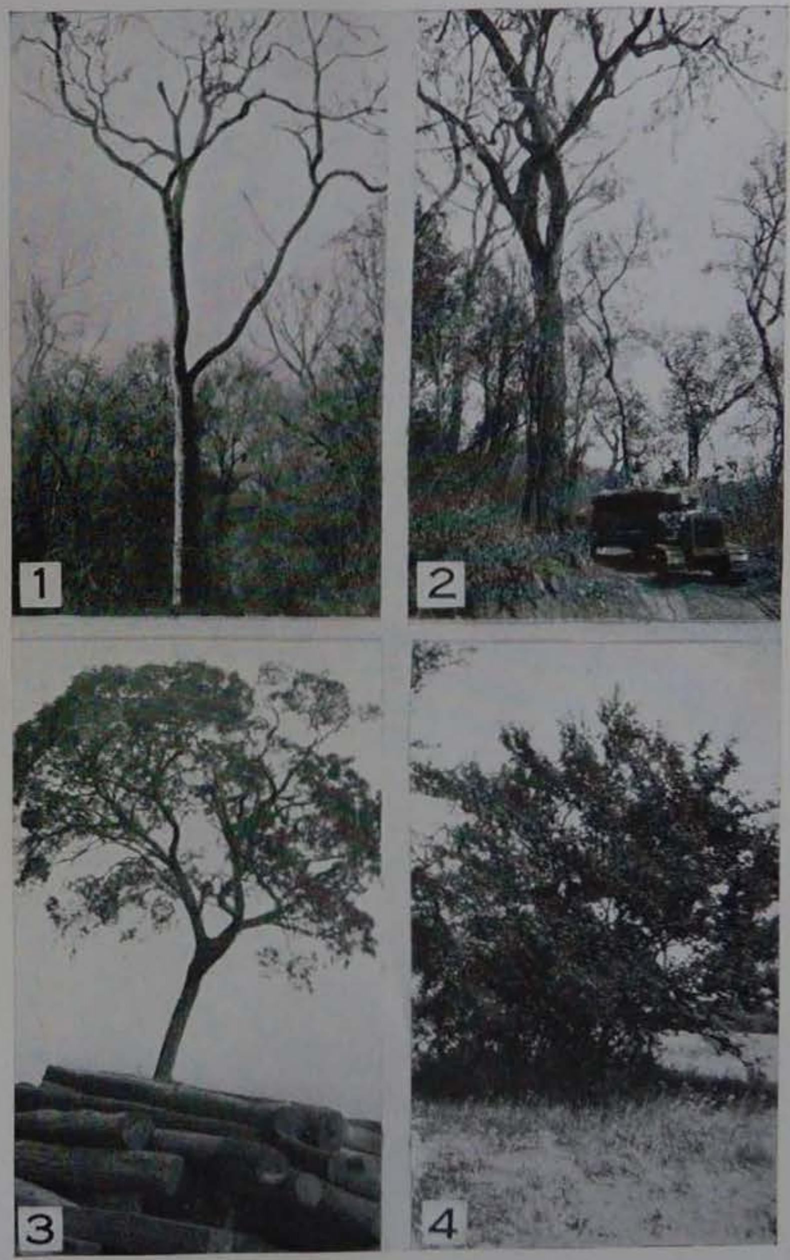
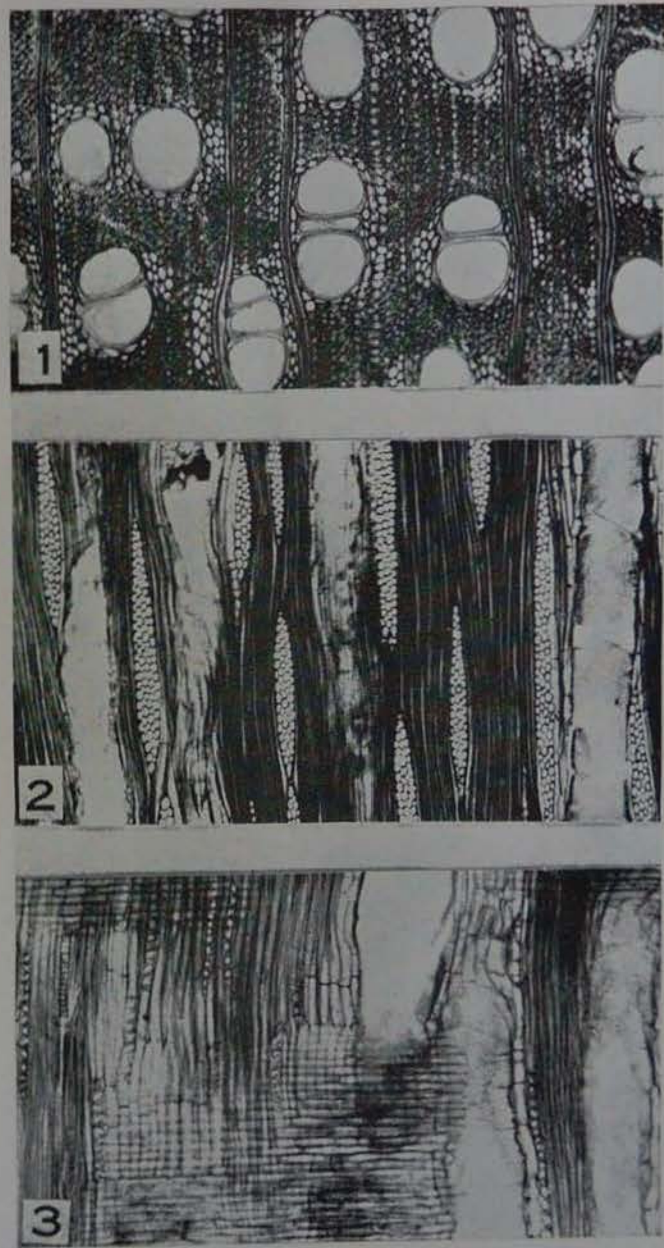


PLATE II



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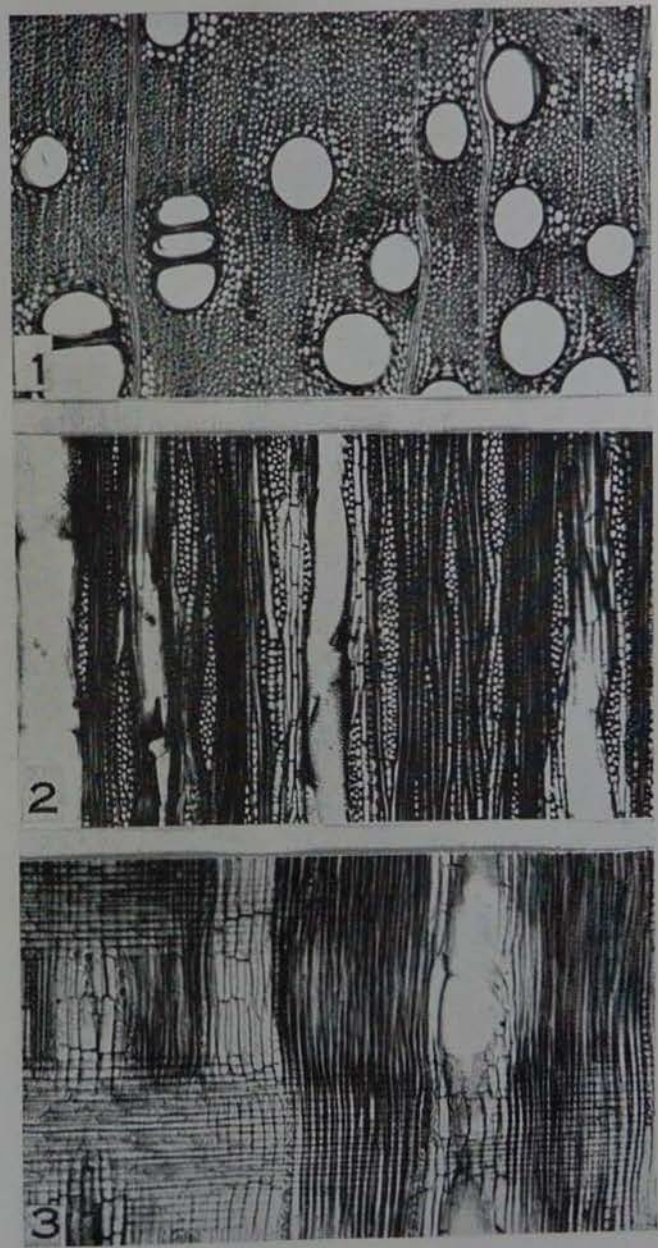

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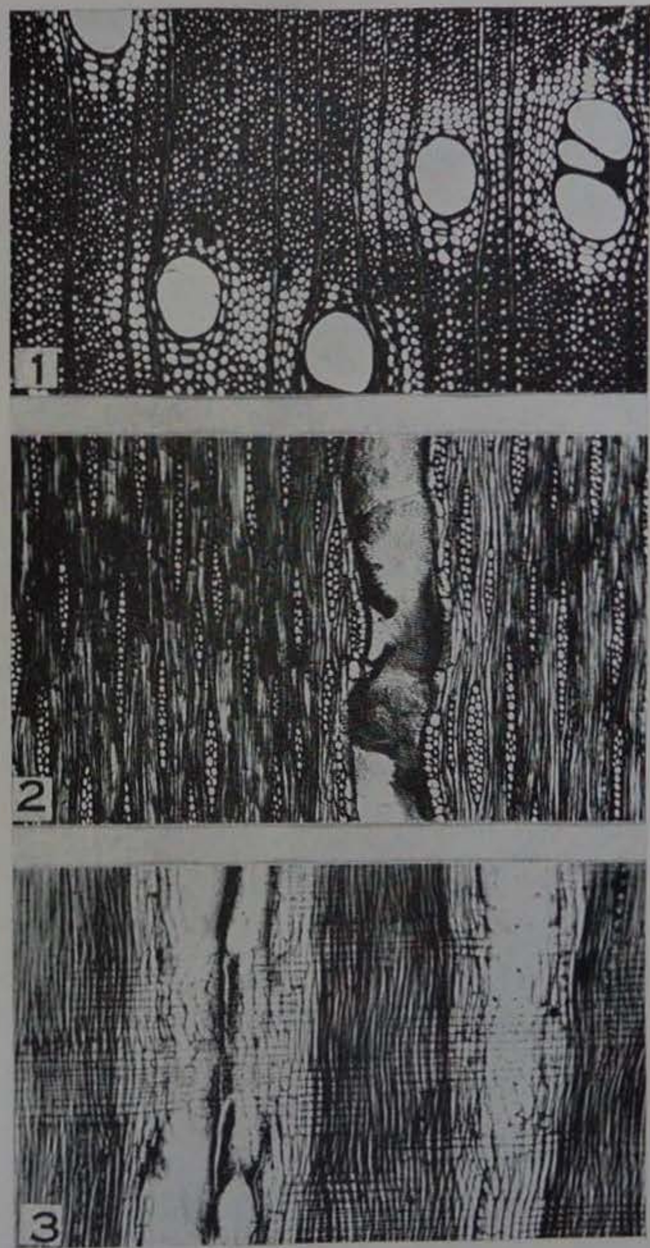

