F. H. Chittenden

Price 25 cents

Yale University School of Forestry

TROPICAL WOODS

NUMBER 89 MARCH 1, 1947

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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.*

Subscription price One Dollar for four consecutive numbers. Remittances should be made payable to TROPICAL WOODS.

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

COMMERCIAL POSSIBILITIES OF THE FORESTS OF ECUADOR—MAINLY ESMERALDAS PROVINCE

By M. ACOSTA SOLÍS

Director, Ecuadorian Institute of Natural Sciences

The Republic of Ecuador is on the Pacific Coast of South America 2200 miles directly south of Miami, Florida and 4360 miles southeast of Los Angeles, California; lying between 2 degrees north latitude and 5 degrees south latitude. The principal port, Guayaquil, is 990 miles south of the Panama Canal. The Republic obtains its name from the fact that it lies directly across the Equator. It is bounded on the north and east by Colombia and on the south and east by Peru. Ecuador has approximately 100 kilometers of coastline. The total area, as of the latest boundary settlement (Rio de

Janeiro, January, 1942) is approximately 300,000 square kilometers or about the same as for the state of Oregon. The Galápagos Island group, a dependency, lies about 1100 kilometers off the west coast of Ecuador. The group consists of sixteen islands and a number of rocky islets. The large islands have a combined area of approximately 10,400 square kilometers.

The population of Ecuador, according to the best estimate, is 3,500,000 people, consisting of Indians–50%, mixed blood–36%, Whites–13%, Negroes–1%.

Traversing the Republic in a general north and south direction are the eastern and western Cordilleras–two parallel chains of the Andes Mountains, about thirty miles apart. These high mountain ranges divide the county into three natural divisions: (1) the Coast or western region, between the Pacific Ocean and the western Cordillera; (2) the Inter-Andean or Sierra region which is a high plateau with an average elevation of 2400 meters, lying between the two mountain ranges; (3) the Oriente or eastern region, from the eastern Cordillera to the boundaries of Colombia and Peru. About twenty mountain peaks extend above the snow line which is reached at approximately 4500 to 5000 meters. There are several active volcanoes but there has been very little volcanic activity in recent years. Earthquake shocks seem to be no more frequent or severe than those of California. In Quito, capital of the Republic, there are many adobe buildings more than three hundred years old which show no evidence of violent earth movements.

In the Coast region are the cities of Guayaquil (pop. 220,000), Salinas (pop. 8,000), Manta (pop. 15,000), and Esmeraldas (pop. 16,000). Guayaquil is the most modern city in the Republic as well as the main port of entry. It has a few fairly good stores and one excellent hotel together with other fairly good hotels. A large U. S. air base is located at Salinas, a popular vacation spot with a fine beach. The presence of a large number of Americans has caused this city to become quite modern.

The temperature of the Coast region is much milder than might be expected in the equatorial tropics. This is because of cold Humboldt ocean currents from the antarctic regions which bathe these shores and the fact that the prevailing winds are from the west. The temperature is fairly uniform throughout the year. The "winter" or rainy season (January to June) differs from the "summer" season (June to December) mainly in the increased humidity, the high water level in the rivers and the general increase in the numbers of insects.

The Inter-Andean region is the home of one of America's oldest civilizations–the Incas. Here is located the capital city of Quito (pop. 300,000) as well as Cuenca (pop. 60,000), Latacunga (pop. 17,000), Ambato (pop. 25,600), Riobamba (pop. 25,000), and Ibarra (pop. 18,000). Because of the high elevation the climate of these cities is definitely cool throughout the year. In fact, in Quito a topcoat is necessary in the evening for all except the most rugged individuals. A definite dry season exists and in many places irrigation is necessary. This central plateau is inhabited by a large number of Indians, mostly descendants of the original tribes, and a few Incas. The standard of living of these people is very low, although they are very industrious. If these Indians were properly trained, they would be a fine source of labor for agriculture and other types of industry. There are virtually no forests in this region because of their removal by ancient civilizations to use for fuel and to make room for necessary crops. Eucalyptus is now grown in woodlots for fuel and for rough construction purposes. There is a distinct shortage of wood for fuel in the Sierra and it is very expensive.

The Oriente region east of the mountains is largely a vast unexplored forest. There are no cities (except Indian villages) no roads and very few trails. Transportation is by means of rivers, and this is very difficult in the higher regions due to the rapid fall of the land from the great heights of the Andes. This region is reported to be exceedingly rich in forest and mineral resources, the exploitation of which must await the development of transportation systems. At

present the Rubber Development Corporation and the Shell Oil Company have exploring crews in this district.

The types of trees and other plants in any given district depend to a great extent on the quantity and distribution of rainfall. The wet regions, comprising the greatest part of the Republic, are heavily forested and are, for the most part, totally unexploited. So few botanical collections have been made that it is not possible to give a complete technical description of the composition of these forests. My collections are as yet incomplete, but when they are finished, including study of the plant society (especially forest associations), I am sure they will represent Ecuador completely and favorably. The botanical names of many of the trees are often doubtful and the common names vary according to the district. A group of men from the U. S. Forest Service have been making a systematic study of the trees of Ecuador. When this information is published we should have a much clearer picture of the botanical classification of the various trees.

The Pacific slope of the western Cordillera and the adjoining lowlands are covered with dense evergreen forests. In most of the northern half of the country these dense forests extend down to the seacoast. At the foot of the Cordillera this vegetation becomes typical rain forest type. Farther to the west the climate gradually becomes drier while to the south the heavily forested belt decreases in width and almost disappears as the land becomes more arid near the Peruvian frontier. The forests extend up the mountains to 3,500 meters. This is the general limit of tree growth in Ecuador although sometimes small stands of trees may grow up to 3,900 meters in sheltered places. Higher in altitude, beyond the tree line, lies the "páramo" which is a grass and herb type of vegetation covering the high ridges and plateaus of the Cordilleras up to the snow line at about 15,000 feet. In places the upper limit of arborescent vegetation is formed by pure stands of *Escallonia*, *Polylepis*, or *Gynoxys* which sometimes end abruptly on the páramo. The trees near this border are usually only 8 to 12 feet tall with very thick trunks—sometimes 90 centimeters in diameter. See Figure 1.

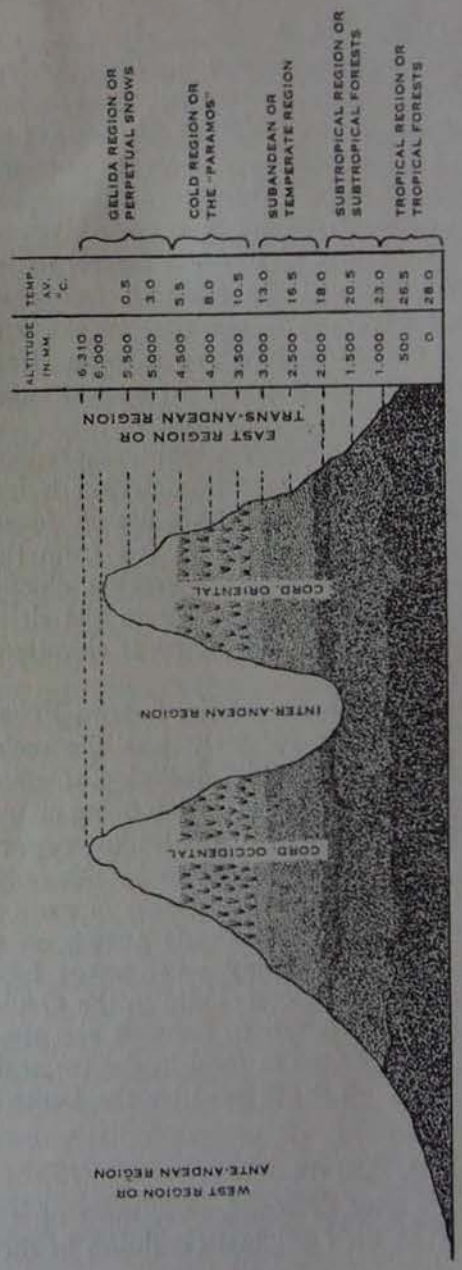

FIGURE 1

THE NATURAL REGIONS AND THE ALTITUDINAL VEGETATION BELTS OF ECUADOR

The altitudinal range of the forest can be seen in table on the right.

Also, the promedial temperature limit of each belt can be noted.

Agriculture

Agriculture is important in two regions: the Inter-Andean valley and the Occidente. The products from these regions are distinctive. Agriculture in the Sierra is intensive, producing a large variety of cereals and vegetables for domestic consumption. The products of the Occidente are tropical crops grown mainly for export. In the Sierra corn, wheat, barley, rye, potatoes, peas, beans, alfalfa and several native Andean vegetables are produced. In addition temperate climate fruits such as apples, pears, peaches, grapes, and strawberries are grown. The warmer valleys at lower elevations in the Sierra produce citrus fruits, avocados, sugar cane, coffee, and tobacco.

The great variety of climate permits a highly diversified agriculture. Where humidity is favorable, dairying is important, and progressive pasturing practices are in force. The dry valleys are irrigated from streams fed from the perpetual snows of the Sierra. Uncontrolled grazing, chiefly by sheep, is practiced by Indians, especially in the drier regions. Cattle are also common in the páramo at elevations over 3500 meters.

The Occidente region is the home of the famous Ecuadorian cacao, of which Ecuador formerly was the main producer. Production has been steadily declining. Coffee ranks second to cacao in importance, production being about one-half as valuable. Rice has been one of the leading export crops during recent years. It is considered to be the crop of greatest promise in the Occidente. Tobacco is grown mainly for home consumption. Sugar cane is grown on a limited area. Cotton is grown to supply local textile factories. Cattle are raised, both in the Sierra and in the Occidente, mainly for domestic consumption. Bananas are produced in large quantities, being used as food in the tropical lowlands. A portion of the crop is exported by the United Fruit Company.

The Forests

The forests of Ecuador, once dominant over most of its area, are still to be found in their original condition in the more remote locations. They are complex, containing many tree species, some of which grow to large sizes. Clearly distinct associations are found under different environmental conditions, and in the same association in the mountains the trees become progressively shorter at higher altitudes.

The composition of the forest is affected to a considerable extent by the altitudinal temperature gradient, which changes at the rate of about one degree Centigrade for each 200 meters change in altitude. Differences in the composition of the soil and location also cause differences in the composition of the forest. See Figure 2.

No information is available as to Ecuador's original forest area, and only estimates exist as to its present area. There is little doubt that the country originally was almost entirely forested from sea level to timberline at the base of the páramo. The Oriente Provinces, containing 150,000 square kilometers, are densely forested and almost untouched. Little forest growth of value occurs in the Galápagos islands.

A timbered area of approximately 20,000 square kilometers is located on the west slope of the western Cordillera below the 2500 meter contour. The Inter-Andean valley and higher Andean ridges are at present without forests, a large part of the wood consumption of the Inter-Andean valley being supplied from Eucalyptus plantations (introduced from Australia, first in 1865).

Although the Oriente provinces contain large quantities of timber, a small part of which is being brought out through the Baños region, the forests in the Occidente are the best prospects for satisfying immediate demands.

Cutting and culling of the forests have been in progress for many years in the Occidente along the lower Guayas River and its tributaries, a navigable system with a good harbor at its mouth. A wooden ship-building industry was established in Ecuador in 1602. For over a century the land cleared of forest in the Occidente has been producing numerous tropical crops, of which cacao probably covers the largest area. The region directly west of Guayaquil, being a dry savanna, is devoid of useful timber growth. The

western half of the Province of Manabi, settled since the days of Pizzaro, does not contain much forest growth. Inroads have been made in the forests south of the Gulf of Guayaquil in the settlements of the agricultural province of El Oro, except in the dry savanna along the coast.

The western Andean slopes between the upper limit of the tropical region and timberline (between 800 and 3000 meters elevation) are well covered with forest except in the accessible areas along the Quito-Guayaquil railroad and in the vicinity of the principal mining centers. This region is little inhabited as slopes are too steep for agriculture and transportation is extremely difficult. The water and soil conservation value of these mountain forests is great because of the rough topography and because this region contains the headwaters of the rivers of the Occidente.

In summary, the following areas are still well forested and economically accessible:

1. At least 75% of the Province of Esmeraldas amounting to approximately 11,000 square kilometers. Some clearings for farming have been made along the Esmeraldas River and

EXPLANATION OF FIGURE 2:

- Gelida Region or Perpetual snows
- Cold Region or Los "Páramos"
- Andean "Sotobosque" or Highland Forestry
- Sub-Andean Region or Sub-Andean Forests
- Temperate Region or Inter-Andean Region
- Subtropical Region or Subtropical Forests
- Tropical Region or Tropical Forests
- Hills and Mountain Forests of the Tropic
- Xerophytic Coastal Area or Desertic Lowlands

Sketched by the Author

Scale = 1:4,000,000

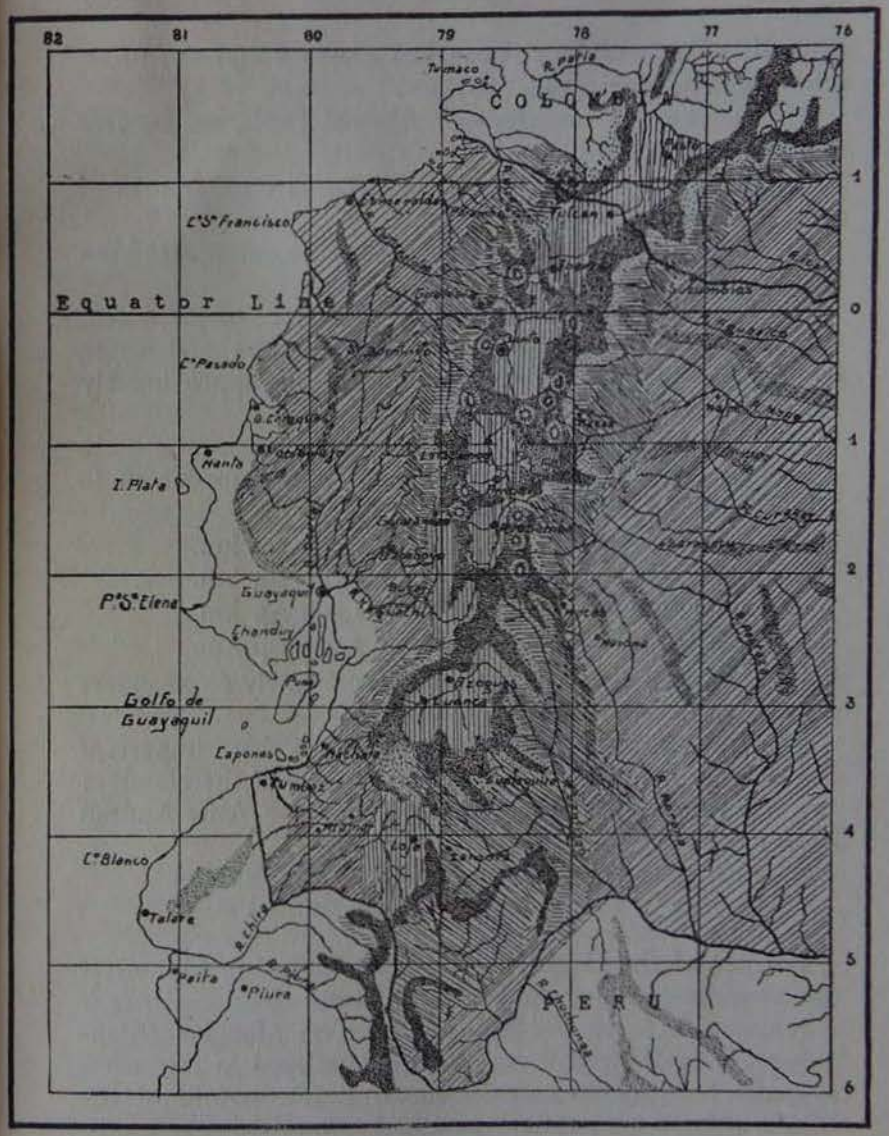

FIGURE 2

PHYTOGEOGRAPHICAL DISTRIBUTION OF THE VEGETATION AND FORESTS OF ECUADOR

along the coast and the streams, but a large volume of forest resources remains in this province.

2. The eastern one-third of Manabí Province, an area of 8,000 square kilometers.

3. Forty per cent of the Province of El Oro, an area of approximately 3,000 square kilometers.

4. One quarter of Guayas Province or 5,000 square kilometers.

5. The western two-thirds of the Province of Pichincha, which drains north through the Esmeraldas and south through the Guayas river basins. This area is approximately 5,000 square kilometers.

Thus the total area of well forested land is approximately 32,000 square kilometers. The area in second growth or in heavily culled forests is as follows:

Esmeraldas	700 to 1,000 sq. km.
Manabí	2,000 to 2,500 sq. km.
Guayas	2,000 to 2,500 sq. km.
El Oro	500 to 1,000 sq. km.

In the aggregate this is an area of approximately 6,000 square kilometers.