PLATE V

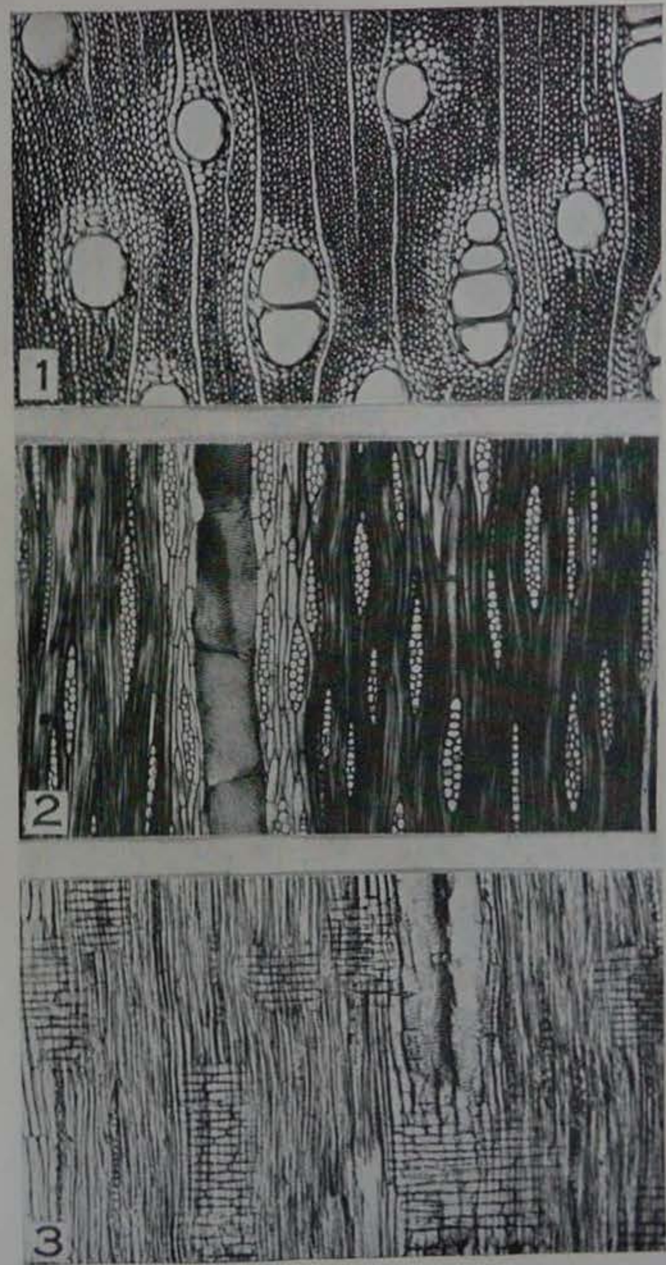

PLATE VI

PLATE VII

Explanation of Plates

Plate II.
- Fig. 1. *Piptadenia macrocarpa.*
- Fig. 2. *Piptadenia excelsa.*
- Fig. 3. *Piptadenia rigida.*
- Fig. 4. *Piptadenia paraguayensis.*

Plate III. *Piptadenia macrocarpa.* ×70
- Fig. 1. Cross section
- Fig. 2. Tangential section
- Fig. 3. Radial section

Plate IV. *Piptadenia* aff. *macrocarpa.* ×70
- Fig. 1. Cross section
- Fig. 2. Tangential section
- Fig. 3. Radial section

Plate V. *Piptadenia excelsa.* ×70
- Fig. 1. Cross section
- Fig. 2. Tangential section
- Fig. 3. Radial section

Plate VI. *Piptadenia rigida.* ×70
- Fig. 1. Cross section
- Fig. 2. Tangential section
- Fig. 3. Radial section

Plate VII. *Piptadenia paraguayensis.* ×70
- Fig. 1. Cross section
- Fig. 2. Tangential section
- Fig. 3. Radial section

ANATOMICAL STUDY OF THE WOOD OF "SHUI-SHA" (*METASEQUOIA GLYPTOSTROBOIDES* HU ET CHENG)

By John Yoh-han Li*

Some twelve species of *Sequoia* were once dominant, only two are now surviving and these are limited to the western coast of North America. Several other closely related surviving genera are also found in North America and Asia. However, the most closely related genus, *Metasequoia*, was only recently (1944) discovered on a temple grounds at Wan-Hsien region, Szechuan, China, by Mr. C. Wang of the National Research Bureau of Forestry.

The genus *Metasequoia* was described by a Japanese, S. Miki, in 1941. His description was based upon fossil materials of *Sequoia disticha* Heer and *S. japonica* found in 1941 in Japan and now represented by living species discovered in Szechuan and Hupeh provinces. Other related living species are: *Taxodium* (America), *Cryptomeria* (China, Japan), *Glyptostrobus* (China) and *Taiwania* (Formosa).

The present investigation was based on the study of a specimen collected in 1947, at Mou-Tao-Hsiang, Wan Hsien, Szechuan, by Mr. Chong Yu-kwang, from the National Research Bureau of Forestry.

Description of the Wood

Growth rings distinct, narrow to wide. Sapwood light buff, narrow. Heartwood orange-vinaceous. Wood generally straight-grained, fine-textured, moderately heavy, moderately hard. Spring-wood zone narrow to wide; usually three times as wide as the summer wood; transition from spring to summer wood gradual. In the lighter colored material parenchyma cells are readily visible with a hand lens because of their resinous contents. Rays very fine, rela-

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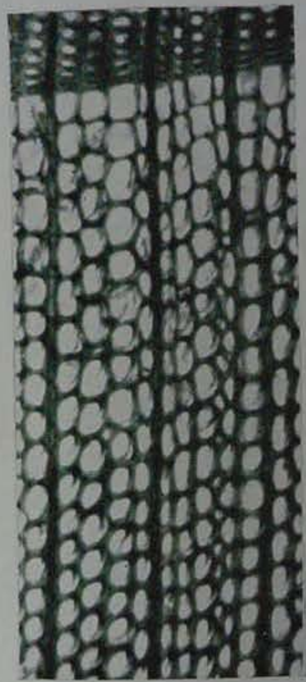

Fig. 1

Transverse Section

Fig. 2

Tangential Section

Wood of *Metasequoia*

tively conspicuous on quarter surfaces. Resin ducts lacking. Sapwood not resistant to decay. (Bark dark brown-grayish to brown, fissured, roughened when aged.)

Minute anatomy.—Tracheids up to 66 (35 to 55) microns in diameter (Fig. 1). Bordered pits in 1 or 2 (frequently 1) rows on the radial walls; many, oval-shaped. Parenchyma metatracheal. Thickness of the wall of spring-wood tracheids 1 to 1.5 microns, and 3 microns for the wall of summer-wood tracheids. Tracheids without spiral thickenings. Rays uniseriate (very rarely in part biseriate), consisting entirely of ray parenchyma; the tallest up to 17 (average 7 to 11) cells and over 270 microns in height, frequently with dark resin contents (Fig. 2). Pits leading to ray parenchyma fairly large, quite uniform in size, orbicular (the long-axis of the pit orifice less than 10 microns), generally 3 per ray crossing.

KEYS TO AMERICAN WOODS (CONTINUED)

By ROBERT W. HESS

This key is the twenty-first of a series intended to assist in the identification of certain groups of North and South American timbers. The last previous numbers of the series appeared in *Tropical Woods* 85: 11-19. It is intended that these keys be used in conjunction with *Timbers of the New World*.

XXI. *Parenchyma in numerous concentric bands.* The woods in this group are characterized by parenchyma that occurs in numerous concentric lines or bands. The variations in spacing among specimens, or even in the same specimen make it difficult to draw the line sharply against those specimens whose bands are too widely spaced to be called "numerous." Similarly the amount of broken bands that can be included in the "concentric band" classification is subject to considerable variation and necessitates arbitrary decision. However, for the most part, it is a strongly marked group and contains many important timbers.

In general, the parenchyma pattern discussed starts with the metatracheal type in numerous concentric uniseriate lines or narrow bands as exemplified by many of the Annonaceae, Lecythidaceae, Sapotaceae, and Euphorbiaceae. Reticulate or broken tangential lines are excluded. Difficulties of decision in this type arise among the woods with variable, often indefinite or poorly aggregated bands such as are found in the Myrtaceae, Melastomaceae, and Rubiaceae. Among the woods having bands of intermediate width the greatest difficulties are caused by the paratracheal-confluent pattern which not infrequently has a considerable amount of broken-confluent bands, particularly in the early wood. Among the woods with coarse-banded parenchyma the problem generally resolves itself into the excluding of woods whose confluent bands are too wavy or broken to form a consistent concentric pattern.

Included in the key are genera of thirty-eight families. The fifty-four genera of the Leguminosae constitute the largest group. Other families with considerable numbers of genera having parenchyma in numerous concentric bands include Euphorbiaceae (twenty-three genera), Sapotaceae, Annonaceae, Lecythidaceae, Moraceae, Myrtaceae and Guttiferae.

Woods of this group typically are hard and heavy, or moderately so. They predominately have simple perforations, alternate intervascular pitting, small to medium-sized vessel pits, and heterogeneous rays. A notably large number have large, oval or elongated vessel-ray pit-pairs. Very few have septate fibers, normal gum ducts, or tangentially arranged pores.

XXI. PARENCHYMA IN NUMEROUS CONCENTRIC BANDS

1 a. Rays in part large and conspicuous. 2
b. Rays not conspicuous, though often distinct. 19

2 a. Fiber pits distinctly or conspicuously bordered. 3
b. Fiber pits simple or indistinctly bordered. 10

3 a. Pores in arcs or clusters arranged tangentially between the large rays. 4
b. Pores not tangentially arranged. 7

4 a. Pores comparatively few, rounded; in tangentially arranged clusters often appearing as though suspended from the parenchyma lines. Fibers very thick-walled. *Roupala* (Proteaceae).
b. Pores numerous, angular; crowded in narrow acuate bands. Fibers with thin to moderately thick walls. 5

5 a. Vessels with spiral thickenings. .... *Guevina* (Proteaceae).
b. Vessels without spiral thickenings. 6

6 a. Pore bands mostly 1 or 2 pores wide. *Embothrium* (Proteaceae).
b. Pore bands mostly 3 or 4 pores wide. *Lomatia* (Proteaceae).

7 a. Pores all solitary or virtually so. 8
b. Short to long radial multiples common to abundant. 9

8 a. Pores more or less uniformly distributed. Raphides present in ray cells. .... *Curatella* (Dilleniaceae).
b. Latewood pores in distinctive radial or dendritic arrangement. .... *Lithocarpus*, *Quercus* (Fagaceae).

9 a. Pores small; fairly numerous. Vascular pits vestured. Larger rays up to 100 cells high. ....*Lagetta* (Thymelaeaceae).
b. Pores large in part; few to very few. Vascular pits not vestured. Rays up to 200 or more cells high. *Panopsis* (Proteaceae).

10 a. Pores (and parenchyma) in festoons between the large rays. (See 4 to 6 above, and 15 b.). .... Proteaceae.
b. Pores not so arranged. 11

11 a. Ripple marks present, not always distinct; parenchyma sometimes in secondary seriation. 12
b. Ripple marks absent. 14

12 a. Vessel-ray pitting coarse to very coarse. *Catostemma* (Bombacaceae).
b. Vessel-ray pitting fine to medium. 13

13 a. Vascular pits vestured. Crystalliferous parenchyma strands numerous. Sheath cells typically few or absent. *Erythrina* (Leguminosae).
b. Vascular pits not vestured. Crystals solitary in ordinary parenchyma cells or absent. Sheath cells abundant. *Basiloxylon*, *Sterculia* (Sterculiaceae).

14 a. Parenchyma in narrow bands forming a spider-web pattern with the large rays. 15
b. Parenchyma not forming spider-web patterns with large rays. 16

15 a. Parenchyma bands only 1 or 2 cells wide. Pores not tangentially arranged. Uniseriate rays few; cells squarish. Annonaceae.[1]

b. Parenchyma bands 1 to 4 cells wide. Pores often tangentially grouped. Uniseriate rays numerous; cells frequently upright. .... *Panopsis* (Proteaceae).

16 a. Parenchyma bands uniseriate and very closely spaced; crystalliferous strands numerous. Largest rays 200 or more cells high; 15 cells wide. .... *Gustavia* (Lecythidaceae).

b. Parenchyma bands few to many cells wide, variable in spacing; crystals solitary or lacking. Largest rays 50 to 120 cells high; 6 to 12 cells wide. (Moraceae). 17

17 a. Uniseriate rays numerous, composed entirely of square or upright cells. Heartwood dark brown. *Trophis* (Moraceae).

b. Uniseriate rays usually few to very few, composed in part of procumbent cells. 18

18 a. Heartwood bright yellow becoming golden brown on exposure. .... *Clarisia* (Moraceae).

b. Heartwood indistinct or lacking; wood grayish, pale brown, or yellowish. .... *Anonocarpus*, *Ficus* (Moraceae).

19 a. Pores virtually all solitary. 20

b. Pore multiples present, usually numerous. **33**

20 a. Largest rays 3 or more cells wide. 21

b. Rays exclusively uniseriate or uniseriate and biseriate. 26

21 a. Pores in wavy, often branched, radial arrangement. Vasicentric tracheids present. .... *Vismia* (Guttiferae).

b. Pores not in definite radial arrangement. 22

22 a. Fiber pits distinctly bordered. Rays decidedly heterogeneous. 23

b. Fiber pits simple or indistinctly bordered. 25

23 a. Phloem strands present. Pits vestured. *Mouriria* (Melastomaceae).

b. Included phloem absent. 24

24 a. Parenchyma bands irregular, often loosely assembled, commonly with considerable diffuse or short tangential lines. Pits vestured. Vasicentric tracheids usually present. Rays usually 1 and 2, occasionally to 3 or 4 cells wide. Myrtaceae.

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[1]For descriptions of the Annonaceae see *Tropical Woods* 88:13-30.

b. Parenchyma bands regular, fairly uniformly spaced; without abundant diffuse or short tangential lines. Pits not vestured. Vasicentric tracheids lacking. Rays 1 to 4 cells wide. .... *Zinowiewia* (Celastraceae).

25 a. Vessel-ray pit-pairs medium-sized to very large, elongated. Tyloses abundant. .... *Symphonia* (Guttiferae).

b. Vessel-ray pit-pairs very small (4μ), rounded. Tyloses absent. .... *Torralbasia* (Celastraceae).

26 a. Pores in branched radial (dendritic) arrangement. 27

b. Pores not in definite radial arrangement. 29

27 a. Wood definitely ring-porous. .... *Castanea* (Fagaceae).

b. Woods not definitely ring-porous. 28

28 a. Single row of early-wood pores markedly larger in size. Rays homogeneous or nearly so. Fibers with small, distinctly bordered pits. .... *Castanopsis* (Fagaceae).

b. Larger row of early-wood pores lacking. Rays heterogeneous. Fibers with small indistinctly bordered pits. *Calophyllum* (Guttiferae).

29 a. Vessel-ray pit-pairs, at least in part, large and elongated. Vessel pits not vestured. 30

b. Vessel-ray pit-pairs small, and rounded. Vessel pits vestured. 32

30 a. Vasicentric tracheids present. Vessel-ray pitting all coarse. .... *Cyrillopsis* (Cyrillaceae).

b. Vasicentric tracheids absent. 31

31 a. Vasicentric parenchyma present, 2 to 4 cells wide. Vessel-ray pitting distinctly 2-sized. Rosaceae-Chrysobalanoideae.

b. Vasicentric parenchyma absent or very sparse. Vessel-ray pitting all coarse. .... *Ochthocosmos* (Linaceae).

32 a. Strands of included phloem present. *Mouriria* (Melastomaceae).

b. Included phloem absent. .... *Kotchubaea* (Rubiaceae).

33 a. Rays uniseriate or virtually so. 34

b. Part of rays 2 or more cells wide. 69

34 a. Ripple marks present. 35

b. Ripple marks absent or local and very irregular. 50

35 a. Rays heterogeneous to weakly heterogeneous. 36

b. Rays homogeneous or virtually so. 42

36 a. Vascular pits small or very small. 37

b. Vascular pits medium-sized or larger. 40

37 a. Rays heterogeneous with many of the cells square or upright. Fiber pits indistinctly bordered. *Diospyros* (Ebeneaceae).
b. Rays weakly heterogeneous, typically with single rows of marginal square or upright cells. Fiber pits simple. 38

38 a. Ripple marks 110 to 175 per inch. Tallest rays generally 6 to 8 cells high. Part of pores rather large and distinct without lens. ....*Dalbergia* (Leguminosae).
b. Ripple marks 60 to 90 per inch. Tallest rays more than 10 cells high. Pores generally indistinct or not visible without lens 39

39 a. Heartwood dark brown or nearly black, sometimes reddish brown. Tallest rays 15 to 25 cells high. *Swartzia* (Leguminosae).
b. Heartwood pale brown, often pinkish. Tallest rays 30 to 40 cells high. ....*Crudia* (Leguminosae).

40 a. Ripple marks 115 or more per inch. Tallest rays less than 10 cells high. 41
b. Ripple marks 75 to 90 per inch. Tallest rays 15 to 25 cells high. ....*Swartzia* (Leguminosae).

41 a. Pores in part distinct without lens. Ripple marks 110 to 175 per inch. ....*Dalbergia* (Leguminosae).
b. Pores indistinct or not visible without lens. Ripple marks 180 to 190 per inch. ....*Brya* (Leguminosae).

42 a. Pores in part large and distinct without lens. 43
b. Pores not large, sometimes up to medium-sized and barely visible or indistinct without lens. 44

43 a. Parenchyma paratracheal, short to long aliform, becoming confluent into irregular bands in late wood. Heartwood yellowish. ....*Tipuana* (Leguminosae).
b. Parenchyma metatracheal, in loosely constructed, broken concentric bands, often merging into reticulate. Heartwood brown, reddish, or purplish. *Dalbergia* (Leguminosae).

44 a. Parenchyma typically and often very abundantly paratracheal and confluent into irregular bands 2 to 8 cells wide. 45
b. Parenchyma not abundant about pores and usually not surrounding them; bands typically narrow and fairly concentric. 48

45 a. Ripple marks 90 to 120 per inch. Parenchyma strands with 2 to 4 cells. ....*Zollernia* (Leguminosae).
b. Ripple marks generally more than 120 per inch. 46

46 a. Parenchyma strands with 2 to 4 cells. Ripple marks 140 to 150 per inch. ....*Geoffraea* (Leguminosae).
b. Parenchyma strands with 1 and 2 cells. 47

47 a. Concentric parenchyma bands up to 6 cells wide. Ripple marks 120 to 130 per inch. Heartwood (traumatic in specimen) dark brown. ....*Fissicalyx* (Leguminosae).
b. Concentric parenchyma bands generally 2 or 3 cells wide. Ripple marks 120 to 150 per inch. Heartwood variegated red and brown, with blackish streaks. *Etaballia* (Leguminosae).

48 a. Ripple marks 180 to 190 per inch. Rays mostly 5 or 6 (10) cells high. Heartwood dark brown, variegated or finely striped. ....*Brya* (Leguminosae).
b. Ripple marks 75 to 120 per inch. 49

49 a. Ripple marks about 120 per inch. Rays up to 15, mostly less than 10, cells high. Heartwood brownish red, generally lacking. ....*Pterocarpus* (Leguminosae).
b. Ripple marks 75 to 90 per inch. Rays up to 15 (25) cells high. Heartwood dark brown to nearly black, sometimes reddish brown, sometimes variegated. *Swartzia* (Leguminosae).

50 a. Parenchyma bands paratracheal-confluent. 51
b. Parenchyma bands metatracheal. 52

51 a. Rays heterogeneous. Wood bright yellow. *Coursetia* (Leguminosae).
b. Rays homogeneous. Heartwood dull reddish brown. *Campsiandra* (Leguminosae).

52 a. Included phloem present in fusiform rays and vertical strands in the parenchyma bands. .....*Bonyunia* (Loganiaceae).
b. Included phloem lacking. 53

53 a. Vessel pits vestured. 54
b. Vessel pits not vestured. Parenchyma bands not typically coarse-celled, loosely aggregated, or broken. (Euphorbiaceae). 57

54 a. Pores very small, barely visible with lens. Vessel pits to rays small. Parenchyma bands not coarse-celled or loosely aggregated. ....*Potalia* (Loganiaceae).
b. Pores mostly medium size, readily visible with lens. Vessel pits to rays mostly large, often elongated, occasionally medium-sized. Parenchyma bands often coarse-celled or loosely aggregated. 55

55 a. Wood dull olive gray. ....*Meriania* (Melastomaceae).
b. Wood pale reddish brown. 56

56 a. Vascular pits much elongated in part. *Calyptrella* (Melastomaceae).
b. Vascular pits normally rounded. *Graffenrieda* (Melastomaceae).

57 a. Vessel-ray pit-pairs large, oval to elongated or irregular. 58
b. Vessel-ray pit-pairs medium-sized, rounded. 64

58 a. Latex tubes present in some of rays. 59
b. Latex tubes absent. 60

59 a. Rays up to 50 cells high. Density medium. *Nealchornea* (Euphorbiaceae).
b. Rays up to 25 cells high. Density rather low. *Anomalocalyx* (Euphorbiaceae).

60 a. Fibers thick-walled. Large radial channels present. 61
b. Fibers thin-walled. Large radial channels absent. 62

61 a. Rays less than 25 cells high. Wood dark brown, oily in appearance ....*Gavarretia* (Euphorbiaceae).
b. Rays up to 50 cells high. Wood light grayish brown. *Conceveiba* (Euphorbiaceae).

62 a. Pores small to minute. Rays mostly less than 25 cells high. Parenchyma bands 1 to 3 pore-widths apart. *Maprounea* (Euphorbiaceae).
b. Pores medium-sized. Rays up to 50 cells high. Parenchyma bands about one pore-width apart. 63

63 a. Locally biseriate rays common. *Dodecastigma* (Euphorbiaceae).
b. Locally biseriate rays few to rare. *Nealchornea* (Euphorbiaceae).

64 a. Fibers with very thick gelatinous walls. 65
b. Fibers with thin to moderately thick walls. 66

65 a. Vessel-ray pitting fine. Wood waxy olive-brown with fine green or black stripes. ....*Bonania* (Euphorbiaceae).
b. Vessel-ray pit-pairs medium-sized. Wood light to very dark brown. ....*Pera* (Euphorbiaceae).

66 a. Rays less than 25 cells high. Parenchyma bands 2 or 3 pore-widths apart. 67
b. Rays up to 50 cells high. Parenchyma bands about 1 pore-width apart. 68

67 a. Parenchyma in definite lines about 3 pore-widths apart. Wood yellowish. ....*Actinostemon* (Euphorbiaceae).
b. Parenchyma in poorly defined bands about 2 pore-widths apart. Wood variegated olive. ......*Sebastiana* (Euphorbiaceae).

68 a. Fibers with moderately thick (gelatinous) walls. Tyloses present. ....*Cleidion* (Euphorbiaceae).
b. Fibers with rather thin (not gelatinous) walls. Tyloses absent. ....*Caryodendron* (Euphorbiaceae).

69 a. Concentric bands of included phloem present. *Machaerium* (Leguminosae).
b. Included phloem absent. 70

70 a. Ripple marks present. 71
b. Ripple marks absent. 113

71 a. Rays homogeneous. 72
b. Rays heterogeneous or weakly so. 92

72 a. Parenchyma bands coarse, readily visible to conspicuous. 73
b. Parenchyma bands rather narrow to narrow, commonly indistinct, sometimes distinct, without lens. 81

73 a. Ripple marks 50 to 70 per inch. 74
b. Ripple marks 100 to 140 per inch. 75

74 a. Pores large to very large. Parenchyma cells mostly short and plump. Density medium; heartwood yellow. Ripple marks about 50 per inch. ....*Dussia* (Leguminosae).
b. Pores medium-sized. Parenchyma cells mostly long and slender. Hard and heavy; heartwood orange-brown, deepening to reddish brown. Ripple marks 60 to 70 per inch. *Martiodendron* (Leguminosae).

75 a. Non-crystalliferous parenchyma strands mostly with 4 cells. 76
b. Non-crystalliferous parenchyma strands not predominately 4-celled. 77

76 a. Vessel pits small (less than 6μ). Pores small; few. Rays 1 to 3 cells wide and up to 20 (40) cells high. Ripple marks about 100 per inch. Heartwood probably yellowish. ....*Fairchildia* (Leguminosae).
b. Vessel pits medium-sized (7 to 8μ). Pores medium-sized in part; fairly numerous. Rays 1 and 2 (3) cells wide and up to 15 (30) cells high. Ripple marks 100 to 140 per inch. Heartwood dark red, chocolate brown, or blackish. *Libidibia* (Leguminosae).

77 a. Rays mostly 3 or 4 cells wide and frequently up to 50 cells high; many rays occupying more than 1 tier. Pores rather large in part; not numerous, sometimes few and scattered. 78
b. Rays 1 and 2, sometimes 2 to 4, cells wide and infrequently more than 15 cells high; with few rays occupying more than 1 tier. 79

78 a. Vessel pits small (5 to 7μ). Parenchyma bands fairly uniform. Ripple marks 110 to 130 per inch. Heartwood probably light colored. .... *Clitoria* (Leguminosae).
b. Vessel pits medium-sized (8 to 9μ). Parenchyma bands irregular and more or less anastomosed. Ripple marks 120 to 150 per inch. Heartwood yellowish to dark brown. *Piscidia* (Leguminosae).

79 a. Rays 1 and 2 cells wide, the uniseriates numerous; ray-height usually considerably less than tier-height. Four-celled parenchyma strands common; fusiform cells few. Pores medium-sized in part; very few. Ripple marks about 100 per inch. Heartwood dull brown to brick-red, becoming chocolate, purplish or nearly black. *Stahlia* (Leguminosae).
b. Rays mostly 2 or 3 cells wide, the uniseriates few; ray-height often approximately full tier-height. Four-celled parenchyma strands few. 80

80 a. Fusiform parenchyma cells numerous. Pores large to small; few to rather numerous. Ripple marks 100 to 140 per inch. Heartwood yellowish brown to dark red. *Lonchocarpus* (Leguminosae).
b. Fusiform parenchyma cells few. Pores rather large; few. Ripple marks about 140 per inch. Heartwood said to be orange. .... *Bergeronia* (Leguminosae).