The Ecuadorian forests are divided into three important classes corresponding to the natural regions of the country:

1. Forests of the Occidente, Coastal, or Ante-Andean Regions.
2. Forests of the Inter-Andean or Central Region.
3. Forests of the Oriente or Trans-Andean Region.

Forests of the Occidente Region. In the brackish water belt near the seashore and in the salt water estuaries, there is a remarkable forest formation known as Manglar (Mangrove). The Manglar forest is best developed in two main districts—first, in the extreme north at the mouths of the Mira and Santiago river systems, and secondly, in the southern part of the country around the estuaries of the Guayas River and from there southward along the narrow coastal plain as far as Peru. The principal species are the Mangle Colorado *(Rhizophora mangle)* which grows very tall, sometimes as high as 40 meters; the Mangle Concha *(R. mangle)*, and Mangle Pecho de Pava *(R. mangle);* the Mangle Salado or Mangle Iguanero *(Avicennia nitida);* Mangle Blanco *(Laguncularia racemosa);* and the Mangle Jeli *(Conocarpus erecta)* which usually grows farther back from the water.

In the coastal plain and the lower parts of the Cordillera, the average height of the forest trees is between 24 and 40 meters, but some species attain 60 and even 80 meters. Stem diameters of 0.60 to 1.80 meters are common. In the shade of these tall trees are found smaller species such as Cacao de Monte *(Theobroma Mariae)*, Membrillo de Monte *(Gustavia pubescens)*, Arete *(Heisteria Spruceana)*, Petaquilla *(Tabernaemontana)*, Palma Mulata *(Zamia muricata)*, and *Passiflora gigantifolia*. In many of these latter species flowers and fruits appear on the main stem and the older branches instead of on the young twigs.

The forest floor is quite devoid of vegetation in some places, in others it is covered by an undergrowth of fern, aroids, *Heliconia*, *Calathea*, and *Piper*. Here we find the palm-like Toquilla *(Carludovica palmata);* the leaves of this plant supply the material for the so-called Panama hats which are manufactured only in Ecuador. In the rain forest the trunks of the trees are covered locally with climbing ferns, Cyclanthaceae, Selaginellales and Aroideae. The exceedingly long and tough aerial roots of *Heteropsis ecuadoriensis* are an excellent substitute for rope and are used by the natives to bind the logs of a raft or to lash the bamboo supports of their homes together. High in the trees the climbing Vanilla Orchid *(Vanilla planifolia?)* can be detected by its well-known fragrance.

The most abundant palm trees are Palma Mocora *(Astrocaryum* spp.) the fiber of which is used to make hammocks; the majestic Palma Real *(Cocos butyracea)*, which bears fruit containing an oily kernel; Cadi or Tagua *(Phytelephas macrocarpa, P. microcarpa)*, the seeds of which supply the vegetable ivory of commerce; and, the Pambil *(Euterpe*

chaunostachys Burret). In many places the forest is broken up by thickets of Bamboo *(Guadua* spp.).

Differences in altitude, in the composition of the soil, and in location also cause differences in the composition of the forest. For instance, Laurel *(Cordia)*, Moral, Huasango, Bantano, and Amarillo *(Centrolobium ochroxylon)* grow on elevations while Jagua, Jagua de Lagarto *(Crataeva tapia)*, Pechiche *(Vitex gigantea)*, Roble *(Tabebuia pentaphylla)*, and Figueroa prefer moist depressions.

Forests of the Inter-Andean Region. The forests in this region are limited to a strip along the higher, inner slopes of both Cordilleras and are more or less simliar to those at the same altitude along the outer slopes. The central portions of the Sierra bear a "chaparral" of such shrubs as Chilca *(Baccharis polyantha)*, Chámano *(Dodonaea viscosa)*, Chivocaspi *(Buettneria parviflora)*, Mote-casha *(Duranta triacantha)*, and Supirosa *(Lantana quitensis)*, or are of the semi-desert type with Agaves and Cacti. There are also a few isolated trees, including three having good, durable wood—the Molle *(Schinus molle)*, the Capuli *(Prunus salicifolius)*, and the Huarango *(Caesalpinia spinosa* or *Coulteria spinosa)*. In the moist valleys there are also Sauces *(Salix Humboldtiana)* and Alisos *(Almus* spp.). South of Loja, near Gonxanamá, some good timber is obtained from *Lafoensia speciosa*. The Inter-Andean region has always been densely populated from pre-Inca times. It produces many of the crops characteristic of the temperate zone, such as alfalfa, wheat, barley, potatoes, peas, apples, peaches, strawberries, huckleberries, cabbage, etc. The Tungurahua province is the most important in the production of temperate zone fruits. The demand on the native forest has been heavy and most of the original timber has been removed.

Considerable planting has been done throughout the entire region during the past eighty years, especially of *Eucalyptus globulus* which grows very well at elevations of 1800 to 3000 meters. Large areas, particularly those which are too rugged for other uses, have been planted to Eucalyptus and thus cultivated timber is now by far the most important timber of this region. About 80 to 85% of the total Eucalyptus grown is used for house construction (studding, joists, window frames, and floors). The rest is used for fuel for domestic consumption, a purpose for which it is highly unsatisfactory due to the fact that during most of the year dry wood is unobtainable. The leaves and branches from the wood-lots and the shavings from the many small furniture factories are used by the Indians to fire their brick kilns. Needless to say, properly fired bricks are unknown—they are little more than dried-out clay. It is remarkable that buildings and homes constructed of such crude materials and by such primitive methods can last so long. In the villages of the Sierra of Ecuador, the following timbers, besides the Eucalipto, are used in construction: the Chaguarqueros (floral axes of *Agave americana* and *A. gigantea)* and the Carrizo *(Arundo nitida)*. These materials are principally used for roofs in the "bareques" or for walls filled with mud. The country houses are covered with "Sigse" grass *(Cortaderia rudiuscula);* and in the páramos only Paja Blanca *(Stipa* and *Festuca)* is used for the Indians' huts.

The external slopes of the two Cordilleras, Occidente and Oriente, are still rich in forests but there is need for control of the cutting.

Forests of the Oriente Region. Due to the almost uninterrupted rainy season in the Oriente, the land is covered with a very dense forest growth of the distinct rain-forest type. The enormous buttresses of many trees, the great quantity of palms with stilt roots *(Iriartea)*, the extraordinary number of root climbers, and the immense variety of vines and lianas indicate the humidity of the region. Some of the best known trees are the resin-producing Copa *(Hymenaea courbaril)* frequently found at altitudes around 2500 feet near Canelos and Nacas; the Canelo *(Nectandra* sp. and *Drimys Winteri)* which furnish an article of commerce known as "ishpingu"—the fleshy aromatic calyx of the fruit; the thorny Chonta-ruru or Egg Palm *(Guilelma speciosa)* whose egg-like, red, edible fruits, ripening from March to May, are an important article of food among the native

Indians; Cascarilla *(Cinchona* spp.), the bark of which furnishes the quinine of commerce, is frequently found in the middle heights of the Cordillera; and, a great many rubber trees are to be found in the lowlands. Also in these lowlands along the rivers are extensive stands of tall palm trees such as the Cadirina with stiffly upright leaves, the Shiona with hanging feathery fronds, the Miriti *(Mauritia)* with fan-like leaves and scaly, dark red fruits.

Forest Exploitation

Until a relatively few years ago the lumber business in Ecuador was carried on in a very primitive manner. The logs, after being roughly squared, were sawed by hand (whipsawed) and were sold to the public at a price per board. There was little uniformity in price (particularly in the inland cities) as each individual piece was bargained for. Later on, with the advent of the sawmill, the board-foot measure system was introduced and now each board is measured at the mill and usually the total number of square feet is marked on the board. Kiln dried lumber even now is very scarce as there are only a few dry kilns in the country.

In the Inter-Andean valleys, in the cities of Quito, Ambato, Riobamba and Cuenca, the most antiquated methods of cutting and transporting lumber are in operation. The trails over which timber is brought are so difficult that one seldom sees boards over seven feet long in the markets of this region.

Today's sawmills in Ecuador are assembled from a very motley assortment of machinery. For motive power one sees German-built steam engines, United States automobile engines, German or Swedish Diesel engines, even French airplane motors and nameless marine engines. Some preference seems to be given to a verticle gangsaw manufactured in England. American circular saws are used mainly for sawing extremely hard wood, such as Mangrove and Guayacán, and for squaring the sides of hard wood logs. Most of the small machines, such as planers, are from the United States although there are quite a few German machines.

Other than Balsa, very little lumber is exported from Ecuador. Fairly large quantities of Bamboo have been shipped to Peru and Chile where it is used for temporary framework in the construction of large buildings. In the case of a large scale industry, the most logical procedure would be to clear the timber lands, selling the soft woods for local consumption and accumulating the more valuable hard woods until sufficient quantities are available for export. The land thus cleared should be planted to fast growing species of trees (which can be used for paper or cellulose), or to other commercially important plants.

Economics of Forest Products in Ecuador

In normal times, Ecuador imports approximately 5,000 to 6,000 tons of paper of all classes per year with a total value of somewhat more than $700,000. With a population of about 3,000,000 people, this represents a consumption of about four pounds of paper products per year. Other neighboring countries consume 10 to 25 pounds of paper products per person per year and the United States uses more than 150 pounds. Even with this low consumption, one can readily see that Ecuador and her immediate neighbors use large quantities of paper of which practically the entire amount is imported. If a large paper mill is built in Ecuador, the government has agreed to work out a reciprocal trade treaty with her neighbors for the benefit of the paper industry. This should make it possible to distribute economically the entire output of a large size mill with no serious impediments.

While the literacy rate of these countries (particularly Ecuador) is very low compared with the United States standards, this bad condition is changing rapidly. Radios, airplanes, improved schools, and new roads are raising the literacy rate with great rapidity. In addition to these improvements, there is a greatly increasing appreciation of the value of paper products in the promotion of sanitation (food wrapping, toilet tissue, etc.) which will cause a manifold increase in the demand for paper products in the immediate future. These new demands for paper will be very large

and will necessitate the opening up of new sources of supply due to the fact that raw materials for paper manufacture in the United States and Canada are already becoming a limiting factor in expansion of the industry there.

Why is paper not manufactured on a large scale on the west coast of South America? It is either an oversight or industrialists of the United States have underestimated the capacity of these countries to consume paper products or to produce the raw materials. There can be no question that paper products can be produced in the tropics. As evidence of this fact, statistics show that even as far back as 1935 Brazil produced over 100,000 tons of paper in large and small factories from many different raw materials. Before the war, both German and Japanese interests had applied for concessions to manufacture paper in Ecuador.

It is possible that industrialists of the United States have underestimated the purchasing power of the people in these west coast countries. The people (excluding the Indians) dress as well as the people in New York or Los Angeles. Costume jewelry, cosmetics, and other luxury items are on sale at most stores, the same as in the United States, and these items sell for two to five times as much as in the United States. Likewise, the large number of automobiles in Quito and Guayaquil belies the inability of the populace to purchase things they desire. There can be no doubt that living standards in these countries are going up rapidly and, with the advent of a few large industries and better means of transportation, the desire for all modern conveniences and commodities will be greatly accelerated.

As I have stressed elsewhere in this survey, the success of any paper products industry in Ecuador will be directly proportional to the extent to which the management realizes the necessity for research to develop diversified manufacturing. The country is immensely wealthy in natural resources and in conditions favorable to low-cost production of commodities produced from these raw materials. However, the field is virgin and very little is known about the industrial application of many of the raw materials available.

It is not feasible to remove from the forests one type of tree for the production of a single commodity. The districts must be logged off systematically and the various woods used for purposes for which they are found most suitable. There are many species of relatively soft-wooded trees containing different percentages and types of fibers as well as cellulose. After the land has been logged off, the commercial cultivation of desired trees or other plants should be undertaken to take advantage of the rapid rate of growth in the tropics. The following industries are necessarily coöperative in the development: (1) lumbering, with the possible production of plywood and fiberboard or prestwood; (2) paper products of all types; (3) cellulose for artificial fibers, plastics, lacquers, and similar materials.

Besides the above mentioned forest products industries, Ecuador has large deposits of sulphur, high grade iron ore, manganese ore, limestone, magnesite, and other minerals, as well as a plentiful supply of crude oil and potential hydroelectric power. The presence of all of these resources indicates the future development of mining and a heavy chemical industry perhaps of considerable magnitude. Although significant deposits of many minerals have been found in Ecuador and undoubtedly many regions are rich in minerals, it is well to point out that a large portion of the country is covered by ancient lava flows which effectively conceal the mineral wealth. Also, that portion which is not covered by lava is usually heavily forested so that the location of minerals awaits the coming of roads and the removal of the forests. It is doubtful that there is any other district of comparable size which has the rich resources and industrial possibilities existing in Ecuador and particularly in the Province of Esmeraldas.

Reasons for Locating a Forest Industry in Ecuador

Here, I shall consider briefly the industrial possibilities of the west coast of South America, that is, the countries of Chile, Peru, Ecuador, and Colombia. In this regard, an American technician has said:

"Chile has extensive forests similar to those of the west coast of the United States, however, the most accessible timber has already been exploited in the best localities in southern Chile. As in the United States, the commercial varieties of timber suitable for pulpwood are relatively slow growing in contrast to the rate of growth in the tropics in Chile. There are several small pulp mills which supply the local demand.

"Peru has very little large scale possibility in this industry due to the fact that its entire coast line is desert and the only timber available is in the high mountains or in the Oriente, both of which are quite inaccessible.

"Colombia has good raw materials for an industry of this type; however, it lacks several essential features which are present in Ecuador. The coast line of Colombia is extremely rugged and there are very few streams of such a nature that logs can be transported economically to a centrally located factory. Also in Colombia there is no deep water port which is located immediately adjacent to a supply of raw material so that a big export business would be handicapped."

In summary Ecuador offers the following advantages to forest products industries:

1. Except Brazil and Chile, the countries of South America either produce no paper, or only a quantity sufficient for their own use, and thus constitute a large market for paper products.

2. Ecuador is paper conscious now as never before. Paper of all kinds has always been expensive in the Republic, but now there is a great shortage and prices are three to four times higher than normally.

3. In the tropical region of Ecuador there are fast growing plants and trees which may be used for their fiber and cellulose thus releasing slow growing northern timber for other uses.

4. There exists in Ecuador an unusual combination of rich natural resources readily accessible by a magnificient seaport and large rivers which combine to make an ideal factory location near the ocean.

5. Because Ecuador needs a paper mill so much, the government will grant unusual concessions and privileges to industrialists. These include freedom from taxation and cancellation of import duties on industrial equipment for a specified period of years.

6. Public lands may be had free by concession and private land may be purchased at very low prices.

7. Raw material for paper and cellulose manufacture is cheap and plentiful as well as readily accessible.

8. Labor is very cheap in Ecuador.

9. Ecuador can produce large quantities of wood, pulp and other products for export.

10. The United States needs greater quantities of wood for its numerous industries and the new ones being created continually. Thus, Ecuador would have a great and permanently secured market.

Areas Suitable for Immediate Exploitation

As has been pointed out previously, Ecuador is divided into three natural regions: the Oriente, the Inter-Andean, and the Occidente regions. Of these three regions, the Oriente probably has the greatest and most extensive supply of raw materials; however, because of its inaccessibility, its exploitation at present is impractical. The external slope of the Andean region has a very meager supply of raw materials and also is relatively inaccessible. This leaves us with only the Coast portion of the Occidente region to consider.

In the southern part of the Coast region, forest resources are not extensive enough for large scale exploitation. There are extensive forests of fine woods at relatively high altitudes on the western slope of the Cordillera but these forests are very difficult to exploit because of the rugged nature of the terrain. The mountains are so steep that it is difficult, if not impossible, to construct roads suitable for heavy hauling. It is true that in this mountainous region there is a higher

percentage of soft woods than nearer the coast, but the topographical and climatological difficulties are nearly insurmountable. In the first place, these high mountains serve as the condensation points for the heavy equatorial rains. These rains produce innumerable landslides such as are responsible for the enormous maintenance cost of the Guayaquil-Quito railway. Any road which is not properly surfaced becomes impassable mud for ten months of the year. It is quite impossible to imagine huge ten- to twenty-ton trucks operating under such conditions with the steepest of grades, sharp bends, and terrific precipices. It is true that a limited amount of this rich timber can probably be taken out by log chutes and flumes such as have been used in the Pacific Northwest part of the United States for many years, but all such things are very expensive and in this case unnecessary because there are regions which can be more easily exploited.

There are five locations in Ecuador in which a paper, cellulose and a large lumber industry may be feasible: (See map and "The Forests" section of this paper.)

1. At least 75 per cent of the Province of Esmeraldas or approximately 11,000 square kilometers. Some clearings for farming have been made along the Esmeraldas River and along the coast and the streams, but a large volume of forest resources remains in this province.

2. The eastern one-third of Manabí Province, an area of 8,000 square kilometers.

3. Forty per cent of the Province of El Oro, an area of approximately 3,000 square kilometers.

4. One quarter of Guayas Province, or 5,000 square kilometers.

5. The western two-thirds of the Province of Pichincha, which drains north through the Esmeraldas and south through the Guayas river basin. This area is approximately 5,000 square kilometers.