81 a. Pores infrequently with complete parenchyma sheath. 82
b. Pores usually with complete parenchyma sheath. 85

82 a. Parenchyma in part reticulate. Ripple marks 110 to 175 per inch. .... *Dalbergia* (Leguminosae).
b. Parenchyma not reticulate in part. 83

83 a. Ripple marks 180 to 190 per inch. Rays uniseriate and biseriate; up to 5 or 6 (10) cells high. Heartwood rich brown, variegated or with fine stripes. ....*Brya* (Leguminosae).
b. Ripple marks 75 to 105 per inch. Rays frequently up to 3 or 4 cells wide. 84

84 a. Pores small. Vessel pits medium-sized (8 to 10μ). Rays sometimes up to 40 (60) cells high. Heartwood uniform brown or reddish brown. ....*Dialium* (Leguminosae).
b. Pores medium-sized. Vessel pits small (not over 6μ). Rays up to 15 (25) cells high. Heartwood brown, reddish brown or blackish; sometimes variegated. *Swartzia* (Leguminosae).

85 a. Vessels filled with tyloses in heartwood. Pore clusters and long multiples numerous. Ripple marks 140 to 160 per inch. Heartwood dark brown, somewhat variegated. *Olneya* (Leguminosae).
b. Vessels with little or no tyloses. 86

86 a. Vessel pits not vestured. Rays 1 to 4 cells wide and up to 30 (50) cells high. Parenchyma strands usually coarse-celled. Ripple marks about 120 per inch. *Bauhinia* (Leguminosae).
b. Vessel pits vestured. 87

87 a. Parenchyma cells storied. 88
b. Parenchyma cells not definitely storied. 90

88 a. Vessel pits very small (4μ). Parenchyma bands in part wavy (ulmiform pattern). Ripple marks 115 to 140 per inch. Heartwood purplish brown with darker streaks. *Holocalyx* (Leguminosae).
b. Vessel pits small or medium-sized (6 to 9μ). Parenchyma bands not in wavy pattern. 89

89 a. Uniseriate rays numerous. Heartwood dark violet-brown, more or less streaked; some specimens walnut scented. *Machaerium* (Leguminosae).
b. Uniseriate rays few. Heartwood deep reddish brown, dark olive, or blackish. ....*Zollernia* (Leguminosae).

90 a. Pores rather few; scattered irregularly. Parenchyma bands unevenly spaced; prominent on tangential surface. Fibers thick-walled. Ripple marks 120 to 150 per inch. Heartwood variegated red and brown. ....*Etaballia* (Leguminosae).
b. Pores rather numerous; fairly evenly distributed. Parenchyma bands fairly evenly spaced, particularly in late wood. 91

91 a. Non-crystalliferous parenchyma strands mostly 4-celled. Vessel pits mostly medium-sized (7 to 8μ). Wood fibers with thick walls. Ripple marks 100 to 140 per inch. Heartwood dark red, chocolate brown, or nearly black. *Libidibia* (Leguminosae).
b. Non-crystalliferous parenchyma strands mostly 2-celled. Vessel pits mostly small (6 to 7μ). Wood fibers with medium-thick walls. Ripple marks 105 to 125. Heartwood said to be light brown with darker streaks. *Platypodium* (Leguminosae).

92 a. Vessel-ray pit-pairs large, irregular oval or elongated. Vessel pits not vestured. 93
b. Vessel-ray pit-pairs small to rather large, rounded (resembling intervascular pit-pairs). Vessel pits vestured (except *Lueheopsis*). 97

93 a. Vessels filled with tyloses in heartwood. 94
b. Vessels without tyloses. 96

94 a. Largest rays 4 cells wide. Pores mostly in small multiples or clusters. Vessel-ray pit-pairs distinctly 2-sized; small-rounded and large-elongated. Heartwood light to dark olive or reddish brown; waxy; density high.
Christiania (Tiliaceae).

b. Largest rays 6 or more cells wide. Pores mostly solitary or in pairs. Vessel-ray pit-pairs irregular, not distinctly 2-sized. 95

95 a. Heartwood rich reddish brown; density high.
Aguiaria (Bombacaceae).

b. Heartwood yellow-brown; density medium.
Catostemma, Scleronema (Bombacaceae).

96 a. Wood light and soft, whitish to pale brownish. Vessel-ray pitting not distinctly 2-sized. Wood fibers thin-walled.
Cochlospermum (Cochlospermaceae).

b. Wood hard and rather heavy. Heartwood brown, distinct from lighter sapwood. Vessel-ray pitting distinctly 2-sized. Wood fibers with very thick walls. *Carpodiptera* (Tiliaceae).

97 a. Rays with small tile cells. Vessel pits not vestured. Wood yellowish or grayish brown. ....*Lueheopsis* (Tiliaceae).

b. Rays without small tile cells. 98

98 a. Vessel pits not vestured. Pores rather few, variable in size with tendency to ring-porous; walls very thick, particularly where two vessels contact. Parenchyma pits clustered on radial walls. Ripple marks 70 to 80 per inch.
Diospyros virginiana (Ebenaceae).

b. Vessel pits vestured. (Leguminosae). 99

99 a. Vessels filled with tyloses in heartwood. Ripple marks about 130 per inch. Heartwood olive-brown.
Gliricidia (Leguminosae).

b. Vessels containing little or no tyloses though gum may be abundant. 100

100 a. Parenchyma bands coarse. 101

b. Parenchyma bands rather narrow or fine. 104

101 a. Pores distinctly 2-sized: large and small. Density medium. Ripple marks about 100 per inch.
Clitoria brachycalyx (Leguminosae).

b. Pores not distinctly 2-sized; small or medium-sized. Generally hard and heavy. 102

102 a. Parenchyma cells storied; non-crystalliferous strands fusiform or 2-celled. Vessel pits medium-sized (7 to 8μ), Ripple marks about 100 per inch. Uniseriate rays numerous. Heartwood reddish brown. ....*Ateleia* (Leguminosae).

b. Parenchyma cells not storied; non-crystalliferous strands mostly with 2 to 4 cells. Vessel pits small (4 to 6μ). Ripple marks 60 to 80 per inch. 103

103 a. Uniseriate rays numerous. Parenchyma bands spaced 1 or 2 pore-widths apart. Heartwood brownish.
Crudia (Leguminosae).

b. Uniseriate rays few. Parenchyma bands mostly 2 to 4 pore-widths apart. Heartwood orange-yellow.
Poecilanthe (Leguminosae).

104 a. Pores medium-sized to rather large. 105

b. Pores small to very small. 108

105 a. Vessel pits medium-sized to large (8 to 12μ). 106

b. Vessel pits small (5 to 7μ). 107

106 a. Scattered irregular multiples and clusters of very small pores present. Ripple marks 95 to 150 per inch. Heartwood purplish brown. ....*Machaerium* (Leguminosae).

b. Irregular pore multiples and clusters absent or rare. Ripple marks 85 to 110 per inch. Heartwood yellow.
Apuleia (Leguminosae).

107 a. Scattered long radial multiples of small, flattened pores present. Uniseriate rays few. Ripple marks 50 to 60 per inch. Heartwood brown to purplish brown.
Dicorynia (Leguminosae).

b. Long radial multiples of flattened pores absent. Uniseriate rays numerous. Ripple marks 100 to 120 per inch. Heartwood reddish brown, with orange hue.
Le Cointea (Leguminosae).

108 a. Vessel pits small or very small (4 to 6μ). 109

b. Vessel pits medium-sized (7 to 9μ). 111

109 a. Ripple marks 150 to 190 per inch. Rays 6 to 8 cells high. (Vessel pits 6 to 8μ.) Heartwood chocolate brown, often with olive cast; waxy. ....*Pictetia* (Leguminosae).

b. Ripple marks 75 to 125 per inch. Rays up to 12 to 25 cells high. 110

110 a. Heartwood dark brown to nearly black. Ripple marks 75 to 90 per inch. Rays weakly heterogeneous. Gum contents of vessels brown or dark brown. *Swartzia* (Leguminosae).

b. Heartwood light yellowish brown, sometimes with pinkish streaks; somewhat waxy. Ripple marks about 125 per inch.

Rays with many cells square or upright. Gum contents of vessels yellow or light red; occasionally white.
Harpalyce cubensis (Leguminosae).

111 a. Wood rather light and soft. Fibers thin-walled. Rays only partially biseriate. Parenchyma cells mostly fusiform. Ripple marks about 150 per inch. Heartwood probably red. .... *Drepanocarpus* (Leguminosae).
b. Woods hard and heavy. Fibers very thick-walled. Rays abundantly biseriate or wider. Parenchyma strands mostly with 2 cells. 112

112 a. Rays 1 and 2 cells wide. Heartwood chocolate-brown; sapwood yellowish. .... *Pictetia* (Leguminosae).
b. Rays 1 to 3 (4) cells wide. Heartwood olive, more or less streaked with black. Sapwood whitish.
Belairia (Leguminosae).

113 a. Wood fibers with distinctly bordered pits. 114
b. Wood fiber pits simple or indistinctly bordered. **140**

114 a. Rays typically homogeneous. 115
b. Rays typically heterogeneous. 122

115 a. Latewood pores in definite radial, often branched, arrangement. 116
b. Latewood pores not in definite radial arrangement. 117

116 a. Pores in early wood numerous, crowded in a band 2 or more pores wide. With distinctive odor and astringent taste. .... *Castanea* (Fagaceae).
b. Pores in early wood few, separated and in a single row. Without distinctive odor or taste. .... *Castanopsis* (Fagaceae).

117 a. Vessel pits large, those to rays often oval or irregular in shape. 118
b. Vessel pits medium-sized or small, those to rays rounded. Tyloses sparse or lacking. 120

118 a. Pores decreasing in size toward outer part of growth ring. Heartwood chestnut to chocolate brown, often with purplish tinge. .... *Juglans* (Juglandaceae).
b. Pores not decreasing in size toward outer part of growth ring. 119

119 a. Heartwood pores plugged with tyloses. Heartwood reddish brown, sharply demarcated from sapwood, moderately hard and heavy. .... *Bertholletia* (Lecythidaceae).
b. Heartwood pores all or mostly open, tyloses relatively sparse or absent. Heartwood light yellowish brown, sometimes pinkish, rather light and soft.
Couroupita (Lecythidaceae).

120 a. Rays uniseriate and biseriate. 121
b. Largest rays 4 to 8 cells wide. .... Annonaceae.

121 a. Pores 2-sized, in part large (150 to 350μ). Latex tubes lacking. Pits not vestured. Wood yellow.
Duckeodendron (Solanaceae).
b. Pores all medium-sized (100 to 140μ). Latex tubes present. Vessel pits vestured. Wood pale brownish.
Hancornia speciosa (Apocynaceae).

122 a. Rays weakly heterogeneous, commonly with single marginal rows of square or upright cells. 123
b. Rays distinctly heterogeneous, commonly with few to several rows of square or upright cells. 128

123 a. Rays uniseriate and biseriate. (Apocynaceae). 124
b. Largest rays generally 4 or more, occasionally 3 (e.g. *Linociera*) cell wide. 126

124 a. Pores mostly solitary, with rather few radial pairs. Latex tubes absent. Wood yellowish brown or orange, very hard and heavy. .... *Geissospermum* (Apocynaceae).
b. Short radial multiples numerous. 125

125 a. Latex tubes present. Wood parenchyma bands spaced about one pore-width apart. Wood cream-colored or pale brown, often with pinkish tinge; light in weight but firm.
Couma (Apocynaceae).
b. Latex tubes absent. Wood parenchyma bands spaced about 2 pore-widths apart. Heartwood very dark brown, or somewhat variegated; sapwood yellowish; very hard and heavy. .... *Cameraria* (Apocynaceae).

126 a. Vessel pits large. Often with slight fetid odor. Heartwood light yellowish brown, sometimes pinkish, rather light and soft. .... *Couroupita* (Lecythidaceae).
b. Vessel pits small to medium-sized. Without distinctive odor. 127

127 a. Parenchyma in part aliform to aliform-confluent. Pores numerous or very numerous. .... *Linociera* (Oleaceae).
b. Parenchyma almost exclusively in fine, uniformly spaced lines or narrow bands. Pores typically few. .... Annonaceae.

128 a. Pores in radial or dendritic arrangement. 129
b. Pores not radially arranged. 130

129 a. Vessels with spiral thickenings. Pores in dendritic patches. Parenchyma in irregularly spaced narrow bands. Wood light brown. .... *Osmanthus* (Oleaceae).

b. Vessels without spiral thickenings. Pores mostly in small multiples in irregular radial rows. Parenchyma bands fairly regularly spaced. Wood white. ....*Microtropis* (Celastraceae).