Of these five sections, Esmeraldas is probably the one that has the most advantages for immediate forest exploitation.

For these reasons, and because it is the one nearest to the Panama Canal, I shall describe the Province of Esmeraldas.*

The Forests of Esmeraldas Province

The forest of Esmeraldas Province may be divided in five areas of exploitation: (1) the Santiago-Cayapas river system; (2) Esmeraldas River; (3) Atacames; (4) Galera and Tortuga; and (5) Muisne.

The Areas of the Santiago-Cayapas River System. In the northwest corner of Ecuador, there is a group of islands and estuaries of the ocean which form the mouth of the Santiago-Cayapas river system and extend north to the Mataje River which forms the boundary with Colombia. The Santiago and Cayapas Rivers combine before entering the bay. The silt from this river system is deposited at the southern end of the series of bays, particularly in the bay of Limones, so that near the village of San Lorenzo the estuaries are clear and deep. It is possible for large steamships (5,000 to 10,000 tons) to enter the canal of Bolivar and anchor at a dock at San Lorenzo. Because of the deep, clear water and the fact that the ground of San Lorenzo is high and rocky, this place has excellent possibilities as a deep sea port.

The entire region drained by this river system is almost unexploited. There are no roads, practically no trails, and no cities except the tiny negro villages of Limones, Borbón, Maldonado, and Concepción. Communication is carried on entirely by small launches and dugout canoes. Most of the

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*I have previously published the following works on the Province of Esmeraldas: "Vegetación y Riqueza Forestal de la Provincia de Esmeraldas", *Maderil* (Buenos Aires, Argentina), February and March 1942; "Maderas Más Conocidas en la Provincia de Esmeraldas", *Maderil* Nos. 168, 169, May, June, and July 1942. These are also reproduced in the book, "Nuevas Contribuciones al Conocimiento de la Provincia de Esmeraldas", Quito, 1944.

I have also presented a report on the Economic Importance of Forest Exploitation in the Province of Esmeraldas to the management of the Ecuadorian Development Corporation, June 1945.—M. A. S.

inhabitants are negroes who eke out a miserable existence by selling bananas, coconuts, tagua nuts, balsa and some other logs. Further up the rivers are several tribes of Indians who live about the same as the negroes. At present, there are three small sawmills operating on balsa in this district. One of these is at Limones and the other two are at Borbón. The sawmill located at Limones is operated by a naturalized Italian by the name of Bruno. Another, larger mill (in good condition) is located at Palma and is owned by an Italian by the name of Yannuzzelli. This mill is on the blacklist and therefore is not in operation at present. The Italian mills have been in operation for some thirty years, but owing to the vast extent of this river system, they have removed only an insignificant portion of the available timber. The supply of balsa wood is inexhaustible because it replenishes itself in four to five years.

This district seems to have great possibilities for exploitation because it is practically virgin territory, and the rivers are very large and not too swift for navigation. Boats of more than 1,000 tons can easily go up to Borbón and much farther up the Cayapas. The lower parts of these rivers are over 100 yards wide and 20 to 30 feet deep. Transportation by small launch is feasible for a considerable distance, until rapids are encountered, and then it is necessary to transfer to dugout canoes propelled by skilled negroes. These canoes can be poled and paddled practically up to the base of the mountains. This entire region is virtually a beautiful tropical garden in which all manner of plants grow luxuriantly. The rainfall is very heavy—about 80 to 100 inches a year. The rains are very considerate, however, in that they usually fall late in the afternoon and at night so that they interfere very little with work or pleasure. The climate is very pleasant and not excessively humid. The wettest part of the year is from January to June although rains may occur at any time. The rivers are clear and free of sediment down nearly as far as Borbón except for a short time after heavy rains. The soil of the lower portion of this district is a reddish clay type with an igneous rock base. The forest floor is

covered deeply with humus and decaying vegetable matter, so much so that many of the springs are stained brown by the tannins and humic acids of decaying vegetation.

The trees of the low districts around the salt water estuaries are entirely Mangrove, the dark red timber of which is used for marine purposes because of its exceptional hardness and durability. Further up the streams we find the following species of commercially valuable woods:*

1. Cascol	*(Libidibia corymbosa)*
2. Marequensis or Quende	*(Brosimum* sp. ?)
3. Guayacán de Costa	*(Tabebuia chrysantha* ?)
4. Ebano	*(Zizyphus thyrsiflora)*
5. Cascarillo	*(Cinchona* sp. ?)
6. Sándalo or Bálsamo	*(Myroxylon balsamum)*
7. Nato	*(Mora megistosperma)*
8. Moral Fino	*(Chlorophora tinctoria)*
9. Moral Bobo	*(Sideroxylon* sp.)
10. Colorado or Pay-pay	*(Pouteria* sp.)
11. Caoba	*(Nectandra caucana)*
12. Guayacán Pechiche del Norte	*(Minquartia guianensis)*
13. Guión	*(Pseudolmedia eggersii)*
14. Manzano	(?)
15. Roble	*(Terminalia amazonia)*
16. Bejuquillo	(?)
17. Dormilón	*(Pseudovouapa stenosiphon)*
18. Amarillo Lagarto Obscuro	*(Centrolobium ochroxylon)*
19. Amarillo Lagarto Claro	*(Centrolobium ochroxylon,* var.)
20. Amarillo Tainde	*(Nectandra rectinervia* ?)
21. Tillo	(?)
22. Manglillo	(Rubiaceae)
23. Jagua	*(Genipa caruto)*
24. Seca de Castilla	*(Geoffroea spinosa)*
25. Seca	(Leguminosae)
26. Guachapelí	*(Pseudosamanea guachapele)*
27. Jigua Palealte	(Lauraceae: *Nectandra acutifolia* ?)
28. Tangaré or Figueroa	*(Carapa guianensis)*
29. Lengua de Vaca	(?)
30. Laurel Prieto	*(Cordia alliodora* ?)
31. Laurel Injerto	*(Cordia alliodora* ?)

*This list was taken from the book "Nuevas Contribuciones al Conocimiento de La Provincia de Esmeraldas", 1944. The order of that check list has been made from the harder wood (Cascol) to the softer and lighter (Balsa).

32. Caracol	(Anacardiaceae)
33. Cedro Colorado or Cedro Rosado	(*Nectandra* sp. and *Ocotea caracasana*)
34. Cedro Pardo	(*Nectandra* sp. or *Cedrela rosei*)
35. Calade	(?)
36. Calade Manchado	(?)
37. María	(*Calophyllum lucidum*)
38. Sande	(*Brosimum utile*)
39. Machare	(Clusiaceae)
40. Cedro Pálido	(*Cedrela* sp.)
41. Sajo	(*Cespedesia* sp.)
42. Guadaripo	(*Nectandra lucida* ?)
43. Chimbusa	(?)
44. Jigua Nasde	(Lauraceae)
45. Chalviande	(*Virola* sp. ?)
46. Chalviande Rayado	(?)
47. Jigua Mongado	(?)
48. Higuerón	(*Ficus* sp. ?)
49. Tachuelo	(?)
50. Peine de Mono or Mono	(*Apeiba aspera*)
51. Zapote Arizco	(*Casimiroa* ?)
52. Balsa Chillalde	(?)
53. Balsa Macho	(*Ochroma* sp. ?)
54. Balsa Hembra	(*Ochroma lagopus*)

The composition of the forest in this region is by no means uniform. Variations in soil composition, moisture, location, and altitude all effect the ultimate composition of the native forest. Usually the trees are not as large as the firs and cedars of the U. S. Pacific Northwest. The average size log is from 12 to 24 inches in diameter and from 15 to 25 feet in length. The density of the timber throughout the entire district varies greatly depending on the number of palms and other smaller plants or trees. There are between five and twenty trees per acre having a diameter greater than 12 inches at the base, and containing two or three logs per tree. This is the average density of the timber over a large area. It must be realized that the entire area is heavily covered with vegetation and that, in those districts where there are few timber trees, the average density of vegetation is the same as in those districts which contain more actual timber. The difference is caused by thickets of bamboo, palms, etc., which are not now used commercially but which in the future may be valuable.

No. 3. Foot-hills of the western Cordillera of Ecuador covered with forests rich in tropical species. All kinds of woods, from the lightest (Balsa) to the hardest and heaviest, are found here.

No. 4. A river in the Province of Esmeraldas with great forests at its banks. The rivers offer the best means of transportation in the lowlands of Ecuador.

In considering the exploitation of the forests of Ecuador, it is well to point out that they are typical tropical forests and are in no way similar to the forests of the United States which contain more or less pure stands of one type of timber. In this country the trees are approximately one-third of the hard wooded variety, one-third with soft woods, and one-third intermediate. A further consideration is the fact that there are also present other types of trees and plants, frequently in large quantities, which probably have as yet undeveloped commercial possibilities. I refer particularly to the large number of palms and bamboo. Some of the palm trees reach large size and have an exceedingly hard wood, such as the Chonta palm, the wood of which is as hard as ivory. Other palms are much softer and are very fibrous, suggesting that their pulp may be suitable for paper or fiber board. Bamboo occurs in dense thickets and grows very rapidly. Because of its strength and tubular structure, it has an infinite number of uses for construction in the tropics. Bamboo has been tested and used for production of cellulose and paper. The scientific exploitation of forest resources such as are present in the northern part of Esmeraldas Province must provide for a really good laboratory and technicians to study and develop the most efficient uses for and methods of utilization of the infinite variety of plant material available. Another point to consider is the fact that in these tropical regions plant growth is much more rapid than we of the United States can possibly realize. For this reason, it would seem most feasible to systematically remove the native forest growth and use this material for whatever purpose it is most suited and then to plant this logged-off land into fast growing species for some particular use. For instance, balsa grows at a phenomenal rate; in six months from seed a balsa tree will be 25 feet high and 5 inches in diameter, and in three to five years it will be over 2 feet in diameter at the base. There are other trees and fibrous plants which grow correspondingly fast.

Technically, nothing is known of many of these plants. Their wood is sometimes very fibrous and contains up to 60

per cent cellulose, which suggests that these rapid-growing plants should be propagated here in the tropics and used for the production of paper and cellulose which are at present, for the most part, produced from relatively slow-growing coniferous trees of the temperate zone. The importance of this point can hardly be overemphasized. These fast-growing tropical plants can make available large quantities of valuable timber in the temperate zone for construction purposes, and at the same time constitute a very low cost source of valuable cellulose and fiber. Another industry which may have great importance in the future development of these tropical forests is the production of fine plywoods using the new resin and plastic type bonding agents. Because of the many beautiful woods which are available here, it should be possible to produce exceptionally beautiful plywoods. Plywoods should have a very important place in the construction of permanent homes in the tropics because they can be made immune to the ravages of termites and resistant to rot which, in these humid atmospheres, take a prodigious toll of the woods used in house construction at present.

The Areas of Esmeraldas System. The entire region drained by the Esmeraldas River is covered with dense forests which, for the most part, have been exploited only near the main river itself. The greatest objection to this region, from the industrial point of view is the transportation problem. The Esmeraldas River probably flows as much water as the Guayas River but it is very swift and large boats, or even launches, cannot ascend it. The terrain through which the tributaries of this river pass is very hilly; this complicates the problem of logging a short distance back from the stream. The most logical location for a mill would seem to be either at the confluence of the Rio Guaillabamba and the Rio Quinindé which compose the Esmeraldas River, or at the confluence of the Rio Blanco and the Quinindé. This makes available for exploitation the tremendous forest reserves of the territory drained by these rivers. However, it still remains that it would be necessary to construct a road

from Esmeraldas to the mill. There is no possibility of a port at Esmeraldas and ships must anchor about two miles out from the mouth of the river.

Atacames. Atacames is a large and rich province of Esmeraldas. In this area are included the old "Ecuador Land Company" agricultural lands, pastures and forests which are now abandoned.

Some time ago, the Ecuador Land Company exploited part of the River Súa's forests. In general, however, all of the Atacames and Súa section is totally covered with forests, with the exception of small parcels of land along the coast which are used for agriculture and cattle raising.

There would be numerous advantages for a timber industry established at Atacames. The belts of forests are very wide, and are close to the coast. There is a big and natural harbor that can be used as an exportation port as well as to anchor boats and steamships. This harbor is very well protected against winds.

In the Súa harbor there are buildings which were constructed by the Ecuador Land Company. These buildings could be used for employees' homes. For rapid communication with the city of Esmeraldas that lies at only 30 kilometers up the coast, it would be a simple matter to build a good highway for the use of trucks and cars. Construction of an airport would not be difficult at either Súa or Atacames, affording air communication with Quito and Guayaquil, the two most important cities of Ecuador.

The Galera and Toruga Areas. All along the southern coast of the Esmeraldas Province lie large and rich forests that produce all kinds of woods, but especially hard and heavy types. No commercial exploitation of this area has been made as yet.

The local exploitation of these forests could begin in Galera or in Tortuga. The boards, large timbers, poles, beams, etc., could be transported to Súa for better preparation for export. It would be necessary to build highways or

roads along the coast and small roads from the forests to the sawmill or to the nearest principal highway.

The mountains and coast of Atacames to Galera and Punta Tortuga are very rich in forest products and principally in woods; of the latter, the most used are: Guayacán, Amarillo Lagarto (three kinds), Pechiche, Guachapelí, Caóbano, Bálsamo (Sándalo), and Seca.

The first class woods are: Cascarillo, Bejuquillo, Calade (also called Cedro), Jigua, Asta, Tachuelo, Tillo, Membrillo, Colorado (or Pay-pay), Muchina (called Fernán-sánchez in Guayaquil), Clavo (or Júpano in Manabí).

For the woods used to build canoes and rough canoes, we can mention the following: Higuerón Polo, Higuerón de Venado, Matapalo, Ceibo de Montaña (not Ceibo de Lana), Bototillo, and Ovo de Monte (called Ovo Cimarrón also).

From the stems of the small cultivated tree "Mate" (*Crescentia cujete* L.) is obtained a white, flexible, and lightweight wood which is used for the manufacture of cylindrical boxes. The fruits of this tree are called "Bototos" or "Pilches" and are much used as containers for water, juices, syrup, and other liquids.

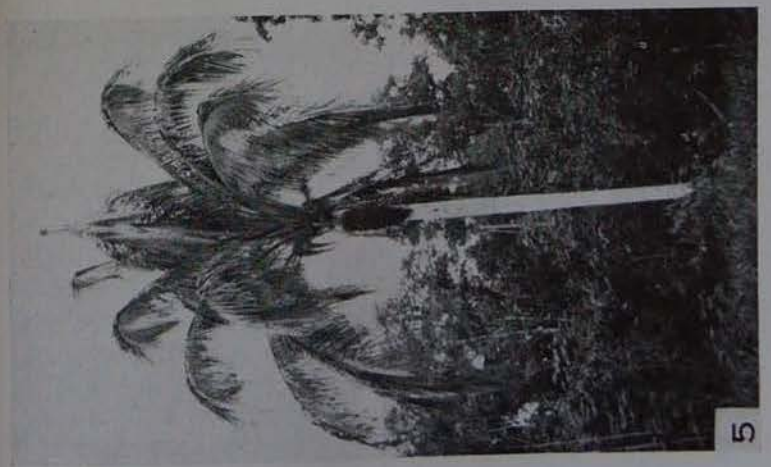
The Muisne Areas. These areas are situated in the southern part of Esmeraldas Province with the Province of Manabí as a boundary. They are rich in forest timbers, principally hard woods and Mangroves along the coasts and the estuary of the Muisne River.

A sawmill could be established within the area and the woods exported directly from Muisne. The abundance of labor is a distinct advantage for forest exploitation in this area.

Location of a Mill in the Esmeraldas Province

Careful inspection of the map of the Province of Esmeraldas will show clearly how the rivers of the Santiago-Cayapas Rivers district combine at the village of Borbón. This is undoubtedly the ideal site for a paper mill and related industries. The valuable timber is all located within a short

No. 6. Bamboo or Guadua (*Guadua latifolia* Kunth) is used for the construction of houses, fences, ladders and baskets.