130 a. Vessel pits vestured. 131
b. Vessel pits not vestured. 134

131 a. Parenchyma bands in part aliform-confluent. Ray cells nearly all square or upright. ....*Mouriria* (Melastomaceae).
b. Parenchyma bands metatracheal. Rays with strata of procumbent cells. 132

132 a. Wood very light in weight (sp. gr. 0.15) and soft. Large radial channels sometimes present. Wood creamy white. *Ambelania laxa* (Apocynaceae).
b. Density medium to high. Woods yellowish brown to orange, often greenish. 133

133 a. Rays 1 to 5 (6) cells wide. ....*Hamelia* (Rubiaceae).
b. Rays 1 to 3 (4) cells wide. ....*Guettarda* (Rubiaceae).

134 a. Perforations multiple in part. 135
b. Perforations exclusively simple. 137

135 a. Pores uniformly distributed. Vessel pits to rays very small. ....*Lissocarpa* (Lissocarpaceae).
b. Pores with pronounced diagonal arrangement. Vessel pits to rays in part very large and elongated. 136

136 a. Rays 1 to 3 cells wide, up to 30 cells high. *Engelhardtia* (Juglandaceae).
b. Rays 1 and 2 cells wide, up to 50 cells high. *Alfaroa* (Juglandaceae).

137 a. Latex tubes present. Rays uniseriate and biseriate. Heartwood orange-brown, sharply demarcated from white sapwood. ....*Glycydendron* (Euphorbiaceae).
b. Latex tubes lacking. Largest rays 3 or more cells wide. 138

138 a. Vessel pits typically small, occasionally medium-sized. Annonaceae.
b. Vessel to ray pits large, oval to elongated; intervascular pitting coarse (10 to 16μ). 139

139 a. Pores medium-sized, uniform. Thick-walled to sclerotic tyloses abundant. Rays 1 to 3 cells wide. Wood pale brownish. ....*Micrandra* (Euphorbiaceae).
b. Pores large to small, decreasing in size toward late wood. Rays usually 1 to 5 cells wide. Wood chestnut to chocolate brown. ....*Juglans* (Juglandaceae).

140 a. Pores in definite radial or dendritic arrangement. 141
b. Pores not in definite radial arrangement. 147

141 a. Parenchyma bands paratracheal-confluent. 142
b. Parenchyma bands metatracheal. 143

142 a. Parenchyma bands coarse, making up about 50 percent of ground mass. Pores large (215 to 350μ), few. Vessel pits to rays large, oval to elongated. Heartwood brownish yellow. ....*Moronobea* (Guttiferae).
b. Parenchyma bands rather narrow. Pores small to medium-sized (40 to 120μ), rather numerous. Vessel pits to rays small. Heartwood rich dark brown. *Bunchosia* (Malpighiaceae).

143 a. Vessels in part with spiral thickenings. Vasicentric tracheids present. Pores arranged in distinctive dendritic or flame-like pattern, at least in late wood; clusters numerous. *Bumelia, Paralabatia* (Sapotaceae).
b. Vessels without spiral thickenings. Vasicentric tracheids absent. Pore clusters few or lacking, arrangement not typically flame-like. 144

144 a. Vessel-ray pits in part large, oval or elongated. Vessel pits not vestured. (Sapotaceae). 145
b. Vessel-ray pits small, rounded. 146

145 a. Crystalliferous parenchyma strands numerous. *Achras, Manilkara* (Sapotaceae).
b. Crystalliferous strands few or absent. ....Sapotaceae.

146 a. Parenchyma bands 2 to 4 cells wide; cells fusiform or in 2-celled strands. Wood with faint disagreeable odor. *Steriphoma* (Capparidaceae).
b. Parenchyma in uniseriate, occasionally biseriate, bands; strands with 4 or more cells. Wood without distinctive odor. ....*Diospyros* (Ebenaceae).

147 a. Vessel pits vestured. 148
b. Vessel pits not vestured. 170

148 a. Rays homogeneous. (Leguminosae) 149
b. Rays heterogeneous. 163

149 a. Semi-ring-porous or with strong tendency to ring-porous arrangement. 150
b. Pores distributed without pattern. 151

150 a. Heartwood yellowish or orange brown. Traumatic vertical gum ducts sometimes present. ....*Cercidiopsis* (Leguminosae).
b. Heartwood dull purplish brown, somewhat variegated. *Acaciopsis* (Leguminosae).

151 a. Largest rays 5 to 8 cells wide. 152
b. Largest rays 3 or 4, rarely 2 cells wide. 155

152 a. Fibers septate. Taste not distinctive. 153
b. Fibers non-septate. 154

153 a. Heartwood dull reddish brown, more or less streaked, not sharply demarcated from the greenish-yellow sapwood. Crystalliferous strands very numerous. *Dugandia* (Leguminosae).
b. Heartwood dark brown or olive-brown. Crystalliferous strands few to moderately numerous, diffuse. *Senegalia* (Leguminosae).

154 a. Heartwood bright orange, becoming red or reddish black on exposure. Taste sweetish. ....*Haematoxylon* (Leguminosae).
b. Heartwood dark brown or olive-brown. Taste not distinctive. ....*Senegalia* (Leguminosae).

155 a. Aliform-confluent parenchyma unilaterally compound, at least in part. Heartwood purplish brown, purple or violet. *Peltogyne* (Leguminosae).
b. Parenchyma not unilaterally compound. Heartwood not purple. 156

156 a. Rays 1 to 3 cells wide. 157
b. Rays 1 to 4 cells wide. 158

157 a. Parenchyma bands very irregular, making up more than 50 percent of the ground mass. Rays up to 30 cells high. Vessel pits medium-sized (7 to 8μ). *Campsiandra* (Leguminosae).
b. Parenchyma bands fairly regular, comprising considerably less than 50 percent of the ground mass. Vessel pits small (4 to 7μ). ....*Calliandra* (Leguminosae).

158 a. Tyloses common to abundant. Crystals numerous to very numerous in rays. 159
b. Tyloses absent or sparse. Crystals few or lacking in rays. 160

159 a. Vessels plugged with tyloses. Crystals in ordinary wood parenchyma cells (not in strands). Heartwood yellowish white. ....*Callistylon* (Leguminosae).
b. Vessels partially filled with tyloses. Crystalliferous parenchyma strands present. Heartwood probably blackish. *Humboldtiella* (Leguminosae).

160 a. Vessel pits small (5 to 6μ). Without distinctive odor or taste. 161
b. Vessel pits medium-sized (about 8μ). Taste or odor distinctive. 162

161 a. Parenchyma vasicentric and vasicentric-confluent in combination with confluent bands. Rays up to 40 cells high. Heartwood lustrous reddish brown; sapwood whitish. *Fishlockia* (Leguminosae).
b. Parenchyma mostly in narrow confluent bands with some aliform and confluent. Rays up to 70 cells high. Heartwood dark brown, marked with fine yellow vessel lines; sapwood yellowish. ....*Uleanthus* (Leguminosae).

162 a. Heartwood brown with purplish tinge, marked by deeper colored vertical streaks. Mild licorice-like odor present; taste not distinctive. Rays 1 to 3 cells wide. *Cyclolobium* (Leguminosae).
b. Heartwood bright orange, becoming red or reddish black on exposure. Taste sweetish; odor not distinctive. Rays 1 to 4 or more cells wide. ....*Haematoxylon* (Leguminosae).

163 a. Parenchyma bands metatracheal. 164
b. Parenchyma bands paratracheal-confluent. 165

164 a. Rays 1 to 4 cells wide. Vessel pits medium-sized (8μ). Pore distribution irregular with definite ring-porous tendencies. Heartwood yellowish or orange-brown. *Cercidiopsis* (Leguminosae).
b. Rays uniseriate and biseriate. Vessel pits very small (3 to 4μ). Pores uniformly distributed. Heartwood mixed light and dark brown. ....*Heterostemon* (Leguminosae).

165 a. Pores in diagonal or concentric arrangement. Rays with large to very large integumented crystals. Heartwood rich dark brown. ....*Bunchosia* (Malphigiaceae).
b. Pores not in distinctive arrangement. Large crystals absent from rays. 166

166 a. Vessel pits small (3 to 5μ). Tyloses absent or sparse. 167
b. Vessel pits medium-sized (about 8μ). 168

167 a. Rays 1 to 5 cells wide and up to 75 (100) cells high. Sclerotic parenchyma cells common. Heartwood dark brown, somewhat variegated, sharply defined from sapwood. ....*Clathrotropis* (Leguminosae).
b. Rays 1 to 3 cells wide and up to 50 cells high. Sclerotic parenchyma lacking. Heartwood reddish brown, grading into sapwood. ....*Cynometra* (Leguminosae).

168 a. Tyloses lacking or very sparse. Pores large, very few. Rays 1 to 5 cells wide. Heartwood light brown with pinkish hue. .... *Clathrotropis macrocarpa* (Leguminosae).
b. Tyloses abundant. Pores medium-sized or small. 169

169 a. Parenchyma strands short, with 1 or 2 cells. Rays 1 to 3 cells wide. Heartwood and sapwood bright yellow. *Coursetia* (Leguminosae).
b. Parenchyma strands with 2 to 4 cells. Rays 1 to 4 cells wide. Sapwood yellow, heartwood probably dark colored. *Humboldtiella* (Leguminosae).

170 a. Parenchyma bands paratracheal-confluent. 171
b. Parenchyma bands metatracheal. **194**

171 a. Parenchyma bands coarse; typically comprising one-third or more of the ground mass. 172
b. Parenchyma bands fine to medium-sized. 184

172 a. Vessel pits to rays large, oval to elongated. 173
b. Vessel pits to rays medium-sized to very small, rounded 177

173 a. Radial gum ducts present. ....*Moronobea* (Guttiferae).
b. Radial gum ducts absent. 174

174 a. Rays homogeneous to weakly heterogeneous. Pores mostly large (occasionally small in *Symphonia*). *Moronobea, Platonia, Symphonia* (Guttiferae).
b. Rays definitely heterogeneous. 175

175 a. Largest rays 8 to 12 cells wide. Pores barely visible without lens. ....*Anonocarpus* (Moraceae).
b. Largest rays 4, rarely 6, cells wide. 176

176 a. Latex tubes present. Pores indistinct without lens. *Olmedia* (Moraceae).
b. Latex tubes absent. Pores not visible without lens. *Sorocea* (Moraceae).

177 a. Fibers septate, at least in part. 178
b. Fibers not septate. Vessel pits small to very small. 183

178 a. Vessel pits very small. Rays 1 to 2, occasionally 3, cells wide; up to 35 cells high. Density medium (sp. gr. 0.58 to 0.70). Heartwood pinkish to deep reddish brown. *Guarea* (Meliaceae).
b. Vessel pits large to rather large. (Sapindaceae). 179

179 a. Wood ring-porous. ....*Sapindus* (Sapindaceae).
b. Wood diffuse-porous. 180

180 a. Wood yellow, whitish yellow, or streaked yellowish white. 181
b. Wood light brown. 182

181 a. Parenchyma making up one-half or more of the ground-mass. ....*Sapindus* (Sapindaceae).
b. Parenchyma making up about one-third of the ground-mass. ....*Melicocca* (Sapindaceae).

182 a. Parenchyma bands uniform in size throughout growth ring. Growth ring formed by wider spacing of parenchyma bands. ....*Dipterodendron* (Sapindaceae).
b. Parenchyma bands decreasing in size toward outer part of growth ring. Growth ring formed by variation in width of parenchyma bands. ....*Talisia* (Sapindaceae).

183 a. Wood whitish. Rays 1 to 6 cells wide. *Casimiroa* (Rutaceae).
b. Wood yellowish with greenish cast. Rays 1 to 3, occasionally to 5, cells wide. ....*Zanthoxylum* (Rutaceae).

184 a. Rays decidedly heterogeneous. 185
b. Rays homogeneous to weakly heterogeneous. 188

185 a. Vessel pits to rays large, oval to elongated. 186
b. Vessel pits to rays small to medium-sized, rounded. Heartwood red or reddish brown, sometimes pale to dark olive; very dense. ....*Zizyphus* (Rhamnaceae).

186 a. Oil cells present in wood parenchyma strands. Wood yellowish brown to blackish, of moderate density. *Beilschmiedia* (Lauraceae).
b. Oil cells absent. Wood reddish brown, very dense. 187

187 a. Largest rays 3 or 4 cells wide. Fibers septate. *Pseudolmedia* (Moraceae).
b. Rays uniseriate and biseriate. Fibers not septate. *Lorostemon* (Guttiferae).

188 a. Fibers septate. Vessel pits very small. Density medium. Heartwood pinkish to deep reddish brown. *Guarea* (Meliaceae).
b. Fibers not septate. Vessel pits small to large. 189

189 a. Vessel pits to rays in part large, oval to elongated. 190
b. Vessel pits to rays all small or medium-sized, rounded. 191

190 a. Latex tubes present. Rays up to 6 or 8 cells wide. Heartwood reddish brown. *Pseudolmedia oxyphyllaria* (Moraceae).
b. Latex tubes absent. Rays up to 4, rarely 6, cells wide. Heartwood light brown with orange hue. *Sorocea* (Moraceae).

191 a. Woods very hard and very heavy. Crystals very numerous in rays. 192
b. Density mostly medium, occasionally rather high. Crystals few or lacking in ray cells. 193

192 a. Rays 1 to 5 cells wide, with marginal row of square cells. Pores small, indistinct without lens. *Paraclarisia* (Moraceae).
b. Rays 1 to 4 cells wide, with interspersed square cells. Pores very small; not visible without lens. *Doerpfeldia* (Rhamnaceae).

193 a. Wood typically yellowish often with greenish cast, rarely copper-brown. Largest rays 3 to 5 cells wide. *Zanthoxylum* (Rutaceae).

b. Wood whitish. Largest rays 6 cells wide. *Casimiroa* (Rutaceae).

194 a. Rays uniseriate and biseriate. 195
b. Largest rays 3 or more cells wide. **208**

195 a. Vessels with scalariform perforation plates. Tanniniferous tubes present. Rays very numerous. *Compsoneura* (Myristicaceae).

b. Vessels with perforations exclusively or predominately simple. 196

196 a. Latex tubes present in part of rays. Wood lustrous yellowish brown with black and brown markings. *Hippomane* (Euphorbiaceae).

b. Latex tubes absent. 197

197 a. Rays heterogeneous. 198
b. Rays homogeneous 204

198 a. Vessel pits to rays rounded, similar in size and shape to intervascular pit-pairs. 199
b. Vessel pits to rays, at least in part, elongated or large oval. 201

199 a. Tyloses and parenchyma cells in part sclerotic. Vessel pits to rays rather large. ....*Chaetocarpus* (Euphorbiaceae).
b. Sclerotic cells absent. 200

200 a. Heartwood variegated olive and dark brown; very hard and heavy (sp. gr. 1.1 to 1.2). Vessel pits to rays small. Crystals abundant in ray cells. *Gymnanthes* (Euphorbiaceae).
b. Heartwood light reddish brown. Density medium to rather high (sp. gr. 0.35 to 0.8). Vessel pits to rays very small. Crystals in ray cells few or absent. ....*Trichilia* (Meliaceae).

201 a. Intervascular pitting coarse. Crystalliferous parenchyma strands numerous. ....*Allantoma, Eschweilera* (Lecythidaceae).
b. Intervascular pitting fine. Crystalliferous parenchyma strands lacking or very few. 202

202 a. Wood rather light and soft to moderately hard and heavy, pale brown. Pores solitary and in short multiples. *Pausandra* (Euphorbiaceae).

b. Wood very hard and very heavy. Pores mostly in short multiples. 203

203 a. Taste distinctively sweetish, becoming astringent or bitter. Rays up to 60 or more cells high. Tyloses present but not abundant. Wood dull grayish brown. *Pradosia* (Sapotaceae).

b. Taste lacking or not distinctive. Rays up to 30 cells high. Tyloses abundant. Heartwood light brown with reddish or orange tinge. ....*Chromolucuma* (Sapotaceae).

204 a. Vessel pits large. 205
b. Vessel pits small or very small. 206

205 a. Parenchyma bands coarse. Vessel pits to rays rounded. Wood fibers septate. ....*Talisia* (Sapindaceae).
b. Parenchyma bands fine. Vessel pits to rays in part elongated or irregular. Fibers not septate. *Eschweilera* (Lecythidaceae).

206 a. Heartwood light reddish brown. Density medium to rather high (sp. gr. 0.35 to 0.8). Pores small to medium-sized. *Trichilia* (Meliaceae).

b. Heartwood olive-brown. Density high (sp. gr. about 1.0). Pores very small. 207

207 a. Parenchyma bands coarse, straight to wavy. Pores not very numerous. ....*Piranhea* (Euphorbiaceae).
b. Parenchyma bands narrow, wavy. Pores very numerous. *Celaenodendron* (Euphorbiaceae).

208 a. Rays homogeneous or weakly heterogeneous (then typically with single marginal row of square cells). 209
b. Rays definitely heterogeneous. **214**

209 a. Pores arranged in tangential or diagonal bands of clusters. Vessels with spiral thickenings. Wood light brown. *Planera* (Ulmaceae).

b. Pores not in bands of clusters. Spiral thickenings absent. 210

210 a. Ring-porous or intermediate ring-porous. Pores in early wood large, decreasing in size toward late wood, few. Sapwood whitish; heartwood brown or reddish brown. *Carya* (Juglandaceae).

b. Not ring-porous or intermediate ring-porous. 211

211 a. Vessel pits small. Small oil cells present in parenchyma strands. Tyloses absent or sparse. Wood gray with greenish cast. ....*Bocageopsis* (Annonaceae).
b. Vessel pits to rays in part large, irregular or elongated. Oil cells lacking. Heartwood vessels filled with tyloses. (Lecythidaceae). 212

212 a. Wood of medium density. 213
b. Wood hard and heavy. Rays 1 to 4 cells wide. Heartwood brown or reddish brown. ....*Lecythis* (Lecythidaceae).

213 a. Rays 1 to 3 cells wide; up to 50, mostly less than 20 cells high. Heartwood yellowish, pinkish, or reddish brown. Without distinctive odor. .... *Cariniana* (Lecythidaceae).
b. Rays 1 to 5 cells wide; up to 90 cells high. Heartwood reddish brown. Fetid odor present. *Couratari* (Lecythidaceae).

214 a. Vessel perforations scalariform at least in part. Vessel pits to rays elongated. 215
b. Vessel perforations exclusively simple. 218

215 a. Perforations exclusively multiple. Tanniferous tubes present. .... *Compsoneura* (Myristicaceae).
b. Perforations in part simple. 216

216 a. Rays up to 100 cells high. Parenchyma in uniseriate lines. Tyloses abundant; sometimes sclerotic. Heartwood dark reddish brown. .... *Asteranthos* (Lecythidaceae).
b. Rays less than 80 cells high. 217

217 a. Parenchyma in irregular uniseriate and biseriate lines. Rays up to 50 cells high. .... *Paradrypetes* (Euphorbiaceae).
b. Parenchyma bands 1 to 5 cells wide. Rays up to 75 cells high. Heartwood deep olive brown. *Bracteanthus* (Monimiaceae).

218 a. Vessel pits to rays distinctly elongated, large. 219
b. Vessel pits to rays rounded, medium-sized to small. 220

219 a. Pores mostly large. .... *Hevea* (Euphorbiaceae).
b. Pores very small. .... *Pausandra* (Euphorbiaceae).

220 a. Sheath cells present. Rays 1 to 4 cells wide; up to 70 (100) cells high. Vessel pits medium-sized (8μ). Wood pale yellow. .... *Mappia* (Icacinaceae).
b. Sheath cells lacking. Rays 1 to 3, occasionally 4, cells wide; up to 40 or 50 cells high. Vessel pits mostly small to very small. 221

221 a. Pores readily visible without lens. Heartwood dark brown. Sclerotic tyloses and parenchyma cells present. Traumatic gum ducts absent. .... *Cunuria* (Euphorbiaceae).
b. Pores indistinct without lens. Heartwood light yellow or yellowish white. Sclerotic tyloses and parenchyma cells absent. Small vertical traumatic gum ducts often present. 222

222 a. Parenchyma bands rather coarse, mostly 5 to 8 cells wide. Pores well distributed. .... *Metrodorea* (Rutaceae).
b. Parenchyma bands narrow, mostly 3 to 5 cells wide. With tendency towards tangential or diagonal arrangement of pores. .... *Esenbeckia* (Rutaceae).

TROPICAL WOODS CHANGES POLICY

It is with regret that the Editor announces the suspension of *Tropical Woods* from regular publication. Henceforth the magazine will be issued irregularly as conditions and available manuscripts warrant. Individual issues may be concerned with a single topic and may be considerably larger than in the past.

There will be no subscriptions and each copy may be purchased separately as issued. Number 95 is being prepared for publication in October or November and will apply on paid-up subscriptions.

During the latter part of 1948 we expect to publish a cumulative index to the first 94 numbers of *Tropical Woods*. This will be sold at a price of $1.00. If desired by the subscriber, the index will complete the paid-up subscription for the year without extra charge.

It is our hope that the magazine as issued in the future will interest our present subscribers and will suffice to continue the periodical exchange we have so long enjoyed with other technical publications printed throughout the world.

We hope that regular publication can be resumed eventually. Any comments received concerning this move will be of interest to us.

CURRENT LITERATURE

The New World cypresses. By Carl B. Wolf and Willis W. Wagener. *El Aliso* **1**: 1-444; 80 figs., 1948.

The three parts of this excellent monograph cover taxonomy and distribution, diseases, and horticultural studies. Fifteen species of *Cupressus* are recognized as native to the New World.

Rancho Santa Ana Botanic Garden, Anaheim, California, publishes the new journal.

The forest industries of Trinidad and Tobago. By John Cater. *The Caribbean Forester* (Rio Piedras, Puerto Rico) 9: 1: 1-6; January 1948.

Of the 300 to 400 species of trees growing in Trinidad only about 60 are commonly used for lumber. Those most favored are: Cedar *(Cedrela mexicana)*, Balata *(Manilkara bidentata)*, Crappo *(Carapa guianensis)*, Mora *(Mora excelsa)*, Poui *(Tabebuia serratifolia)*, Cypre *(Cordia alliodora)*, Tapana *(Hieronyma caribaea)*, Mahoe *(Sterculia caribaea)*, Toporite *(Hernandia sonora)* and several species of Laurier (Lauraceae). A match factory uses about 100,000 cubic feet of Jereton *(Didymopanax morototoni)* annually. The preferred woods for furniture manufacture are Crappo, Cypre, Cedar, Mahogany *(Swietenia macrophylla)*, and Saman *(Samanea saman)*.

Forest research within the Caribbean area. By The Caribbean Commission, 1736 Vermont Ave., Washington, D. C., 1947. Pp. 128; illus., 1 folded map.

A comprehensive survey of the present status of knowledge and the future need for research is presented in concise style. A bibliography of pertinent literature is given for each country participating.

Flora taxonomica Mexicana. Tomo II. By Casiano Conzatti. Sociedad Mexicana de Historia Natural, Mexico, D.F., 1947. Pp. 220.

This volume includes 22 plant families, in addition to the 30 covered previously [Tomo I], the principal ones being the Palmaceae, Liliaceae, Amaryllidaceae, Iridaceae, Zingiberaceae, Orchidaceae, Esmilaceae and the Dioscoreaceae.

Flora of Panama. Part V, Fascicle 1. By Caroline K. Allen. *Ann. Missouri Bot. Gard.* (St. Louis) 35: 1: 1-106; 53 figs.; February 1948.

Described in this fascicle are the Lauraceae, Hernandiaceae, Papaveraceae, Capparidaceae, and Cruciferae. Keys to the species and genera are included.

National survey of the forest resources of Panama. By R. D. Garver. U. S. Forest Service, Washington, D. C., April 1947. Pp. 28; 2 maps, 4 plates; "ditto" print.

This report is a preliminary appraisal of the forest situation in Panama and a recommendation for a detailed forest survey. The forests, timbers, and wood-working plants are discussed.

The resistance to dry-wood termite attack of some Central American woods. By George N. Wolcott. *The Caribbean Forester* 9: 1: 53-54; January 1948.

None of the woods tested proved as resistant to "polilla" attack as West Indian Mahogany. Among the more resistant woods tested were: Cenisero *(Samanea saman)*, Aguacatillo *(Ocotea* sp.?), Amarillo *(Anacardium excelsum)*, and Guanacaste *(Enterolobium cyclocarpum)*.

Notes on South American melastomes. By H. A. Gleason. *Phytologia* (N. Y. Bot. Gard.) 2: 10: 428-432; 1 fig.; April 1948.

The genus *Pachydesmia* and species of *Calyptrella* and *Miconia* are described as new.