No. 5. A Royal Palm or Palma Real (*Cocos butyracea* L.f.). The oil obtained from the seeds is used in the manufacture of soap.

distance of some one of the tributaries of the Cayapas or Santiago Rivers and even the small tributaries flow sufficient water to float the logs to the larger streams and thence to the mill. The geography of the upland country is such that there are no large mountains or any excessively rugged terrain between the rivers which could impede mechanized logging. For the most part, logging operations can be conducted in the fashion to which we are accustomed in the U. S. Pacific Northwest, with tropical modifications. The density of many of the hardwoods is such that they will not float so that it is customary practice to tie such logs between two small balsa logs. Because balsa and vines are always nearby, this is not a problem. With the mill located at Borbón, the finished paper, lumber, cellulose, or other products can be loaded directly onto small ocean going vessels for transport to nearby countries or can be taken by small boat up the Santiago-Bogota Rivers to the proposed road or to its terminus at San Lorenzo and thence to Quito and other cities of the Inter-Andean Valleys. While the tides back the water up the river somewhat farther than Borbón, the flow of the rivers is so great that salt water can be clarified by filtration, or a plentiful supply of clear water is readily available from dug wells. The ground in the vicinity of Borbón is high so that good sanitation for company employees and the plant itself is easily provided. After the forest has been cleared for some distance back around the factory site, vital crops and cattle can easily be raised on the land. Because of the ready accessibility of this location by means of canoes and launches, food products from all over the district are brought in by the natives. All types of tropical fruits and vegetables grow luxuriantly here and, when the road to Ibarra is completed, all the temperate zone foods, such as carrots, beans, lettuce, cabbage, apples, pears, etc., will be available. The climate at Borbón, although tropical, is delightful. It never gets too hot and it never gets chilly. The recreational facilities afforded by this district are remarkable; there is every type of boating, fishing, hunting, swimming, and sightseeing. When a change from the tropical climate is desired, it is

only a few minutes by airplane to the high Inter-Andean temperate zone or to the cool, arid region near Salinas with the world's finest beach. Future roads will make extraordinary examples of nature's beauty and grandeur accessible.

Land for a factory site in or near Borbón and on the river can be purchased very cheaply ($1 to $2 per acre). Back from the river all of the land belongs to the State and is available by concession.

Oil is plentiful in Ecuador and can be brought directly to Borbón by barge from the nearby oil fields of the Anglo-Ecuadorian Oil Company of the International Petroleum Company. Practically any quantity of hydro-electric power can be developed in the upper reaches of the streams which flow into this district.

In opening up this district, a certain amount of exploration and survey work will be required. Permanent camps or supply depots should be located at the most accessible strategic locations up the rivers from which it will be no great distance to even the remotest portions of the district. While a dugout canoe is fairly satisfactory method of travel up the smaller streams, it is believed that travel can be expedited by a light flat-bottomed scow propelled by an airplane motor, so that rapids and rocky stretches can be negotiated safely.

Labor and Tools in Ecuador

There are enough men or workers in Ecuador for the exploitation of the forests. The best source of labor is the highland "Chagra" (rustic) or "Mestizo" (half-breed). They are extensively used in textile mills, furniture factories, rock work and house construction. That these people have long been skilled agrarians is evidenced by the way the Inter-Andean mountain slopes are covered with small farms, elaborate terraces, irrigation systems, and mud fences. The Indians of this Inter-Andean region have been exploited for hundreds of years, first by the Incas for whom they did most of the hard work, farming and road construction; then by the Spanish conquistadores, and more recently by the

wealthy land owners. Even under their present more or less emancipated conditions they rarely receive more than fifty to one hundred sucres per month (one sucre = .073 U. S. dollars). However, it is also true that the majority of Indians are hard workers and desire to improve their lot in life by way of a steady job and education for their children.

As may be expected, these highland Indians are as susceptible to tropical diseases as the white man from the United States, principally to the paludismo or "malaria", which exists in the low lands of Ecuador, especially in the Occidente Region. However, with quinine and a little more care in their way of living, the percentage of people affected with paludismo can be reduced greatly.

The working people of the Sierra, the Chagras and the Indians, like to go away from their homes to the tropics to work because of the better payment and better treatment they receive; as they have their food furnished where they work, they can save their money and come back to their homes five or six months later, give Catholic parties, buy small farms, build houses, and so forth. These people like to work during the "verano" (dry months, from June to December), but workers could be found for the "invierno" (rainy months, from December to May) by paying higher salaries and giving better treatment.

As life in Ecuador is a little more expensive now, I believe that for a salary of ten sucres per day (= $0.73) and the food supplied by the company, costing about two more sucres ($0.15), many workers could be found, and the total salary per day would be $0.88.

There would be no difficulty in getting men to work for the forest operations, and with better wages the workmen could be induced to work in the sawmills. An experienced sawmill worker might earn as much as $1.00 to $1.50 per day.

As for the sawmill buildings, tools, and necessary machinery for forest exploitation in Ecuador—there are none. It is necessary to bring all equipment from the United States: a large electric motor or diesel engine sawmill and two small

mills; the saws must be made especially for tropical woods which are generally harder and heavier. It would also be necessary to introduce a quantity of saws, axes, machetes, and all other tools necessary for the operation.

The big sawmill building should be located in San Lorenzo or in Borbón, and one of the small ones in Súa or Galera, and the other small one in Muisne. In this way great quantities of wood of every kind would be exploited. Small electric light plants would be necessary and could be established.

Alphabetical Check List of the Principal Forest Species of Ecuador

This list is not complete and is considered temporary; the botanical names of some of the trees are unknown or in doubt. I hope to complete this list when collections are identified or classified in the Herbariums of the United States where I have sent them, principally to the Chicago Natural History Museum.

Not only wood species are mentioned but also other plants that are well known for their common names and local uses; for example: the "Carrizos" *(Arundo Donax)* the canes of which are used in the building of ceilings, roofs, and walls of houses, and also used to make baskets; the "Chaguarqueros" (floral axes of *Agave americana* and *Fourcroya Siseliana)* which are used for roofs, the bulk of ceilings, etc.; the "Bijao" *(Calathea* spp.) whose ample leaves are used to cover roofs in the tropics and to make baskets for fruits and to wrap bricks of sugar cane; the "Sigse" *(Cortaderia rudiuscula)* which are used in many places in the center of the Inter-Andean Region as roofs for small houses; the "Paja Blanca" or "Paja de Páramo" *(Stipa, Festuca,* etc.), used as roofs for the huts in the páramo.

Also mentioned are some exotic species, because they are now established and cultivated as wood species, such as the Eucaliptos *(Eucalyptus globulus* Labill), the Pines *(Pinus* spp.), and the Teak tree *(Tectona grandis* L.f.), lately introduced in the Eucadorian coast regions.

COMMON NAME	BOTANICAL NAME	HABITAT AND AREA OF DISTRIBUTION*				ALTITUDE RANGE METERS
		WESTERN REGION	CENTRAL REGION		EASTERN REGION	
			W. C.	I. V. E. C.		
Agave, Chaguarquero	*Agave americana*			X		1500-2800
Ajo	*Gallesia* sp.	X			?	800-1800
Albarco	*Cariniana pyriformis*	X				800-1600
Alcanfor	*Nectandra rectinervia*	X			?	1600-2800
Algarrobo de la Costa	*Acacia* sp.	X				0-200
Algarrobo de la Costa	*Prosopis Chilensis*	X				0-600
Algarroba de la Costa	Neltuma sp., N. juliflora	X				0-200
Algarroba de la Sierra	Acacia pellacantha			X		1700-2200
Algodon de Montaña	*Bauhinia* ?		X		?	800-1600
Alicúan	Euphorbiaceae	X				800-2200
Aliso	*Alnus* spp.		X	X		2000-2800
Amarillo	*Centrolobium ochroxylon*	X			?	50-1200
Amarillo de Guayaquil	*Centrolobium ochroxylon*	X				50-1200
Amarillo Tainde	*Nectandra rectinervia* ?	X				50-1500
Anime	*Protium* sp.				X	800-1500
Arbol del Pan	*Artocarpus communis*	X				30-300

Legend: W.C. = Western Cordillera
I.V. = Inter-Andean Valley
E.C. = Eastern Cordillera
? = In doubt or unknown
X = Present

*Ecuador is divided in three Natural Regions: Western Region (Occidente), Central or Inter-Andean Region, and Eastern Region (Oriente). The Central Region is subdivided into other environments ("Medios"): the "Páramo" of the Western and Eastern Cordillera, the long Inter-Andean Valley, the external slopes of these two Cordilleras which go through Ecuador from north to south; the Inter-Andean Valley lies between the two Cordilleras.

COMMON NAME	BOTANICAL NAME	HABITAT AND AREA OF DISTRIBUTION*					ALTITUDE RANGE METERS
		WESTERN REGION	CENTRAL REGION			EASTERN REGION	
			W. C.	I. V.	E. C.		
Arbol del Teak	*Tectona grandis*	X					50-800
Arete	*Heisteria Spruceana*	X					1200-1600
Arrayán	*Eugenia* spp.		X		X		1800-2800
Balsa	*Ochroma lagopus*	X				?	50-800
Balsa Blanca	*Heliocarpus popayanensis*	X					200-1200
Bálsamo, Sándalo	*Myroxylon balsamum, M. peruíferum*	X					50-800
Bambulo	*Pterocarpus* ?	X					
Bantano	Caesalpiniaceae	X					50-1000
Barba de palo, Salvaje	*Tillandsia usneoides*			X			1600-2600
Barbasco de la Costa, B. de Agua Salada	*Jacquinia armillaris, J. Sprucei*	X					5-100
Bejuco de Montaña	Araceae	X				X	400-1600
Beldaco	*Bombax Millei*	X					10-600
Bella María	*Calophyllum lucidum*	X					200-800
Bijao	*Calathea lutea*, and other spp.	X				X	50-1800
Bombón	*Erythrina* sp.	X					200-800
Bototillo	*Cochlospermum vitifolium*	X				?	50-600
Cabo de Hacha	?	X					300-1200
Cabuyo Blanco	*Fourcroya Siseliana*			X			800-2800
Cabuyo Negro	*Agave americana*			X			1700-3000
Cacao Blanco	*Theobroma bicolor*	X					50-600
Cacao cultivado	*Theobroma cacao*	X					50-200
Cacao de Monte	*Theobroma Mariae*	X					50-600
Cacho de Venado	?	X	X				200-1600
Cactus	*Cereus, Opuntia*, etc.	X		X			30-3000

COMMON NAME	BOTANICAL NAME	HABITAT AND AREA OF DISTRIBUTION*					ALTITUDE RANGE METERS
		WESTERN REGION	CENTRAL REGION			EASTERN REGION	
			W. C.	I. V.	E. C.		
Cadi, Tagua	*Phytelephas macrocarpa, P. microcarpa*	X				X	10-1000
Cafecillo	?	X					800-1800
Cafecillo de monte	?	X					800-1800
Caimitillo	Sapotaceae ?	X				X	20-1200
Caimito	Sapotaceae ?	X					20-500
Calade, C. manchado	?	X	X				100-1600
Camacho	Araceae	X					800-1800
Canalón	?	X					50-400
Candángulo	?	X					200-1200
Candelo	*Ampelocera* sp.	X					400-1200
Canelo	*Drimys Winteri* ?	X	X		X	X	1800-2800
Canelón	Lauraceae		X		X	X	800-1800
Caña Brava	*Gynerium saccharoides*	X					100-1200
Caña Fistula	*Cassia fistula*	X					50-200
Caoba	*Nectandra caucana*	X					50-500
Caoba	*Platymiscium pinnatum*	X					10-400
Capote	*Gynoxys coriaceus*	X					100-600
Capulí	*Billia columbiana*		X				1200-2200
Capulí	*Prunus salicifolius*			X			2000-3000
Cara	Meliaceae ?	X	X				800-1200
Caracol	Anacardiaceae	X					100-800
Caracolí	*Anacardium excelsum*	X					10-200
Caracolillo	?	X					100-600
Caraño	?	X					200-600

COMMON NAME	BOTANICAL NAME	HABITAT AND AREA OF DISTRIBUTION*				ALTITUDE RANGE METERS
		WESTERN REGION	CENTRAL REGION		EASTERN REGION	
			W. C.	I. V. E. C.		
Carrá	*Huberodendron* sp.	X				200-1000
Carrizo	*Arundo Donax, A. nitida*			X		1700-2600
Carboncillo	?	X				100-600
Carbonero	?	X				200-800
Cargabola	?	X				100-600
Cascarilla	*Cinchona* spp. (8 dif.)	X	X	X	X	600-3000
Cascarillo	*Ladenbergia* spp.	X	X	X	X	800-2600
Cascol Claro, C. Negro	*Libidibia corymbosa*	X				200-800
Casha-pujín	*Crataegus quitensis*		X	X		2800-3600
Cativo	*Prioria copaifera* ?	X				200-800
Caucho Blanco	*Sapium verum*	X	X	X	X	1000-1800
Caucho Negro	*Castilla elastica*	X			X	50-800
Cauje	*Pouteria cainnito* ?	X				50-600
Cedrillo	*Cedrela* sp.	X	X	X	X	800-2600
Cedro	*Cedrela rosei*		X			1200-2000
Cedro Colorado	*Ocotea caracasana*	X	X			200-1200
Cedro de Castilla	*Cedrela odorata*	X	X	X	X	200-1200
Ceiba, Ceibo	*Ceiba* sp.	X				50-300
Ceibo de Manabí, Ceibo de El Oro	*Ceiba pentandra*	X				10-200
Cereza de Montaña	?	X	X			600-1200
Cerezo	*Malpighia* ?	X				100-500
Chachacoma	*Escallonia myrtilloides*		X	X		3000-3400
Chachajillo	?	X				200-600
Chachajo	?	X				100-600

COMMON NAME	BOTANICAL NAME	HABITAT AND AREA OF DISTRIBUTION*				ALTITUDE RANGE METERS
		WESTERN REGION	CENTRAL REGION		EASTERN REGION	
			W. C.	I. V. E. C.		
Chaguarquero Blanco	*Fourcroya Siseliana*			X		1500-2500
Chaguarquero Negro	*Agave americana*			X		1700-3000
Chalviande	*Virola* sp.	X				200-600
Chamul	*Humiria floribunda* ?	X				100-600
Chapra	?	X				200-600
Chiche	*Machaerium Millei*	X				200-800
Chigmay	?		X	X		2000-2800
Chilca	*Baccharis polyantha*			X		1800-3000
Chillalde, Chillarde	*Belotia* sp.	X				50-400
Chimbusa	?	X				50-400
Chipero	*Pseudovouapa stenosiphon*	X				5-200
Chirimoya	*Annona cherimolia*			X		1800-2400
Chivo-caspi	*Duranta triacantha*			X		1800-2800
Chonta	*Astrocaryum* spp.	X			X	50-800
Chonta-ruru	*Guilielma speciosa*	X			X	50-600
Ciprés	*Cupressus sempervirens*, other introduced spp.			X		1800-3000
Ciruelo	*Spondias purpurea, S. lutea*	X				30-200
Clavelín	*Brownea* sp.	X				
Clavo, Júpano	?	X				50-400
Clayillo	?	X				
Cocotero	*Cocos nucifera*	X				0-300
Colca	*Miconia* spp.		X	X		1800-2800
Colorado	*Pouteria* sp.	X				100-500
Colorado	*Lucuma obovata*	X			X	800-1800

COMMON NAME	BOTANICAL NAME	HABITAT AND AREA OF DISTRIBUTION*					ALTITUDE RANGE METERS
		WESTERN REGION	CENTRAL REGION			EASTERN REGION	
			W. C.	I. V.	E. C.		
Coquito	*Erythroxylon glaucum*	X					200-1000
Coquito	*Eugenia* sp.		X				1800-2400
Copal	*Hymenaea courbaril*	X				X	200-800
Cordoncillo	*Piper* spp.		X		X		1800-2800
Coronillo	?	X					
Cuángare	*Dialyanthera gordoniifolia*	X					
Cucharillo	?		X				
Cuiba	*Bumelia* sp.	X					10-200
Cuna-cuna	*Trema* sp.	X					
Damajagua	*Inophloeum armatum*	X					200-400
Dedo	?	X					
Dormilón	*Pseudovouapa stenosiphon*	X					100-400
Ebano	*Zizyphus thyrsiflora*	X					20-200
Encinillo, Guasipata	*Weinmannia descendens*				X		1800-2800
Endeo	?	X	X				
Eucalipto	*Eucalyptus globulus, E.* spp.	X		X			1800-3300
Egg-palm	*Guilielma speciosa*	X					50-600
Faique	Mimosoideae	X					
Fernán-sánchez	*Triplaris guayaquilensis*	X					200-800
Fernán-sánchez	*Triplaris Poeppigiana* ?	X					200-800
Figueroa, Tangaré	*Carapa guianensis*	X					30-300
Flor de Mayo	Rubiaceae	X					
Guabalón	Sapindaceae	X				?	
Guabas (various kinds)	*Inga* spp.	X		X		X	50-2600
Guabesay	*Podocarpus oleifolia*				X		2000-2800

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		WESTERN REGION	CENTRAL REGION			EASTERN REGION	
			W. C.	I. V.	E. C.		
Guabilla	*Inga* sp.	X				X	50-2000
Guachapelí	*Pseudosamanea, Lysiloma guachapele*	X					5-300
Guadaripo	*Nectandra lucida* ?	X					50-200
Guadua	*Guadua angustifolia, G. latifolia*	X				X	5-600
Gualpite	?	X					50-400
Guanábana	*Annona muricata*	X		X			50-2200
Guagra Manzana	*Crataegus quitensis*		X		X		2800-3200
Guápala	*Sickingia ecuadorensis*	X	X				200-800
Guarango	*Coulteria tinctoria*			X			1700-2500
Guarango	*Caesalpinia spinosa*			X			1700-2500
Guarapa	?	X					
Guarumo	*Cecropia* spp.		X		X		800-1800
Guarumo de Montaña	*Pourouma* sp.	X	X				
Guasango	?	X					
Guásimo, Guasamo	*Guazuma ulmifolia*	X					10-200
Guasipata	*Weinmannia* sp.		X		X		1800-2800
Guayaba	*Psidium guajava*	X		X			50-2200
Guayacán	*Tabebuia chrysantha*	X					5-800
Guayacán Pechiche	*Minquartia guianensis*	X					5-100
Güilmo	?		X		X		1800-2800
Guión	*Pseudolmedia eggersii*	X					50-400
Guíshca	?		X				
Guitarro	*Erythrina* sp.	X					
Hasta	?	X	X				
Helecho (arborescent)	Various genera	X	X				800-2500

COMMON NAME	BOTANICAL NAME	HABITAT AND AREA OF DISTRIBUTION*					ALTITUDE RANGE METERS
		WESTERN REGION	CENTRAL REGION			EASTERN REGION	
			W. C.	I. V.	E. C.		
Higuerón	*Ficus* spp.	X					200-800
Higuerón	?	X				X	
Hoja Blanca	*Gynoxys Hallii*		X		X		1500-2200
Huaiji	?	X					
Huasca	?	X					400-800
Hueso	?	X					
Huilmo	?		X		X		1600-2800
Inga-rosa	*Lantana velutina*			X			1800-2800
Jaboncillo	*Sapindus saponaria*	X					200-1200
Jagua Dulce, J. de Comer	*Genipa caruto*	X					50-600
Jagua de Lagarto	*Crataevia tapia*	X					200-500
Jaile	?	X					
Jelí	*Conocarpus erecta*	X					sea level
Jigua	*Nectandra* sp. ?	X				?	100-900
Jigua	*Nectandra acutifolia*	X				?	100-1000
Jigua	*Ocotea* sp. ?	X	X			?	100-1000
Jigua Amarilla	Lauraceae	X				?	100-1000
Jigua Chimbusa	Lauraceae	X				?	100-1000
Jigua Guadaripo	Lauraceae	X				?	100-1000
Jigua Nasde	Lauraceae	X				?	100-1000
Jigua Palealte	Lauraceae	X				?	100-1000
Jigua Prieta	Lauraceae	X				?	100-1000
Jobo	*Spondias mombin*	X				?	10-600
Juján	?	X					
Júpano, Clavo	?	X					50-400

COMMON NAME	BOTANICAL NAME	HABITAT AND AREA OF DISTRIBUTION*					ALTITUDE RANGE METERS
		WESTERN REGION	CENTRAL REGION			EASTERN REGION	
			W. C.	I. V.	E. C.		
Laguna	?	X				?	100-1000
Laurel Blanco	?	X					10-1000
Laurel de Costa	*Cordia alliodora*		X				1800-2800
Laurel de Cerro	*Myrsine Sodiroe*	X					20-200
Laurel de Puna	*Cordia* sp. ?	X					100-600
Laurel Macho, L. Negro	*Cordia alliodora*	X	X			X	400-1200
Lechero de Monte	*Centripogon jamesoniana*	X				?	
Lengua de Vaca	?	X				?	
Limoncillo	?	X				?	
Lirio	?	X					
Llaneo	?	X					
Lumo	?	X				?	
Macarey	?	X					
Machare	Clusiaceae	X					50-600
Mādera Negra	*Tabebuia rufescens*	X					sea level
Majagua	*Hibiscus tiliaceus*	X				?	80-800
Majagua	*Inophloeum armatum*	X				?	100-800
Mambla	*Erythrina* sp.	X	X			X	40-800
Mandur	*Clusia* sp.	X					sea level
Mangle Blanco	*Laguncularia racemosa*	X					sea level
Mangle concha	*Rhizophora mangle*	X					sea level
Mangle iguanero, M. negro	*Avicennia nitida*	X					sea level
Mangle injerto, M. rojo	*Rhizophora mangle*	X					sea level
Mangle Jelí	*Conocarpus erecta*	X					sea level
Mangle Pecho de Pava	*Rhizophora mangle*	X					sea level

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		WESTERN REGION	CENTRAL REGION		EASTERN REGION	
			W. C.	I. V. E. C.		
Mangle salado	*Avicennia nitida*	X				sea level
Manglillo	Rubiaceae	X			?	
Manglillo Colorado	*Sickingia* sp.	X			?	
Mango	*Mangifera indica*	X				0-200
Manzanillo	*Hippomane mancinella*	X				0-100
Marañón	*Anacardium excelsum*	X				30-200
Marequende, Quende	*Brosimum* sp. ?	X				50-400
Margarita	?	X				
Maria	*Calophyllum lucidum*	X			?	100-600
Marselo	*Drypetes* sp.	X			?	200-600
Masamorra	?	X				
Mascar	?	X			?	
Matapalo Blanco	*Ficus* spp.	X			X	100-800
Matapalo Colorado	*Coussapoa villosa*	X			?	200-600
Matapes	?	X				
Matasarna	?	X				
Mate, Pilche	*Crescentia cujete*	X			X	20-1000
Membrillo de Monte	*Gustavia pubescens*	X				100-600
Miriti, Palm	*Mauritia* sp.	X			?	100-600
Mocora, Palm	*Astrocaryum spinosum*	X			X	50-500
Molle	*Schinus molle*			X		2000-2600
Monterillo	*Brownea ariza* Benth.	X				200-800
Mora	Melastomaceae	X			?	
Moral Bobo	*Clarisia racemosa*	X			?	100-600
Moral Comido del Mono	*Clarisia racemosa*	X			?	100-600

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		WESTERN REGION	CENTRAL REGION		EASTERN REGION	
			W. C.	I. V. E. C.		
Moral Fino	*Chlorophora tinctoria*	X			?	50-600
Morito	?	X				
Mosquero	?	X			?	
Motilón colorado	*Hieronyma asperifolia*		X	X		2000-3000
Muchichillán	*Trema* sp.	X				200-600
Muchín, Muchina	*Triplaris Poeppigiana*	X			?	50-900
Muchín	*T. guayaquilensis*	X			?	50-900
Muyuyu	*Cordia lutea*	X				sea level
Naranjillo	?	X	X			
Naranjo de Monte	*Aspidosperma* sp.	X			?	50-800
Nato	*Mora megistosperma*	X			?	50-400
Niguito, Sapán Niguito	*Muntingia calabura*	X				10-200
Nogal	*Juglans neotropica*			X X		1800-2800
Ovo	*Spondias lutea, S. purpurea*	X		X		20-1800
Pacarcar	*Peresa sericea*		X	X		2600-3000
Paccha	?		X	X		2500-2800
Paja Blanca	*Stipa* spp., *Festuca* spp.		X	X		3000-4500
Palealte, Jigua	Lauraceae	X			X	200-900
Palma de Cera	*Ceroxylon andicolum*	X				400-800
Palma de Cera	*Copernicia cerifera*			X	X	300-1000
Palma Mulata	*Zamia muricata*	X			?	100-600
Palma Real	*Cocos butyracea*	X	X	?	?	100-800
Palma Toquilla	*Carludovica palmata*	X	X		X	50-400
Palmiche	*Geonoma* sp. ?	X			X	200-400
Palo de Fósforo	?	X	X		?	400-1800

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		WESTERN REGION	CENTRAL REGION			EASTERN REGION	
			W. C.	I. V.	E. C.		
Palo de Leche	Apocynaceae	X				?	200-600
Palo de Leche	*Sapium glandulosum*	X				?	200-600
Palo de Rosa	*Pradosia* sp.	X	X			?	
Palo de Vaca	*Alseis Eggersii*, and *Galactodendron* sp.	X				?	
Palo Espada		X					
Palo Maria	*Calophyllum* sp.	X	X			?	100-600
Palo Prieto	*Erythrina rambrosa*	X				?	20-200
Palo Santo	*Bursera graveolens*	X					10-200
Palo Serrano	?	X	X				
Pambil, Palm	*Euterpe chaunostachys*	X	X				200-800
Pambil, Palm	*Iriartea* sp.	X	X			X	200-1000
Pantza, Quinua	*Polylepis lanuginosa, P.* sp.		X		X		3300-4000
Pasayo	?	X					
Pechiche	*Minquartia guianensis* ?	X					20-300
Pechiche	*Vitex gigantea, V. flavens*	X					20-200
Peine de Mico, P. de Mono	*Apeiba asprea* Aubl.	X	?			?	100-300
Pela caballo	*Lysiloma* sp.	X					10-100
Petaquilla	*Tabernaemontana* sp.	X				?	50-200
Pialde	*Trichilia* sp.	X					20-100
Pialde Macho	*Guarea* sp.	X					20-100
Pilche, Mate	*Crescentia cujete*	X				X	20-1000
Pino	*Pinus* spp. (cultivated)			X			2400-3500
Pino de Platillo	*Araucaria excelsa*			X			2400-2800
Piña de Monte	*Bromelia* sp.	X					100-800

COMMON NAME	BOTANICAL NAME	HABITAT AND AREA OF DISTRIBUTION*					ALTITUDE RANGE METERS
		WESTERN REGION	CENTRAL REGION			EASTERN REGION	
			W. C.	I. V.	E. C.		
Piñuelo	*Eschweilera Rimbachii* ?	X					50-400
Piquigua	Araceae	X				?	50-400
Platanillo	*Heliconia* spp.	X	X		X	X	50-1800
Porotillo	*Erythrina* sp.	X	X		X	X	100-1000
Pujín	*Hesperomeles latifolia*		X		X		3500-4000
Pulgande	?	X					50-200
Pumamaqui	*Oreopanax floribunda* and other spp.		X		X		1800-2800
Quende, Marequende	*Brosimum* sp. ?	X					50-400
Quiebra Hacha	?	X	X				400-1200
Quina, Cascarilla	*Cinchona* spp.	X	X		X	X	600-3000
Quinua, Pantza	*Polylepsis lanuginosa, P.* sp.		X		X		3300-4000
Quiriquinche	?	X	X				
Quishuar	*Buddleia incana*		X		X		2800-3400
Quitasol	*Phyllanthus* sp.	X	X		?	?	
Rampida, Toquilla	*Carludovica palmata*	X				X	50-400
Retama	*Sarothamnus scoparius*			X			2000-2600
Roble de Costa	*Tabebuia pentaphylla*	X				?	50-300
Roble de Esmeraldas	*Terminalia amazonia*	X					10-400
Roble de Macuchi	*Roupala* sp.		X				1500-2000
Sacha Peral	*Vallea stipularis*		X		X		3000-3600
Sajo	*Cespedesia* sp.	X				?	50-600
Salero	?	X					
Salvaje, Barba de Palo	*Tillandsia usneoides*			X			1600-2600
Samal	*Rapanea andina*		X		X		1800-2800
Samán	*Pithecolobium saman*	X	X				400-800

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		WESTERN REGION	CENTRAL REGION			EASTERN REGION	
			W. C.	I. V.	E. C.		
Samil colorado	Myrsinaceae	X	X			?	200-600
Sándalo	?	X				?	50-300
Sande	*Brosimum utile*	X					50-400
Sangre de Drago	*Pterocarpus officinalis*	X	X		?	X	400-1500
Sangre de Gallina	*Vismia* sp.	X	X				
Sanón	?	X	?			?	
Sanquita	?	X	?				50-200
Sapán de Paloma	*Trema integerrima*	X	X				100-600
Sapán Niguito	*Muntingia calabura*	X				?	10-300
Sapán Veneno de Perro	*Daphnopsis Humboldtiana*		?	X			2000-2400
Sapotolón	Bombacaceae	X				?	50-200
Sasafráz	*Zanthoxylum* sp.	X	?				50-600
Sauce	*Salix Humboldtiana*	X		X			200-2400
Saumerio	?	?	X				
Saupe	?	X	?				
Savaleta	*Trichilia* sp.	X	?			?	100-600
Seca	Leguminosae	X					100-300
Seca de Castilla	*Geoffroea spinosa*	X					100-300
Sigse	*Cortaderia rudiuscula*			X			1800-2800
Sisín, sumi, Guabesay	*Podocarpus oleifolius, P. glomeratus*		X		X		1800-2800
Shanshi	*Coriaria timifolia*		X	X	X		2800-3200
Sota	*Sideroxylon* sp.	X	X				
Suche	*Thevetia* sp. ?	X					
Sumi, Sisín, Guabesay	*Podocarpus oleifolius, P. glomeratus*		X		X		1800-2800
Surillo	*Chusquea* spp. ?		X	X	X		1800-3000

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		WESTERN REGION	CENTRAL REGION			EASTERN REGION	
			W. C.	I. V.	E. C.		
Suro	*Chusquea scandens, C.* spp.		X	X	X		1800-3000
Tachuelo	?	X				?	50-400
Tagua, Cadi	*Phytelephas macrocarpa, P. microcarpa*	X	X			?	10-1000
Tamarindo	*Tamarindus occidentalis*	X					10-100
Tangaré, Figueroa	*Carapa guianensis*	X				?	50-400
Tarqui	*Hedyosmum scabrum*		X		X		2000-2800
Tillo	*Pouteria* ?	X				?	50-400
Tillo Blanco	*Brosimum latifolium* ?	X	X				50-600
Tillo Prieto	?	X	X				
Tocte, Nogal	*Juglans neotropica*			X	X		1500-2800
Toquilla, Rampida	*Carludovica palmata*	X				X	50-400
Tortolero	*Trema* sp.	X					
Tunda	Bamboo		X		X		1800-2800
Tundilla	Bamboo		X		X		1800-2800
Tutumbe	*Cordia toqueve*	X	X			?	200-1000
Uña de Gato	*Bauhinia* sp.	X	?				100-400
Uva de Monte	*Pourouma chocoana*	X	X				200-600
Zapote	Sapotaceae	X				?	50-200
Zapote Arizco	*Casimiroa* ?	X	X			?	50-600
Zapote de Perro	*Calocarpum mammosum* ?	X					50-300
Zapotillo	*Mimusops* ?	X				X	50-600
Zarza	*Buettneria geminifolia*		X				300-800
Zota	*Sideroxylon* sp.	X	X				200-800

NOTE ON A CORDIA WOOD FROM EASTERN BRAZIL

By D. Guilherme de Almeida

Forest Products Laboratory, Forest Service, Brazil

Some months ago Mr. Erik Olavi Ika brought to my attention a kind of wood, known as "Louro", that has been cut in the States of Espirito Santo and Rio de Janeiro, in the eastern region of Brazil.

The present paper is a detailed description of that wood, and the chief object is to compare its micro-structure with those of *Cordia* species perfectly identified. "For it has been shown that a single small sample can not throw much light on the variation likely to occur between different samples, and it follows that any estimate of the value of a description based on a single specimen must depend on previous experience with other species." In order that the comparison should be objective and, as far as possible, exact, an effort has been made to give quantitative data with numerical values approved by the Council of the International Association of Wood Anatomists. The wood sample examined showed the following characteristics:

Heartwood yellowish brown, streaked with somewhat darker brown. Luster golden when viewed in proper lighting. Without distinctive taste or scent (dry specimen). Light and soft; specific gravity, air dry (15% moisture content), 0.40; texture uniform, medium; grain straight, easily worked, though sawing woolly.

Growth rings present. Pores moderately large (mostly from 220 to 300μ ranging from a minimum of 80μ to a maximum of 300μ); very few (from 2 to 5 per sq. mm., frequently 3 per sq. mm.); scattered, solitary and in pairs in early wood, small clusters in late wood, tendency to tangential arrangement in early wood. Vessel members moderately short (frequently from 280 to 320, sometimes less than 200μ); with simple, wide-rimmed perforations; intervascular pitting medium-sized (8μ), alternate. Tyloses present, thin-walled. Rays up to 7 cells wide, frequently 6 cells wide, moderately

broad (maximum width from 150 to 200μ), maximum heights over 100 cells (up to 4400μ high); distinctly heterogeneous, upright and square cells of normal occurrence in association with procumbent cells; sheath cells characteristic, and large interior cells sometimes present; abundance of rays (measured tangentially on tangential section) less than 5 per mm. (frequently 4 per mm.); pits to vessels medium-sized (mostly 7μ) and rounded. Wood parenchyma paratracheal, vasicentric and in broken, tangential bands of irregular width and spacing; vertical strands mostly 4-celled. Wood fibers with medium wall thickness; simple or indistinctly bordered pits. Ripple marks absent. Vertical traumatic gum ducts present.

From the data tabulated for comparison, (see Table I) it is evident that the described wood, No. 3768, has very few pores per square millimeter and has larger rays than any other wood listed in the table. It approaches *Cordia latiloba* in the intervascular pitting dimensions (8μ), number of rays (4 per mm.), and width of the rays measured in micra; and is nearer *C. Goeldiana* in number of pores (3 per sq. mm.), abundance of rays (4 per mm.), size of procumbent cells (height 40 and length 160μ); and maximum height of rays (over 100 cells).