Noticias botanicas Colombianas, X. By Armando Dugand. *Caldasia* 5: 21: 55-64; March 1948.

Among the species described is Caney, a tree which Dugand refers to *Aspidosperma cruentum* R. E. Woodson (vel. aff.).

Algunas Leguminosas de la Amazonia y Orinoco Colombianas. By Armando Dugand. *Caldasia* 5: 21: 65-76; March 1948.

An enumeration of the Leguminosae of the Amazon and Orinoco regions of Colombia, with notes of their geographic extent.

Plant explorations in Guiana in 1944, chiefly to the Tafelberg and the Kaieteur Plateau. By Bassett Maguire and Collaborators. *Bull. Torrey Bot. Club* (Lancaster, Pa.) 75: 1: 56-115; figs. 1-13 and 75: 2: 189-230; figs. 14-17; 1948.

These accounts are the first two of six which will describe the more than 2300 collections made in Surinam and British Guiana.

Enumeration of the herbarium specimens of a Suriname wood collection made by Prof. G. Stahel. By G. J. H. Amshoff. Natuurwetenschappelijke Studiekring voor Suriname en Curaçao (Utrecht) No. 2, 1948. Pp. 46.

The herbarium material has been checked and the names indicated for 380 specimens.

Suriname Timbers I. By Alberta M. W. Mennega. Natuurwetenschappelijke Studiekring voor Suriname en Curaçao (Utrecht) No. 3, 1948. Pp. 59, 8 plates (32 figs.).

Part I of this study is devoted to the introduction, and to descriptions of woods of the Guttiferae, Vochysiaceae, Anacardiaceae, and Icacinaceae families. Keys are given for identification of the woods within each family. Macroscopic and hand lens descriptions are given. Thirty-two low-magnification photographs of cross-sections are appended.

Ensaio de índice da flora dendrologica do Brasil. By M. V. G. Fraga. *Arquivos Servico Florestal* 2: 2: 67-156; November 1946.

The families and genera of the important trees of Brazil are listed in the first section. The important species, with their common names are listed for the states of Paraná, Santa Catarina, and Rio Grande do Sul. A bibliography is included.

As madeiras do Pará. Caracteres gerais e caracteres anatomicos. By Arthur de Miranda Bastos. Arquivos Serviço Florestal (Rio de Janeiro) 2: 2: 157-182; 15 plates; November 1946.

Fifteen timbers are described and illustrated with photomicrographs of cross and tangential sections.

Novas especies e contribuicoes para o conhecimento do gênero *Aristolochia na América do Sul*. By F. C. Hoehne. *Arquivos Bot. do Estado de S. Paulo* 2: 4: 95-103; plates 18-39 (pt. color); October 1947.

Aristolochia macrorrhyncha, A. compta, A. Medellinensis, A. Hœughtiana, and *A. pannosoides* are described as new.

Brazilian substitutes for gutta percha. By Eugene F. Horn. *The Caribbean Forester* 9: 1: 45-47; January 1948.

The production of gutta percha from several species of *Manilkara, Micropholis*, and *Pouteria* is discussed.

El cedro Cubano. *Bol. Consorcio Centros Agrí Manabí* (Portoviejo, Ecuador) 10: 52: 29-33; 1947.

This article consists of several personal letters containing information about Cedro and its use for reforestation in Ecuador.

Anatomia del leño secundario de *Tricomaria Usillo* Gill. ex H. & A. By Domingo Cozzo. *Lilloa* (Tucuman) 13: 17-21; 1 plate; 1947.

Secondary thickenings are reported as occurring in the vessel elements of this species.

Apocináceas Argentinas I. By Teodoro Meyer. *Lilloa* 13: 45-58; 7 figs.; 1947.

In the first part of this study the genera *Forsteronia* and *Mesechites* are dealt with.

Las Sapotaceas Argentinas. By TEODORO MEYER. *Lilloa* 13: 97-124; 11 figs., 2 plates; 1947.

The Argentine Sapotaceae described are *Pouteria, Bumelia,* and *Chrysophyllum.*

Notas Mirtologicas. By EBERHARD KAUSEL. *Lilloa* 13: 125-149; 3 figs.; 1947.

Along with some new combinations is presented the genus *Nothomyrcia.*

A botanical bibliography of the islands of the Pacific. By E. D. MERRILL. *Contr. U. S. Nat'l Herb.* 30: 1: 1-404; 1947.

Included with this important bibliography is a subject index by E. H. Walker.

Report on the flora of Pingelap Atoll, Caroline Islands, Micronesia, and observations on the vocabulary of the native inhabitants: Pacific Plant studies 7. By HAROLD ST. JOHN. *Pacific Science* 2: 2: 97-113; 9 figs.; April 1948.

In addition to the notes on the flora, considerable attention is given to the comparison of vernacular names used on Pingelap and adjacent islands.

Brief notes on Fijian tree species compared with those of Malaya. By G. G. K. SETTEN. *Malayan Forester* 11: 2: 81-83; January 1948.

The important timber trees are enumerated and compared with similar species in Malaya.

Gymnosperms of Eastern China. By Y. W. LAW. *Bot. Bul. Acad. Sinica* (Shanghai) 1: 2: 141-171; 6 figs.; June 1947.

The twenty-five species of seventeen genera are briefly described. Keys to the genera are included.

The forest regions of Kansu and their ecological aspects. By S. C. TENG. *Bot. Bul. Acad. Sinica* 1: 3: 187-200; 1 folded map; September 1947.

"From the standpoint of natural vegetation, the province may be divided into five main regions: (1) the Steppe and Desert of Hosi, (2) the Spruce Forest of Kilienshan, (3) the Deforested Loess Highland, (4) the Pine-oak Woodland of Tsingling, and (5) the Spruce-fir Forest of Minshan."

Metasequoia, another "living fossil". By E. D. MERRILL. *Arnoldia* (Arnold Arb., Jamaica Plain) 8: 1: 1-8; 3 figs.; March 1948.

"This new 'living fossil' is a large tree, attaining a height of at least 115 feet with a trunk diameter of at least 7½ feet. One of its striking characteristics is that, like the various species of *Larix* (larch) and *Pseudolarix* (golden larch), and our *Taxodium* (swamp cypress) its leaves are deciduous, the trees being leafless in the winter months. In general appearance the leafy branchlets suggest those of the genus *Glyptostrobus.*"

The marketing of Malayan soft wood timbers. By D. S. P. NOAKES and C. O. FLEMMICH. *Malayan Forester* 11: 2: 64-68; January 1948.

The marketing difficulties arising from the considerable variation among the soft wooded species is discussed. Segregation of *Shorea* species into Red Meranti, Nemesu (or Dark Red Meranti), Yellow Meranti and, later, White Meranti is proposed.

The commercial timbers of Australia. By I. H. BOAS. Pub. by Council for Scientific and Industrial Research, Melbourne, 1947. Pp. 344; 9 figs., 20 plates.

The first part of this book deals with the general aspects of timber utilization in Australia, including physical and mechanical properties of the woods, seasoning, durability, preservation, bending properties, veneers and plywood, grading, papermaking, improved wood, and essential oils. In the second part about 100 of the more important timbers are described as to habit and distribution, appearance, properties and uses. The Australian timbers suitable for various uses are itemized in tabular form. An extensive classified bibliography is appended.

Tests on small clear specimens of North Queensland Kauri (*Agathis palmerstoni* F. v. M.). By N. H. Kloot. Reprint from *Jour. Council Sci. & Ind. Res.* (Melbourne) 20: 3: 345-360; 1 plate; August 1947.

For most of the important properties Kauri has a lower strength/weight ratio than Bunya Pine or Sitka Spruce.

Cyprus: Report of the Forest Administration for the years 1939-1945. By R. R. Waterer. Government printing office (Nicosia), 1948. Pp. 16, 22 appendix tables.

A review of the forest conditions and policies is given in addition to the usual administrative records.

"Cyprus high forests are almost entirely coniferous. Broad-leaved high forest only occurs as narrow riverine strips in the valley bottoms or small areas of lowland Eucalyptus plantations.

"The main species are:—

Coniferous High Forest Species:

Aleppo Pine (*Pinus halepensis*).—This is the main commercial timber of the Island up to about 4,500 ft. elevation.

Troodos Pine (*Pinus laricio*).—This species replaces Aleppo Pine as the main commercial timber at elevations above 4,5000 ft.

Cyprus Cedar (*Cedrus brevifolia*).—This species is strictly preserved and is not felled commercially.

Troodos Juniper (*Juniperus foetidissima*).—This species is preserved for regeneration and is not felled commercially.

Mediterranean Cypress (*Cupressus sempervirens*).—This species occurs mostly on the northern range and is felled only as round poles.

Stone Pine (*Pinus pinea*).—This species is mostly in the plantations and is not yet of exploitable age.

Broad-leaved High Forest Species:

Plane (*Platanus orientalis*)
Alder (*Alnus orientalis*)
Poplar (*Populus nigra*)
Walnut (*Juglans regia*)
Oak (*Quercus lusitanica*)
Eucalyptus (*Eucalyptus tereticornis*).
Eucalyptus (*Eucalyptus rostrata*)
Eucalyptus (*Eucalyptus gomphocephala*)
and other species.

Understory species which yield much valuable fuel and small articles are mainly:

Golden oak (*Quercus alnifolia*)
Holly oak (*Quercus coccifera*)
Arbutus (*Arbutus andrachne*)
Juniper (*Juniperus phoenicia*)
Acacia (*Acacia cyanophylla*)
Terebinth (*Pistacia terebinthus*)
Maple (*Acer obtusifolia*)
Carob (*Ceratonia siliqua*)
Olive (*Olea europea*)
and other species."

Palestine: Annual report for the year 1947. Pub. by Department of Forests, Jerusalem, 1948. Pp. 12; 3 separate appendices. Price 5 s.

Appendix II consists of a "List of Trees and Shrubs Native to Palestine." Appendix III is a "List of Exotic Ornamental and Forest Trees and Shrubs in Palestine."

The forests of the Transjordan. By J. D. Chapman. *Empire Forestry Rev.* 26: 2: 245-252; 4 plates; 1 folded map; 1947.

"The forests of the Gilead region are of a type once common in Palestine, with species of *Quercus* and *Pistacia* predominating and a ground flora rich in Labiates. The Edom forests are of quite another kind, the main species being a *Juniperus* and *Pistacia atlantica*. Of special interest here is an old group of *Cupressus sempervirens* near Tafile, the only natural trees of this species known to be growing in the country."—*From author's summary*.

Africa. International yearbook of forestry statistics. Vol. III. By J. P. VAN AARTSEN & ERNST PALMGREN. Pub. by Int. Inst. Agri. (Rome), 1942. Pp. 404. Supplement pp. 405-474; 1 folded map.

"The first part of this volume deals with the forests of Africa and their production; the second with the imports and exports of timber and other wood, registered by the countries of that continent."

"The chapter dedicated to each country generally begins by an indication of the area of forests as a whole, followed, in most cases, by a note, under the title 'general information,' which contains some details on the lie of the land, the climate, and when necessary, of biotic, historical and edaphic influences."

"Then follows information available regarding the type of forests according to the most widely accepted classification, closed forests, viz., forests in which the branches of nearby trees intertwine, and open forests."

"After the description of the various types of forests, notes have been added on forest destruction, conservation, reafforestation and property."

"Lastly, in all cases in which more detailed and complete information on the principal species than could be given in the general description of the types of forests of the country was available, it was made the object of a special note. The species indicated are those which are most valuable in the forestry economy of the country surveyed. As far as possible, the names of species have been given in French and in English."–*From authors' introduction.*

Bibliographies and indices are included.

Quelques *Strychnos* Africains inoffensifs ou peu toxique. By AUG. CHEVALIER. *Rev. Bot. App. & d'Agr. Tropicale* (Paris) 299 & 300: 351-377; 6 plates; 1947.

Fourteen species of *Strychnos* (one new) are discussed in this paper.

Contributo sperimentale allo studio delle qualità tecnologiche e meccaniche dei legnami etiopici. By GUGLIELMO GIORDANO. Reprint from *Nuovi Annali dell' Agric. e Foreste* 3 & 4; 1943. Pp. 96; illus.

A complete study of the mechanical properties of a considerable group of Ethiopian woods is presented. A table gives recommendations for uses of the timbers.

Arbres á ail, Huacacées et Styrax à benjoin. By AUG. CHEVALIER. *Rev. Bot. App. & d'Agr. Tropicale* 299 & 300: 401-407; 2 plates; 1947.

Supplementary notes are presented for *Scorodocarpus*, *Afrostyrax*, and *Styrax*.