So far as the wood structure is concerned, the wood described above may be brought to supply the trade where and when Freijó becomes scarce. And probably it has been for its physical properties are like those of *Cordia Goeldiana* Huber, known under the common names of Frei Jorje, Freijó, Cordia Wood, Brazilian Walnut, South American Walnut, and Jenny Wood, which is well suited for cooperage, and is proving very satisfactory for manufacture of fine furniture. It has about the same density as American Walnut, takes a stain very well, and receives a soft patina finish with comparatively little effort. The lumber is of good quality, easy to work, much used for carpentry and joinery, and in place of Teak in naval construction. Most of the small planes used by the Civil Aviation Clubs in Brazil are equipped with laminated propellers, made from the

TABLE I

SPECIMEN NO.	SPECIES	VESSELS: ABUNDANCE PER SQ. MM.	VESSELS: SIZE OF PORES MAX.	VESSELS: SIZE OF PORES MIN.	VESSELS: SIZE OF PITS, MICRA	VESSELS: LENGTH OF MEMBERS, MICRA
294	*Cordia alliodora* (R. & P.) Cham. (*C. gerascanthus* Jacq.)	12	150	75	6	200
296	*Cordia (Gerascanthus) excelsa* A.DC. (= *C. hypoleuca* DC., = *C. frondosa* Schott = *C.* [*Gerascanthus*] *trichotoma* [Vell.] Arab. = *Gerascanthus excelsa* Mart.)	10	144	40	7	300
3713	*Cordia (Gerascanthus) trichotoma* (Vell.) Arab. (= C. [*Gerascanthus*] *excelsa* A.DC. = C. *hypoleuca* DC. = C. *frondosa* Schott. = C. *excelsa* Mart.)	9	125	25	7	200
3749	*Cordia latiloba* Johnst.	7	140	80	8	200
340	*Cordia Goeldiana* Huber	3	200	80	6	220
3768	*Cordia* sp.	3	300	80	8	250

wood of *C. Goeldiana*. Authors agree that its center of distribution lies in the Amazon region.

Undoubtedly, it is of importance to find any wood with characteristics similar to those of *C. Goeldiana*, and having a wider distribution than that species. It is well known that there are several kinds of *Cordia* in Brazil, and that in the eastern, southern and western regions of the country they are generally named "Louro". Under the advice of Mr. A. C. Brade, Botanist of the Forest Service of Brazil, who has dedicated much attention to the plants of the family Boraginaceae, it was possible to select the tree species in Brazil

TABLE I

WOOD RAYS: ABUNDANCE PER MM.	SIZE OF CELLS, MICRA: SHEATH CELLS HEIGHT	SHEATH CELLS WIDTH	PROCUMBENT HEIGHT	PROCUMBENT LENGTH	HEIGHT OF RAYS MICRA	HEIGHT OF RAYS CELLS	WIDTH OF RAYS MICRA	WIDTH OF RAYS CELLS	SPECIMEN NO.
5	50	25	25	—	900	80	100	5	294
5	60	25	25	—	1200	54	80	5	296
5	120	37	40	120	1000	40	100	4	3713
4	90	40	40	80	1600	70	140	5	3749
4	100	40	40	160	2000	130	120	6	340
4	120	60	40	160	4400	150	200	7	3768

from the confusing synonymy of the genus *Cordia*, as follows:

1) *Cordia latiloba* Johnst.
   Brazil (Rio de Janeiro, Espirito Santo)
2) *Cordia Goeldiana* Huber
   Brazil (Amazon Region)
3) *Cordia insignis* Cham.
   Brazil, Bolivia
4) *Cordia glabrata* (Mart.) DC.
   Brazil, Paraguay
5) *Cordia alliodora* (R. & Pav.) Cham.
   Brazil, Antilles, Mexico
6) *Cordia trichotoma* (Vell.) Arab. Bolivia

The scientific material used for this study represents a highly appreciated cooperation offered by Mr. Calvino Mainieri of the Instituto de Pesquizas Tecnológicas do Estado de São Paulo, *Cordia alliodora* from Honduras and *C. Goeldiana* from the Amazon region; and by Mr. João Geraldo Kuhlmann, Director of the Botanical Garden of Rio de Janeiro, *C. excelsa*, *C. trichotoma*, and *C. latiloba*, all three from the rain forests of the coastal mountains around Rio de Janeiro. *C. glabrata* and *C. insignis* were not available. The effective help Mrs. Eunice Pinto de Barros gave in the preparation of the microscope slides and the measurements of the minute anatomy, made possible the construction of the table for comparison of the micrometric data.

THE YALE WOOD COLLECTIONS

Accessions

At the end of the calendar year 1946 the total number of cataloged wood samples in the Yale wood collection amounted to 43,515, representing 12,261 named species and 2,836 genera of 236 families. There were 894 accessions during the year, the largest single contribution being from the Comisión de Botanica del Valle del Cauca, Colombia (615 woods collected in Colombia by Dr. José Cuatrecasas). The sources of all the wood samples received are as follows:

Argentina: Dr. B. Y. Morrison, Plant Industry, Beltsville, Maryland.

Brazil: Dr. D. G. de Almeida, Serviço Florestal, Rio de Janeiro; Dr. A. Ducke, Instituto Agronomico do Norte, Bélem, Pará.

China: Mr. Ying-Pe Chang, Academia Sinica, Shanghai.

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

Costa Rica: U. S. Forest Service, Washington, D. C.

Cuba: Mr. B. A. Krukoff, New York Botanical Garden; Dr. Juan T. Roig, Agricultural Experiment Station, Santiago de las Vegas.

Guatemala: U. S. Forest Service, Washington, D. C.

India: Mr. Ward Cramer, Columbus, Ohio.

Mexico: Mr. G. Proctor Cooper, La Mesa, California; Dr. M. Martínez, Mexico, D. F.

Panama: U. S. Forest Service, Washington, D. C.

Peru: Mr. Rolland C. Lorenz, Forestry Department, Lima; Dr. R. J. Seibert, U. S. Bureau Plant Industry, Lima.

Surinam: Dr. Gerold Stahel, Agricultural Experiment Station, Paramaribo.

U. S. A. (Native and cult.): Dr. A. H. Graves, Brooklyn Botanic Garden; Prof. E. S. Harrar, Durham, N. C.; Prof. H. W. Hicock, Cheshire, Conn.; Mr. J. Kelly, Neelyville, Mo.; Mr. W. F. Opdyke, Cleveland Heights, Ohio; Dr. P. Proctor, Jr., Corvallis, Oregon.

Sections for Microscopic Study

During 1946 there were added to the slide collection cross, radial and tangential sections of 39 specimens, which, allowing for a few changes in species classification, makes a total of 20,373 slides of 11,581 specimens of 6,859 named species, 2,683 genera, and 220 families.

Specimens Distributed

There were distributed during the year 340 wood specimens to the following scientists and institutions:

To Dr. H. P. Brown, Dept. of Wood Technology, New York State College of Forestry (Syracuse), 261 woods of 35 families.

To Prof. E. S. Harrar, Duke Universtiy School of Forestry (Durham, N. C.), 11 samples of *Erythrina*.

To Dr. A. M. W. Mennega, Bot. Mus. and Herbarium of the State University of Utrecht (Netherlands), 21 woods of 8 fa[illegible]

To Prof. M. F. Moseley, Jr., Dept. of Botany, University of Illinois (Urbana), one sample of *Casuarina*.

To Prof. Oswald Tippo, Dept. of Botany, University of Illinois, 33 samples of 3 genera of the family Ulmaceae.

To Dr. William N. Watkins, U. S. Nat'l Museum, Washington, D. C., 4 samples: Bombacaceae (1), Leguminosae (2), Rubiaceae (1).

CURRENT LITERATURE

Ficus in Florida—I. Australian species. By MARY F. BARRETT. *Amer. Midland Nat.* (Notre Dame, Indiana) 36: 2: 412-430; September 1946.

"Most species of the enormous genus *Ficus* seem to have fairly rigid continental limits so far as their natural distribution is concerned. Florida, however, particularly in those sections south of a line from Vero Beach on the east to Clearwater on the west, offers impartially a home to certain African, Asian, Australian, and Central and South American species in addition to its native fig-trees, *Ficus aurea* Nutt. and *F. brevifolia* Nutt."

"The principal objects of the following studies of Australian species of *Ficus* which have been introduced into Florida are: emphasis on correct names, according to the international rules of botanical nomenclature; collection and evaluation of alleged synonyms; descriptions from literature and first-hand observations; and location of specimens in Florida."

El cedro. By JUAN T. ROIG. Estacion Experimental Agronomica (Havana) Bul. 64, 1946. Pp. 47; 14 figs., 4 graphs.

An ecological study of existing plantations and recommendations for commercial propagation and cultivation of Cedro (*Cedrela mexicana* M. J. Roem).

Studies in the Sapotaceae—II. Survey of the North American genera. By ARTHUR CRONQUIST. *Lloydia* 9: 4: 241-292; December 1946.

The genera *Mastichodendron*, *Micropholis*, *Pouteria*, and *Chrysophyllum* are treated in detail. Keys to the genera and species are included. In addition to the genus *Mastichodendron*, a number of species, varieties, and subspecies are presented as new.

A résumé of the American Carisseae (Apocynaceae). By JOSEPH MONACHINO. *Lloydia* 9: 4: 293-309; December 1946.

"In the following résumé of the American Carisseae are presented a key to the genera and supplementary remarks on several species. Certain genera excluded from the tribe are discussed. An errata, addenda, and index to the more important botanical and local names appearing in the author's serial revisions of the American genera of Carisseae are appended."

"Carisseae, both in number of genera and species represented, comprises but a small portion of the Apocynaceae as a whole, and the American members of the tribe are less than one-third the species found in the Old World. *Lacmellea*, with 18 species, is the largest genus in America; *Ambelania*, next in size, has only 11 known species; *Parahancornia* and *Couma*, 6 and 5 respectively; *Landolphia*, 3; *Hancornia*, merely 1. The American genera of Carisseae are endemic to this continent, except *Landolphia* which is represented in both the New and the Old World (3 known South American species and over 50 African)."

"A strictly natural serial arrangement of these genera is not possible, but the following sequence is convenient: *Landolphia*, *Lacmellea*, *Couma*, *Hancornia*, *Parahancornia*, *Ambelania*."

Forestry in Jamaica. By CHRISTOPHER SWABEY. Jamaica Forestry Department (Kingston) Forestry Bul. No. 1, 1945. Pp. 69, 1 folded map.

Included are general descriptions of the country and forests, details of the vegetation types, utilization, silvicul-

tural methods and forest policy. The principal timbers are described, their common and scientific names listed, and their uses given. A selected bibliography is included.

Los *Juniperus* Mexicanos. By MAXIMINO MARTÍNEZ. *An. Inst. Biol. Mex.* 17: 1 & 2: 1-128; 108 figs.; 1946.

A revision of the genus *Juniperus* in Mexico is presented. Twelve species, six varieties, and three forms are described; some are new. The text is well illustrated, specimens are cited, and identification keys given.

Algunas plantas notables del declive oriental de la mesa de Anahuac. By F. MIRANDA. *An. Inst. Biol. Mex.* 17: 1 & 2: 129-136; 4 figs.; 1946.

Included are descriptions of one new species, two new varieties, and one new combination.

Noteworthy plants of South America—III. Specimens of *Mauria*. By FRED A. BARKLEY. *Bul. Torrey Bot. Club* 74: 1: 77-80; 3 figs.; January 1947.

Eight collections of *Mauria* are identified, including four previously undescribed species.

Adiciones a las Leguminosas de Colombia. By LORENZO URIBE-URIBE. *Caldasia* (Bogota) 4: 18: 211-213; October 1946.

Specimens new to the flora of Colombia are given for the genera *Inga*, *Bauhinia*, *Cassia*, and *Macrolobium*.

Nuevas nociones sobre el genero *Ficus* en Colombia, VI. By ARMANDO DUGAND. *Caldasia* 4: 18: 229-230; October 1946.

Information is given about two species; one (*F. loretoyacuensis* Dugand) is new.

Noticias botanicas Colombianas, VII. By ARMANDO DUGAND. *Caldasia* 4: 18: 231-241; October 1946.

Species of eight genera of Bignoniaceae, of *Poulsenia* (Moraceae), and of *Mayna* (Flacourtiaceae) are discussed. *Lundia colombiana* Dugand is described as new.

Consideraciones sobre algunas Lauraceas. By H. DANIEL. Pub. by Sociedad de Ciencias Naturales Caldas (Medellin, Colombia), November 1946. Pp. 6, 2 figs.

A general description of some of the important Lauraceae of Colombia, their correct common and scientific names, and a plea for their preservation.

The Australian blue gum (*Eucalyptus globulus* Labill.) in Ecuador. By IRA L. WIGGINS. *Lloydia* 9: 4: 310-314; December 1946.

The Blue Gum is widely planted as a source of fuel and lumber in the great areas of the Inter-Andean valley which has long since been denuded of its native forests. The tops, limbs, leaves, and bark are used for fuel. The long slender trunk is cut into lumber for carpentry.

Rubber production in Ceará, Brazil. By HUGH C. CUTLER. *Bot. Mus. Leaflets* (Harvard, Cambridge) 12: 9: 301-316; 2 figs., 4 plates; December 1946.

"The surveys showed that in Ceará only two genera were important, *Hancornia* and *Manihot*, occurring wild with the exception of some small plantings of *Manihot* in northern Ceará made during the last rubber boom. A few isolated trees of *Castilla (caucho)* and two small colonies of *Hevea* were planted in damp mountains near Baturité, the Hevea seed coming from the territory of Acre."

Los generos fanerogamas argentinas con radios leñosos altos en su leño secundario. By DOMINGO COZZO. Reprint from *Rev. Argentina de Agron.* (Buenos Aires) 13: 3: 207-230; 3 figs.; September 1946.

Species having woods with conspicuous rays are listed. A brief description of the woods and a key to the genera are given.

Estructura leñosa estratificada en el genero *Plectrocarpa* (Zigofilaceas). By Domingo Cozzo. Reprint from *Rev. Argentina Agron.* (Buenos Aires) 13: 4: 286-292; 2 plates; December 1946.

"In this work is reported the occurrence of storied structure in the secondary wood of the two species of the genus *Plectrocarpa* (Zygophyllaceae) which has not been mentioned before. Horizontal seriation is complete in *P. tetracantha* and with tendency to complete in *P. Roughesii*. The mean height of the strands is 0.07 mm (ranging between 0.058 and 0.077 mm). The number per inch is 362 (the maximum being 437) and exceeding by far the greater quantity (300) registered until the present in vegetable anatomy. This would be therefore the finest storied structure . . ."—*Author's summary*.

Anatomia le leño de *Cyclolepis genistoides* Don. By D. Cozzo. Reprint from *Archivos Farmacia Bioquímica Tucuman* 3: 1: 121-125; 1 plate; 1946.

The structure of the wood is described and the occurrence of storied structure reported.

Forest wealth of Indian states. *Indian Forester* (Dehra Dun) 72: 11: 529-531; November 1946.

A brief discussion of the valuable timbers and other forest products is given.

"Mysore state has the monopoly of the finest species of East Indian sandalwood, seven-tenth(s) of the world's demand being met by it. The tree grows to some extent in Coorg and some of the districts of the Madras and Bombay provinces adjoining the Mysore plateau. The wood is used for carving and as incense in religious rites and ceremonies. Oil is extracted from the wood by distillation with steam. In the Mysore factory, which is the biggest sandalwood oil manufactory in the world, the distillation is carried on continuously day and night. Two subsidiary factories have been installed at Shimoga and Bhadravati in Mysore state. Since the starting of the sandalwood industry in the state in 1916 up to 1940-41, 36,509 tons of wood have been distilled and a net revenue of over Rs. 4⅓ crores has been realised. Other states producing sandalwood are Gwalior, Travancore, and Sandur. Sandalwood was formerly an important forest product in Malwa and today it is found growing profusely in Shajapur, Ujjain and Maundsaur districts in Gwalior."

Additions to the flora of Borneo and other Malay Islands: XIX. By H. N. Ridley. *Kew Bul.* (Kew, Eng.) 1: 31-43; 1946.

Included are descriptions of 30 new species.

Annual report of the director of forestry for the year ended 31st March, 1946. By Alex. R. Entrican. State Forest Service, New Zealand (Wellington). Pp. 67; 1946. Price 1 s. 6 d.

The forest areas, principal species, and utilization of *Eucalyptus* timber are discussed.

"Rimu is still the predominant timber species, but production at 174,000,000 board feet for the year was 15,000,000 board feet less than the cut in 1938-39. The progressive decline in the production of kahikatea, which commenced prior to 1939, continued throughout the war years, the cut in 1945-46 being, as for the previous year, only 17,000,000 board feet, or one-half of the 1938-39 figure. Totara remained constant, but matai was 3,000,000 board feet less than in 1938-39, and kauri fell to an all-time low production of 1,779,000 board feet, or less than 30 per cent of the cut in 1938-39. Tawa was the only indigenous species in which any appreciable increase in production was secured, for, whereas during 1938-39 only a little over 100,000 board feet were sawn, in 1945-46 the output was over 5,000,000 board feet."

Eucalyptus forests in Australia. By D. E. Murray. *Rev. Internat. Bois* (Paris) 13: 113: 183-185; November 1946.

The forest areas, principal species, and utilization of *Eucalyptus* timber are discussed.

Les Malvacées des Antilles française. By H. STEHLÉ. *Boissiera* (Geneva) 7: 27-45: March 1943.

Keys to the genera and species are included with the enumerations of species.

Trois nouveaux *Planchonella* de la Nouvelle Guinée avec une note sur *Krausella*. By H. J. LAM. *Boissiera* 7: 91-99; 2 figs.; March 1943.

Three new tree species are described in the genus *Planchonella*.

Explorations botaniques à la recherche de nouvelles plantes à caoutchouc dans la période 1898-1914 et description d'une plante laticifère africaine: *Vilbouchevitchia atro-purpurea* gen. et sp. nov. By AUGUSTE CHEVALIER. *Boissiera* 7: 248-257; 1 fig.; March 1943.

A brief account of botanical explorations to discover new India-rubber plants in the period 1898 to 1914 is followed by the description of the genus and species *Vilbouchevitchia atro-purpurea* A. Chev.

Un genre nouveau de Caesalpiniées du Gabon. By FRANCOIS PELLEGRIN. *Boissiera* 7: 296-300; 1 fig.; March 1943.

Two species of trees are described for the new genus *Julbernardia*.

Les Diptérocarpées d'Indochine affinités et répartition. By MADAME TARDIEU-BLOT. *Boissiera* 7: 301-310; 1 fig.; March 1943.

The discussion deals with the general characters of the family, its geographical distribution (map) and affinities, and the native names of the commercial species.

***Henoonia*, type d'une famille nouvelle?** By CHARLES BAEHNI. *Boissiera* 7: 346-358; 8 figs.; March 1943.

The relationships, morphological characters, and anatomy are discussed. The conclusions tend to support the formation of a new family for the two species of this genus,

probably situated near the Gesneriaceae or Bignoniaceae in Engler and Prantl's system.

Monographie du genre *Cestrum* L. By PIERRE FRANCEY. *Candollea* (Geneva) 7: 1-132; 3 plates; January 1936.

This work is Part 2, the first part appearing in *Candollea* 6: 46-398: 1935. (See *Tropical Woods* 47: 31.) In addition to the descriptions, lists of species and vernacular names, and an index are included.

Les *Celtis* Sud-Américains. By CHARLES BAEHNI. *Candollea* 7: 189-214; 1936.

Seven species and two varieties are described and their distribution noted. A key and lists of vernacular names, synonyms, and collection numbers are given.

Identification of certain Candollean types of South-American Bignoniaceae. By N. Y. SANDWITH. *Candollea* 7: 244-254; June 1936.

"The object of this paper is to attempt to identify, according to modern generic and specific concepts, those new species of South American *Bignoniaceae* which were described by Augustin Pyramus de Candolle in the ninth volume of the *Prodromus*, and which were either not mentioned at all by Schumann, or were placed among '*species incertae sedis*' at the end of various genera, or were incorrectly interpreted by him."

Les sections du genre *Pouteria*. By CHARLES BAEHNI. *Boissiera* 5: 144-145; 1941. (Reprinted from *Compte Rendu Soc. Phys. Hist. Nat. Genève* 58: 2: 144-145; 1941.)

The complete remodeling of the Sapotaceae family and the creation of a new system of classification (Ch. Baehni: Mémoires sur les Sapotacées. I. Système de Classification. *Candollea* VII, 394-508, 1938.) has rendered necessary the grouping under the generic name of *Pouteria* about 500 species, placed by recent authors in some fifteen genera.

The definition of the revised genus *Pouteria* is distinct: they are the Sapotaceae characterized by a seed with lateral

cicatrice, a simple calyx with free sepals, by petals without dorsal appendages, and an androecium composed of a verticil of stamens alternating with a verticil of staminodes. They grow in both Americas, in Africa, eastern Asia, and Oceania.

The natural sections of this huge complex fall into two series: the first includes those species characterized by serried leaves with parallel veins, giving a striated aspect to the limb; the second is composed of species with leaves having separated veins, connected by a more or less marked network.

The first series comprises three sections: (1) *Gomphiluma*, (2) *Micropholis*, (3) *Myrtiluma*. The second series comprises six sections: (4) *Chromolucuma*, (5) *Discoluma*, (6) *Guapeba*, (7) *Rivicoa*, (8) *Eremoluma*, (9) *Synsepalum*, (10) *Oligotheca*, (11) *Breviea*, (12) *Daphniluma*, (13) *Egassia*.

The thirteen sections do not all correspond to former genera simply retrograded. In fact, only three of them have been considered again recently as independent genera. *Oligotheca* alone was divided into eleven different genera while the nine remaining sections have by turns made part of *Bakeriella*, *Planchonella*, *Sideroxylon* or *Lucuma*. The new limits of the genus *Pouteria* and the sections proposed bring to an end such irresolutions and allow from now on a sure and rational classification of the species thus far studied.—*Mary Record*.

Memoires sur les Sapotacées. II. Le genre *Pouteria*. By Charles Baehni. *Candollea* (Geneva) 9: 147-476; December 1942.

A monograph of the genus as set forth in the preceding article (above). Complete descriptions, indices and keys are included.

La Civica Siloteca Cormio. By Luigi Cormio. Civica Siloteca Cormino (Milan) Pub. No. 12, 1942. Pp. 14: 24 figs.

A part of the actitivites of the Istituto Sperimentale del Legno are carried on by the Civica Siloteca. These consist

of the field of xylology, classification of new woods by histological study; technology, study of physical properties of woods; pathology and defects; preservation, by artificial impregnation; and, utilization, study of uses for native and colonial woods.

Morfologia interna del tronco degli alberi con particolare riguardo alla struttura del legno. By Raffaele Cormio. Reprint from *L'Ingegnere* (Milan) 20: 5: 3-10; 18 figs.; 1942.

General descriptions of the internal morphology of tree stems with particular emphasis upon wood structure.

Monografia sui ciocchi di *Erica arborea* di Eritrea e di Calabria. By Raffaele Cormio. Reprint from *L'Ingegnere* (Milan), August- September 1943. Pp. 3-26; 27 figs.

An experimental study of the resistance of the wood burl of *Erica arborea* to burning by tobacco.

Le régime des cessions et concessions de terres agricoles et forestières au Congo Belge. By Th. Heyse. *Bul. Agricole Congo Belge* (Brussels) 37: 3: 483-553; September 1946.

The laws for cession and concession of lands and forests, and various regulations pertaining to use and exploitation are explained.

Notes sur des *Lonchocarpus*. By É. De Wildeman and L. Pynaert. *Bul. Agricole Congo Belge* 37: 3: 586-597; September 1946.

The importance of chemical study of the various species of *Lonchocarpus* is emphasized. Twenty-seven species are listed with notes concerning their chemical properties or use for medicine, fish-poisons, or insecticides.

Communication à propos des pétrifications calcaires du *Chlorophora excelsa*. By M. Plancquaert. *Bul. Agricole Congo Belge* 37: 3: 629-641; 7 figs.; September 1946.

Porous calcareous rocks which are abundant in the vicinity of Kingunda Mission, province of Léopoldville, proved

to be concretions from the tree *Chlorophora excelsa*. This material makes a superior cement and is also recommended for improvement of cultivated soil.

Note sur quelques insectes ravageurs des bois au Congo Belge. By J. M. VRYDAGH. *Bul. Comptoir Vente Bois Congolais* (233 Rue de la Loi, Brussels) No. 5: 4-7; December 1946.

A discussion of damage caused by various insects to logs (with or without bark) awaiting shipment, and methods of protection. The best method seems to be as rapid drying of the wood as possible before sending it out of the Colony.—*Mary Record.*

Le marche des bois en Afrique du Sud. By H. A. R. BRETT. *Bul. Comptoir Vente Bois Congolais* No. 5: 10-11; December 1946.

Before the war the South African market was supplied chiefly with woods from the United States, teak from Burma and Siam, and Lauan from the Philippine Islands. Some timbers were also obtained from the Dutch East Indies and Australia. When these supplies were cut off during the war, woods were imported from neighboring African countries. Today 90 per cent of the hardwoods used in South Africa are of African origin, with Limba, Iroko, Sapelli, Khaya, and Kiaat being the favorite species.

***Macrolobium Dewevrei* De Wild.** *Bul. Comptoir Vente Bois Congolais* No. 5: i-iv; 1 plate; December 1945.

The Limbali is considered by some Belgian users to be one of the best woods from the Colony. It is used for all sorts of inside and exterior carpentry and is especially good for marine construction and railroad ties because of its resistance to decay.

Included are macroscopic and microscopic descriptions of the wood, a list of regional vernacular names, and a table of physical properties.

Staudtia Gabonensis Warb. *Bul. Comptoir Vente Bois Congolais* No. 6: 10-11; 1 plate; January 1947.

The Niove is a good furniture wood, displaying a beautiful grain, reddish brown color, and taking a good finish. It is also useful for flooring, naval construction, and railway crossties.

A list of regional vernacular names, a table of physical properties, and microscopic and macroscopic descriptions of the woods are included.

A propos de medicaments antilépreux d'origine végétale. *Inst. Royal Colonial Belge* (Brussels).

Part VI. *Senecio* L. By E. DE WILDEMAN. (Reprint from *Bul. des Séances* 17: 1: 317-353; 1946.)

Part VII. Sur des espèces du genre *Eucalyptus* L'Herit. By E. DE WILDEMAN and L. PYNAERT. (Reprint from Bul. 17: 2: 551-552; 1946.)

Part VIII. Sur des espèces du genre *Acacia* L. By E. DE WILDEMAN and L. PYNAERT. (Reprint from Bul. 17: 2: 553-554; 1946.)

Part XI. Sur des representants des genres: *Bauhinia, Caesalpinia, Cicer, Cynometra, Entada, Erythrophleum* de la famille des Leguminosacées. By E. DE WILDEMAN and L. PYNAERT. (Reprint from Bul. 17: 2: 650-707; 1946.)

A continuation of the studies previously reported by Dr. De Wildeman and reviewed in this journal.

Studies in the Theaceae, XV. A review of the genus *Adinandra*. By CLARENCE E. KOBUSKI. *Jour. Arnold Arb.* (Jamaica Plain, Mass.) 28: 1: 1-98; January 1947.

A complete treatment of the genus, including descriptions of the species and identification keys to the species of various regions.

The mango. A list of References. Compiled by HELEN V. BARNES. U. S. Dept. of Agri. (Washington) Library List No. 29, October 1946. Pp. 61.

"This bibliography (712 titles) includes references on all aspects of the mango—botany, culture, diseases and pests, varieties, composition, nutritive value, cookery, toxic effects,

uses, economics, etc. The arrangement is alphabetical by author. The index, in addition to an analysis of the specific subjects included, lists joint authors and issuing agencies."

The relative value of taxonomic characters. By THEODOR JUST. *Amer. Midland Nat.* (Notre Dame, Ind.) 36: 2: 291-297; September 1946.

"At least two sets of characters are . . . constantly used according to the two basic taxonomic procedures: 1) an analytical set for the immediate purpose of identification, composed essentially of diagnostic characters of limited occurrence, and 2) a synthetic set for purposes of classification, represented by fundamental or constant characters of wide occurrence . . ."

"Another, no less important consideration involves the nature and sources of taxonomic characters. It is safe to say that the majority of taxonomic characters is based on external morphological characters, since they still are the most easily accessible and widely used. Yet they are being supplemented more and more from other sources, i.e., the data of paleobotany, anatomy, cytology, genetics, physiology, chemistry, etc."

The role of wood anatomy in phylogeny. By OSWALD TIPPO. *Amer. Midland Nat.* 36: 2: 362-372; September 1946.

A critical analysis of the contributions made by plant morphologists and their application and value in the study of phylogenetic sequences. The extensive bibliography is cited in detail. ". . . morphologists have described the following lines of anatomical specialization:

"1. The prostostele is more primitive than the siphonostele or the dictyostele . . .

"2. In the Angiosperms, the woody stem of trees and shrubs is more primitive than that of herbaceous plants . . .

"3. The vessel element with scalariform perforation plates appeared in plants before the vessel member with a single opening in the perforation plates . . .

"4. Among the vessel elements with scalariform perforation plates, the type with numerous bars and narrow openings is more primitive than the type in which there are few bars separating wide openings or perforations . . .

"5. The vessel elements which are long, small in diameter, and angular in cross-section preceded those which are short, broad, and circular in cross-sectional outline . . .

"6. Vessel elements with long, sloping end-walls are more primitive than those with end-walls which are transverse . . .

"7. The phylogenetic order of the several types of pitting on the side walls of the vessels is scalariform, transitional, opposite, and finally alternate . . .

"8. The type of vessel arrangement in which the pores occur singly throughout the wood (i.e., solitary pores) is less advanced than the various aggregate groupings, such as pore multiples, pore clusters, and pore chains . . .

"9. The diffuse-porous condition is more primitive than the ring-porous state . . .

"10. Evolution has proceeded from tracheids to fiber-tracheids to libriform wood fibers . . . Accompanying this development there has been a progressive decrease in the length of these elements . . .

"11. So far as the several categories of tracheids are concerned, the phylogenetic development in the Angiosperms has been from scalariform tracheids to circular bordered pitted tracheids . . .

"12. The diffuse arrangement of wood parenchyma cells is more primitive than are the various aggregate arrangements, such as banded apotracheal and the various paratracheal types, such as vasicentric, aliform, and confluent . . .

"13. Heterogeneous rays . . . are less specialized than are homogeneous rays . . .

"14. Woods with non-stratified cells are more primitive than those with storied structure . . ."

Supplementary notes on Cockrell's study of the wood structure of *Strychnos*. By ROBERT A. COCKRELL and J. MONACHINO. *Amer. Jour. Bot.* (Burlington, Vt.) 34: 1: 44; January 1947.

A revision of the genus by Krukoff and Monachino necessitates this supplement to "A Comparative Study of the Wood Structure of Several South American Species of *Strychnos*" by R. A. Cockrell, *Amer. Jour. Bot.* 28: 32-41; 1941.

High longitudinal shrinkage and gelatinous fibers in an eccentric cottonwood log. By M. E. BAUDENDISTEL and VIRGINIA AKINS. *Jour. For.* (Soc. Amer. For., Washington, D. C.) 44: 12: 1053-1057; December 1946.

"Indications are that the rough cutting of the veneer from one side of the cottonwood log was due to the presence of large numbers of gelatinous fibers. The corrugations which developed during the drying of the veneer from this side evidently were caused by variations in longitudinal shrinkage.

"A correlation between high longitudinal shrinkage and the presence of gelatinous fibers was found in the eccentric cottonwood log."—*From authors' conclusions.*

M.M. CHITTENDEN

Price 25 cents

Yale University School of Forestry

TROPICAL WOODS

NUMBER 90 JUNE 1, 1947

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Yale University School of Forestry

TROPICAL WOODS

NUMBER 90 June 1, 1947

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.*

Subscription price One Dollar for four consecutive numbers. Remittances should be made payable to TROPICAL WOODS.

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

THE WOOD ANATOMY OF THE MYRTACEAE, I

A Note on the Genera *Eugenia, Syzygium, Acmena,* and *Cleistocalyx*

By H. E. DADSWELL and H. D. INGLE

Division of Forest Products, Council for Scientific and Industrial Research, Australia

After careful examination of *Eugenia*, Merrill and Perry have found it necessary to review the botanical concept of this genus. They have, as a result, reinstated and revised the genus *Cleistocalyx*,[1] decided that *Acmena* is a valid genus of the Myrtaceae and listed various species belonging to this genus,[2] suggested that the genus *Eugenia* be restricted to the species of the New World and that the genus *Syzygium* be

accepted to cover the majority of the species of the Old World.[3] Following this rearrangement it would appear that most of the species in the Australian and Indo-Malaysian regions previously referred to the genus *Eugenia* should now be placed in the genus *Syzygium* excepting, of course, those falling into *Cleistocalyx* or *Acmena*. This revision is of particular interest in Australia where there are a number of species involved and where the timbers derived from some of them are of commercial importance. In addition, timbers from species of New Guinea and neighboring regions are likely to be imported into Australia from time to time. Hence the classifications of Merrill and Perry and the relationships between the genera involved are of some interest to the wood technologist and, for this reason, an examination of the anatomy of various representatives of the genera concerned was considered of importance to determine whether there were any significant differences between the timbers from the Old World and those from the New.

The following description of the wood anatomy of the American species of the genus *Eugenia* was received from the Yale School of Forestry, New Haven, Conn., U. S. A.:

> "Growth rings generally present, but not always distinct. Pores variable in size, typically minute, rarely visible without lens; few to numerous; solitary; irregularly distributed, with tendency to zonate distribution. Gum deposits abundant in vessels of heartwood. Rays 1 to 4, typically 1 or 2, cells wide and up to 40, generally less than 25, cells high; definitely heterogeneous with tall upright cells; pits to vessels very small to minute. Wood parenchyma not distinct without lens and not always with it; finely reticulate (uniseriate lines and diffuse), sometimes also with bands 2 to 8 cells wide; crystalliferous strands present or absent. Wood fibers with medium to very thick walls; pits large, numerous, distinctly bordered; vasicentric tracheids common."