Les Morindas de la Côte d'Ivoire et leurs utilisations Thérapeutiques. By J. KERHARO and A. BOUQUET. *Rev. Bot. App. & d'Agr. Tropicale* 299 & 300: 401-407; 2 plates; 1947.

Included are accounts of *Morinda geminata* DC., *M. lucida* Benth., *M. confusa* Hutch., and *M. longiflora* G. Don.

Le genre *Mansonia* et l'utilisation des quatre espèces connues. By AUG. CHEVALIER. *Rev. Bot. App. & d'Agr. Tropicale* 299 & 300: 422-424; 1947.

The discussion includes *Mansonia Gagei* Drumm., *M. altissima* Chev., and *M. dipikae* C. S. Purkayastha.

Essences forestières et bois du Congo: *Entandrophragma palustre*. By JEAN LOUIS and JOSEPH FOURAGE. Publ. l'Inst. Nat. l'Etude Agron. Congo Belge (Brussels) No. 4, 1947. Pp. 75, 4 plates.

A monograph of the species including an analysis of the genus and ecological considerations. The wood is described in detail, the physical properties enumerated, and the question of nomenclature discussed.

Les forêts du Congo Belge. By EDGAR VAN DER STRAETEN. *Rev. Internat. Bois* (Paris) No. 125: 207-213; 2 figs.; November 1947.

The forests of the Belgian Congo, covering about 120 million hectares, make up part of the forest system which extends through most of central Africa. The author divides these into five principal groups: Equatorial forests of central Congo; Forest of Mayumbe; Open forest and wooded savannahs of Katanga; Forest galleries of Bas and central Congo; Mountain forests.

The distribution and composition of the forests are discussed and the significant features of the important timber families mentioned. Problems of forestry, exploitation, and commerce are discussed.—*M. Record.*

Forestry in Sierra Leone. By W. D. MACGREGOR. *Jour. Forestry* (Washington, D. C.) 46: 3: 184-187; March 1948.

Through shifting agriculture and heavy exploitation the high forests had been reduced to approximately five percent of the total land area by the beginning of the twentieth century. The activities of the Forest Department to alleviate the situation are discussed.

Gold Coast Colony: Report of the forestry department for the year 1946-47. Publ. by Gov. Printing Dept. (Accra), 1947. Pp. 24; 1 folded map. Price 1 s.

"The Closed Forest Zone, some 30,000 square miles in extent, is the timber-producing area of the Gold Coast. It is estimated that there are still approximately 11,000 square miles of unreserved forest in the zone, and it is these forests which at present produce almost all the timber for both local use and export. It is estimated that, in normal times, the rate of destruction of these forests by conversion to agriculture is 300 square miles per annum; in the absence of further reservation, therefore, or of a change of agricultural practices, their remaining life is approximately 40 years, . . ."

Le genre Holarrhena et sa distribution géographique. By AUG. CHEVALIER. *Rev. Bot. App. & d'Agr. Tropicale* 28: 305 & 306: 115-120; March-April 1948.

The genus *Holarrhena* R. Br. (1809), of the Apocynaceae family, has long held the interest of biochemists and pharmacologists because of its many species which are rich in alkaloids. These alkaloids are used in medecine; some formerly for arrow poisons.

According to the author, the twenty or so described species of the genus (trees of medium height, or more often large or small shrubs, leaves as well as branches containing white latex) should be restored to a dozen.—*M. Record.*

Les Holarrhena et leurs propriétés thérapeutiques. By P. LEPESME. *Rev. Bot. App. & d'Agr. Tropicale* 28: 305-306: 121-125; March-April 1948.

Twenty-six species are listed thus far for the Indomalayasian and Ethiopian regions. Revision of the genus is suggested for more convenience and exactitude.—*M. Record.*

The sycamore fig of ancient lineage. By MARY F. BARRETT. *Jour. of N. Y. Bot. Gard.* 48: 575: 254-262; November 1947.

"In the Bible, the most familiar of the collections of ancient literature, the "fig-tree" is that best known species of *Ficus, F. carica.* But the old Testament mentions also another tree of that genus, which grew in the lowlands and furnished both wood and figs. To this, the great botanist Linnaeus in 1753 gave as a specific name its ancient title, *sycomorus.*"

Classification des Apocynacées: IV, genre "*Alstonia*" et genres voisins. By M. PICHON. *Bul. Mus. Nat. d'Hist. Nat.* (Paris) 19: 3: 294-301; May 1947.

In addition to the revision of *Alstonia* presented, two new genera, *Paladelpha* and *Bisquamaria*, are described.

The role of botanical research in the chicle industry. By FRANK E. EGLER. *Economic Botany* 1: 2: 188-209; 24 figs.; 1947.

The various phases of the chicle industry are described and the need for fundamental research outlined.

Fiber length of anilau *(Columbia serratifolia)*, hinlaumo *(Mallotus ricinoides)* and kupang *(Parkia javanica)*. By R. T. CORTES and P. HAMBANADA. *Phillippine Jour. For.* 5: 1: 50-70; 1 fig., 20 tables; 1947.

This study deals with the fiber lengths of non-commercial tree species of possible interest for paper-making.

The nature of plastic deformation in wood at elevated temperatures. By H. G. HIGGINS and FLORENCE V. GRIFFIN. *Jour. Council Sci. & Ind. Res.* 20: 2: 361-371; 1 plate; 5 figs.; August 1947.

"Elastic after-effects were observed in hoop pine plywood panels which had been oven-dried and subjected for five minutes to pressures capable of causing residual deformation at elevated temperatures."

"It appeared probable that the location of flow in the wood tissue was the cell wall as well as the middle lamella zone."—*From authors' summary.*

Variation of the specific gravity of bagtikan *(Parashorea plicata)* from nine provinces of the Philippines. By DOMINADOR G. FAUSTINO. *Philippine Jour. For.* 5: 1: 7-21; 3 figs., 5 tables; 1947.

Bagtikan (white lauan) has a possible specific gravity range of from 0.373 to 0.632, green weight, in the nine provinces considered.

"Insofar as this study is concerned, the densest bagtikan comes from Calubian, Leyte; Dahican, Camarines Norte; and Port Lamon, Surigao. The least dense comes from Iligan,

Lanao." "Bagtikan from Calubian, Leyte has the least variable density."

Les copaliers et arbres a résine de l'Afrique Equatoriale Francaise. By A. AUBRÉVILLE. *L'Agronomie Tropicale* (Nogent-sur-Marne, France) 3: 1 & 2: 18-24; January-February 1948.

The trees that produce copal and their gums are reviewed. The occurrence of secretory canals is noted and vernacular names for trees and copals listed.

Contribution a l'étude chimique de quelques bois Congolais. By E. CASTAGNE, L. ADRIAENS, & R. ISTAS. Inst. Nat'l pour l'Étude Agron. du Congo Belge (Brussels), Sci. Series No. 32; 1946. Pp. 30. Price 15 fr.

The significant chemical constituents of the wood are determined for 36 species. Commercial applications are discussed.

L'attaque du bois de limba *(Terminalia superba* Engl. & Diels) par le *Lyctus brunneus* Le C. By J. FOUARGE. Inst. Nat'l pour lÉtude Agron. du Congo Belge, Sci. Series No. 36; 1947. Pp. 17; 9 figs.

Methods of treating the wood and harvesting practices which may reduce *Lyctus* beetle attack are discussed.

Le Limba. *Bul. Comptoir Vente Bois Congolais* (Brussels) 22: 3-9; 4 plates; May 1948.

Limba is now the standardized commercial name of *Terminalia superba* Engl. & Diels (family Combretaceae). Other commercial names (e. g. Frake, Afara, Mukonja) are also used in Europe, while countless vernacular names apply throughout the parts of Africa where the tree grows.

The article recommends the use of Limba on a large scale, and includes a botanical description and discussions of the characteristics and uses of the wood.—*M. Record.*

Additional notes on the genus *Aegiphila*. IX. By Harold N. Moldenke. *Phytologia* 2: 10: 433-450; 5 figs.; April 1948.

Citations are given for numerous species.

Relacion anatomica entre la estructura del leño de las especies Argentinas de *Capparis* y *Atamisquea*. By Domingo Cozzo. Reprint from *Lilloa* 12: 29-37; 2 plates; 1946.

"The author studies comparatively the anatomical structure of *Capparis Atamisquea* O. K. and *Atamisquea emarginata* Miers ex Hooker et Arnott and gives the synonyms."—*Author's summary*.

Anatomia del leño secundario de Tricomaria Usillo Gill. ex H. et A. By Domingo Cozzo. Reprint from *Lilloa* 13: 17-21; 1 plate; 1947.

"The author studies the secondary wood and reports the occurrence of spiral thickening in members of small vessels, understanding that this constitutes the second case of spiral thickening known in the family Malpighiaceae. The structure is normal."—*Author's summary*.

Softwood cedars. By H. E. Desch. *Wood* (London) 13: 3: 74-76; 8 figs.; March 1948.

Brief descriptions of the woods, their properties and uses are given for the various Cedars (*Cedrus*, *Thuja*, *Libocedrus*, *Chamaecyparis*, *Juniperus*). Low-magnification photomicrographs illustrate each.

The boxwoods. By H. E. Desch. *Wood* (London) 13: 5: 130-132; 8 figs.; May 1948.

Woods of *Buxus*, *Gonioma*, *Canthium*, *Gardenia*, *Phyllostylon*, *Gossypiospermum*, and *Tristania* are described.

Observations on the phloem in the Monocotyledoneae. II. Additional data on the occurrence and phylogenetic specialization in structure of the sieve tubes in the metaphloem. By Vernon I. Cheadle. *Amer. Jour. Bot.* (Burlington, Vt.) 35: 2: 129-131; February 1948.

"These conclusions, rephrased, are that (a) transverse or slightly oblique end walls are more highly specialized than oblique or very oblique, (b) a high percentage of transverse or slightly oblique end walls have simple sieve plates, (c) progressively more inclined end walls are progressively more likely to be composed of compound sieve plates, and (d) very oblique end walls of sieve-tube members have only compound plates."

"The data also support earlier conclusions concerning the occurrence of the various types of end wall positions of sieve-tube members throughout the plant. Based upon the inclination of the end walls, the primitive sieve tubes are most likely to occur in the root, and highly specialized sieve tubes in the leaves, inflorescence axes, corms, bulbs, and rhizomes. The sieve tubes of aerial stems fall between these two extremes."—*From author's summary*.

The variation of tensile strength and modulus of elasticity of hoop pine veneer with the direction of the grain. By R. S. T. Kingston. Div. of Forest Products (Melbourne) reprint No. 98; from *Jour. Council Sci. & Ind. Res.* 20: 3: 338-344; 1 plate; August 1947.

"Hoop pine veneer was tested in tension at various angles to the grain, the maximum tensile strength and the modulus of elasticity determined." "For neither elastic modulus nor maximum tensile strength did the experimental points differ significantly from the computed curve."—*From author's summary*.

Use of the U.D.C. in selecting data with mechanical appliances. By W. W. VAROSSIEAU. Reprint from Reports of the 17th Conference of the Federationale de Documentation, Part 3, Berne, 1947. Pp. 1-5; 3 figs.

"The use of mechanical appliances in selecting data according to the Hollerith system requires a numerical code, which is also the case in the Universal Decimal Classification. This circumstance makes it possible for the U.D.C. to be used not only in literature documentation, but in some cases, also as an aid in scientific investigation."

"Some considerations have been devoted to the potentialities of the U.D.C. in literature documentation according to the Hollerith system. An example has further been given of the use of the U.D.C. in scientific research, which is carried out with mechanical means, viz. in a universal method of identifying wood species. In connection with this subject, it is suggested to extend the U.D.C. section relating to the structure of wood."—*From author's summary.*

Fifth British Empire Forestry Conference. Publ. by H. M. Stationery Office, York House, Kingsway, London, W.C. 2.: 1947. Pp. 56. Price 1 s.

Included is a summary report, resolutions, and reports of committees.

Les tuiles en bois tropicaux. By D. NORMAND. *Rev. Internat. Bois.* No. 131: 99-103, 106; May 1948.

The history of wood shingles has been traced as far back as 2,000 B.C.

The advantages and disadvantages of wood shingles and the inherent requirements of the timber for such a use are discussed. Possibilities of preservative treatment are also mentioned.

Among the woods proposed for consideration are Niangon (*Tarrietia utilis*), Framire (*Terminalia ivorensis*), Niové (*Staudtia gabonensis*), Rikio (*Uapaca* spp.), Sao (*Hopea* spp.), and *Macrocatalpa longissima*.—*M. Record.*