This description agrees with that published by Record and Hess[4] for the Myrtaceae of the New World.

Through the courtesy of Mr. C. T. White, Government Botanist, Queensland, a specimen of *Eugenia uniflora* L. growing in the Botanic Gardens, Brisbane, was forwarded for examination. In addition specimens of *Eugenia confusa* DC. and *Eugenia axillaris* Willd. were available for examination. The anatomy of these species was identical with that set out in detail above. However, in several important respects the anatomy observed and recorded was not in agreement with that of species that have been commonly known in Australia and New Guinea as members of the genus *Eugenia*. The differences are set out in the following table:

ANATOMICAL FEATURES	NEW WORLD SPECIES OF THE GENUS *Eugenia*	AUSTRALIAN AND NEW GUINEA SPECIES
VESSELS	Small, solitary.	Intermediate in size, mainly in short radial multiples or clusters.
RAY-VESSEL PITTING	Small, bordered.	Simple, rounded to scalariform and gash-like vertically or obliquely inclined; sometimes unilaterally compound.
PARENCHYMA	Mostly diffuse or in fine lines, sometimes in bands.	Paratracheal type, vasicentric, aliform to confluent, sometimes in bands.
FIBRE PITTING	Numerous, distinctly bordered.	Mainly indistinctly bordered.

Certain of these differences are illustrated in Plates I and II. Anatomically therefore it would appear that the species from the New World belonging to the genus *Eugenia* are quite distinct from the great majority of the Australian and New Guinea species. This conclusion definitely supports Merrill and Perry.

Mr. C. T. White in discussing the whole question of the nomenclature of *Eugenia* has stated, relative to certain Australian species, "I think *Eugenia carissoides* F. Muell. and *E. macrophila* C. T. White and Francis are true

Eugenias." Through the courtesy of Mr. W. D. Francis of the Herbarium, Brisbane, small specimens from twigs of these two specimens were obtained for examination of anatomical features. This showed that they both undoubtedly belong to that group in which the New World species are classified–that is to say their classification as *Eugenia* is justified anatomically. Plate 1, Fig. 2, shows a cross section of *E. carissoides* in comparison with that of *E. axillaris*–Fig. 1.

In addition, Mr. C. T. White kindly forwarded to the authors for examination twig specimens from herbarium material of the following species:

1. *Eugenia capensis* Harv.	South Africa
2. *Jossinia desmantha* Diels	New Guinea
3. *Eugenia stricta* Panch.	New Caledonia
4. *Eugenia koolauensis* Degener var. *glabra* Degener	Hawaiian Islands
5. *Eugenia koolauensis* Degener	Hawaiian Islands
6. *Eugenia gacognei* Montr.	New Caledonia
7. *Eugenia albanensis* Sond.	South Africa
8. *Eugenia horizontalis* Panch.	New Caledonia

Microscopic examination showed that all of these species were similar in anatomical features to the species of the genus *Eugenia* from the New World. Thus, it would appear that the genus *Eugenia* envisaged by Merrill and Perry extends somewhat further afield than the area usually covered by the term New World. From the botanical material, Mr. C. T. White classed Nos. 1, 2, 4, 5, 6, and 7 as species of *Eugenia* while intimating that Nos. 3 and 8 might be small-leaved *Syzygium*.

The next point for consideration was whether there was any anatomical support for the reinstatement of the genera *Acmena* and *Cleistocalyx*. From Merrill and Perry it would appear that the only Australian representatives of the genus *Cleistocalyx* are:

C. *operculatus* (Roxb.) Merr. and Perry (syn. *Eugenia operculata* Roxb.) and C. *gustavioides* (F. M. Bail.) Merr. and Perry (syn. *Eugenia gustavioides* F. M. Bail.)

Other species of the genus occur in Fiji, New Caledonia, New Guinea, Borneo, Indo-China, China, and the Philippines. The timber of *C. gustavioides* is of some commercial importance in Australia under the name of Grey Satinash.

Of the genus *Acmena* the Australian representatives are:
Acmena hemilampra (F. Muell. ex F. M. Bail.) Merr. and Perry (syn. *Eugenia hemilampra* F. Muell.)
Acmena smithii (Poir.) Merr. and Perry (syn. *Eugenia smithii* Poir.)
Acmena brachyandra (Maiden & Betche) Merr. and Perry (syn. *Eugenia brachyandra* Maiden & Betche).
Acmena divaricata Merr. and Perry.

Other species of the genus are recorded from New Guinea, Borneo, Java and the Andaman Islands. Two of the Australian species, namely *Acmena hemilampra* and *A. brachyandra* give timber of some commercial value. The remaining Australian and New Guinea species with few exceptions must belong to the genus *Syzygium* if the conception of Merrill and Perry is accepted.

The timbers from the Australian representatives of the genus *Syzygium*, of the genus *Cleistocalyx* as listed above, and of the genus *Acmena* (with the exception of *Acmena divaricata* of which no wood sample was available) were examined in detail but no significant anatomical differences between the genera were apparent. Therefore, on the anatomical side it must be concluded that the genera *Acmena*, *Cleistocalyx* and *Syzygium* are practically identical, possessing the following characteristics:

Pores variable in size, small to large but mainly medium and visible to the naked eye; few solitary but majority in radial multiples 2-8, mainly 2-4, with occasional groups or clusters; numerous; distribution mainly even but sometimes irregular in loose tangential rows or zones and occasionally with oblique tendency.

Rays 1-5 seriate, mainly 2-3 in *Cleistocalyx* and 3-5 in *Syzygium* and *Acmena*, and up to 30+ cells high; heterogenous with uniseriate margins consisting of 2-4 upright cells; tendency for rays of two kinds with

uniseriate rays up to 10 cells high and composed entirely of upright and squarish cells; pits to vessels simple, rounded to elongated or scalariform and gash-like, vertically or obliquely inclined; sometimes unilaterally compound.

Parenchyma paratracheal type; vasicentric, aliform to confluent, sometimes forming wavy and discontinuous bands 2-5 cells wide; crystal strands sparse to abundant.

Fibers medium- to thick-walled, pits mainly indistinctly bordered, occasionally with distinct border.

Thus, in this case the botanical separation into three distinct genera, namely *Acmena*, *Cleistocalyx* and *Syzygium* receives little support from the anatomical side, the only possible distinction being in *Cleistocalyx* where the rays appeared consistently narrower (see Plate II and compare Figs. 2 and 3).

References to Literature

1. Merrill, E. D., and Perry, L. M. *Jour. Arnold Arb.* 18: 322-343. 1937.
2. ——— *Jour. Arnold Arb.* 19: 1-20. 1938.
3. ——— *Jour. Arnold Arb.* 19: 99. 1938.
4. Record, S. J., and Hess, R. W. Timbers of the New World. Yale University Press, New Haven, Conn., U. S. A. 1943.

Explanation of Figures

PLATE I

Fig. 1. Cross section of *Eugenia axillaris Willd.* × 75, showing small, solitary pores and diffuse parenchyma.

Fig. 2. Cross section *Eugenia carissoides* F. Muell. × 75, showing very small, solitary pores with tendency to tangential zonate arrangement; rays mainly uniseriate and parenchyma diffuse and in loose bands.

Fig. 3. Cross section *Cleistocalyx gustavioides* (F. M. Bail.) Merr. & Perry × 75, showing medium-sized pores chiefly in radial multiples, and paratracheal type parenchyma.

Fig. 4. Cross section *Acmena brachyandra* (Maiden & Betche) Merr. & Perry × 75, showing medium-sized pores in clusters and radial multiples and paratracheal type parenchyma.

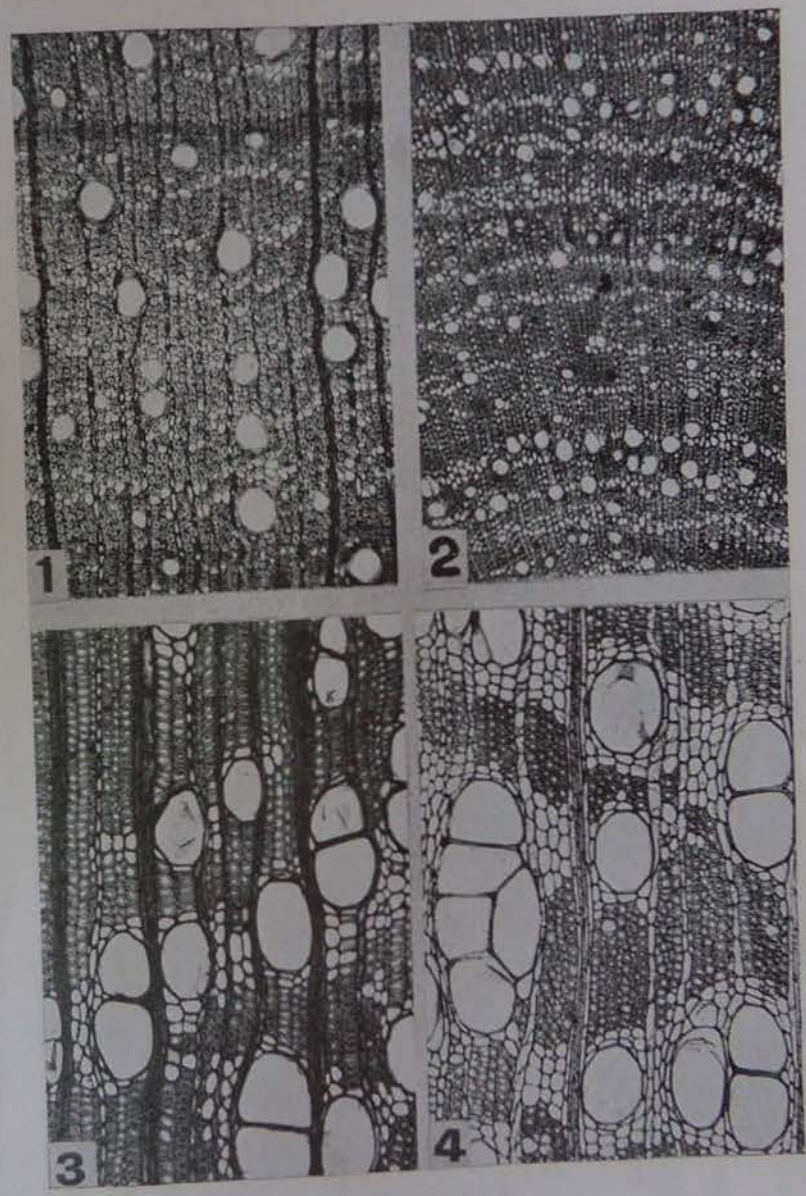

PLATE I

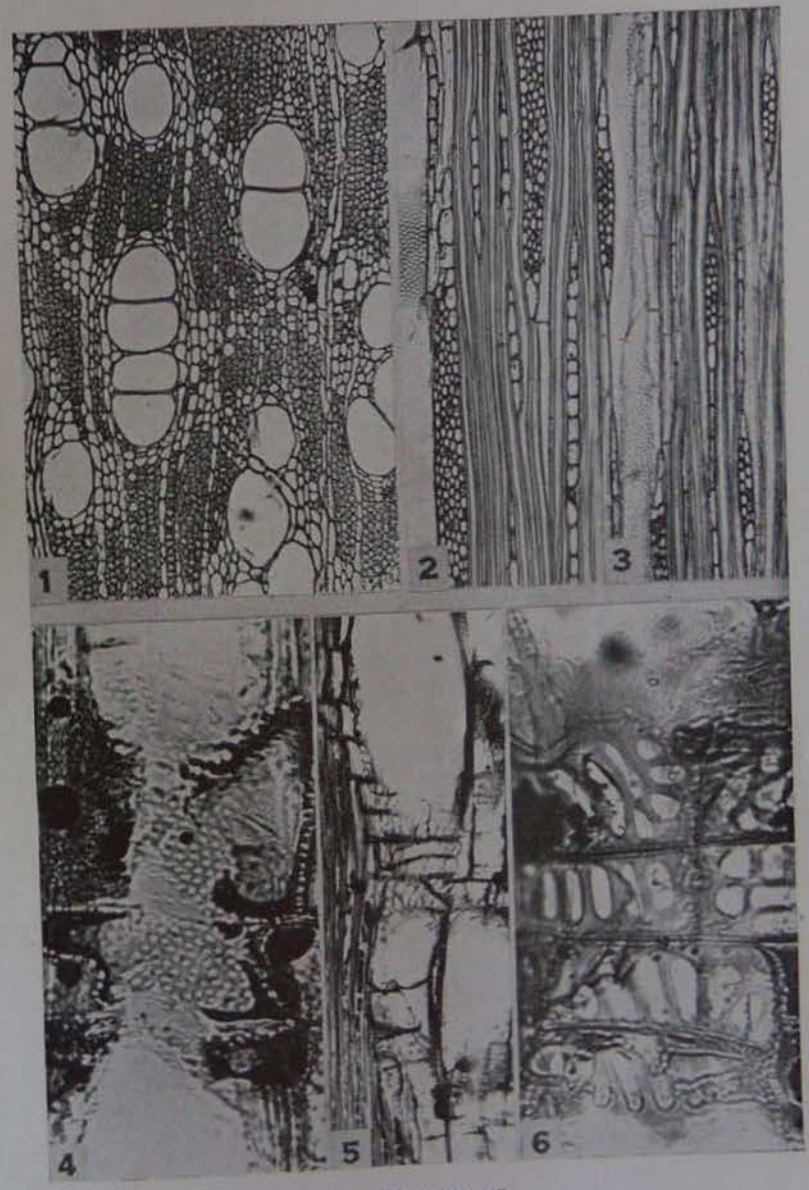

PLATE II

PLATE II

FIG. 1. Cross section *Syzygium ventenatii* (Benth.) Merr. & Perry × 75, showing medium-sized pores in radial multiples and paratracheal type parenchyma.

FIG. 2. Tangential section *Acmena brachyandra* (Maiden & Betche) Merr. & Perry × 100, showing rays 4-5 seriate and tendency to rays of two distinct widths.

FIG. 3. Tangential section *Cleistocalyx operculatus* (Roxb.) Merr. & Perry × 100, showing rays 2-3 seriate.

FIG. 4. Radial section *Eugenia axillaris* Willd. × 430, showing ray-vessel pitting small to minute and similar to vessel pitting.

FIG. 5. Radial section *Cleistocalyx operculatus* (Roxb.) Merr. & Perry × 100, showing simple, elongated to scalariform ray-vessel pitting.

FIG. 6. Radial section *Syzygium buettnerianum* (K. Schum.) Niedenzu × 430, showing ray-vessel pitting simple, elongated to scalariform.

NEW FOREST TREES AND CLIMBERS OF THE AMAZON

Sixth Series*

By ADOLPHO DUCKE

MORACEAE

Brosimum longistipulatum Ducke, sp. nov. – Ex affinitate speciei *Br. paraense* Huber per Amazoniam late dispersae et frequentis, gemmis autem longissimis ut speciei *Br. lanciferum* Ducke, foliis minoribus, receptaculis minoribus et multo longius pedunculatis. Arbor maxima, certa ultra 40 m. alta trunco cylindrico robustissimo. Lignum non examinatum; latex copiosus albus. Ramuli tenues, glaberrimi; gemmae stipulis vulgo ad 40 rarius 45 mm. longis, longissime et acute acuminatae basi vix ultra 1.5 mm. latae, parum acutae. Folia per ramulum numerosa, glabra, petiolo 3-5 mm.

*See *Tropical Woods* 31: 10 (1932), 43: 19 (1935), 50: 33 (1937), 76: 15 (1943), and Instituto Agronomico do Norte, *Boletim Tecnico* 4 (1945).

longo profunde canaliculato, lamina vulgo 35-70 mm. longa et 15-35 mm. lata, ovata vel oblongo-ovata basi obtusa apice breviter sat abrupte acuminata acumine ipso obtuso, tenuiter coriacea elastica, siccitate subtus ferruginescente, costa centrali in utraque pagina modice prominente, costis lateralibus supra obsoletis subtus tenuissime prominulis, e costa centrali angulo valde aperto exeuntibus, cum costulis nonnullis parum conspicuis alternantibus, venulis supra obsoletis subtus solum in uno vel altero folio conspicuis planis pallidis dense reticulatis. Receptacula axillaria solitaria, pedunculo sub anthesi 10-25 mm. longo, stricto vel parum arcuato, patente, gracili, subglabro apicem versus minime tomentello, globosa diametro 3-5 mm. (in exsiccatis), minutissime canotomentella; flos femineus solitarius, stigmatis ramis duobus e receptaculi vertice exsertis; flores masculi numerosi staminibus geminis filamentis conspicue exsertis; perianthia non visa.

Prope Tabatinga (in Brasiliae civitate Amazonas), silva non inundabili ad reipublicae Colombia limen, 30-XI-1945, *Ducke 1916*. Arbor unica observata.

The stipules of the gemmae of this species are extremely long and narrow, entirely like *Br. lanciferum;* the latter, however, has different-shaped leaves, peduncles and receptacles. The real affinity of the present species may be with *Br. paraense*.

The place where the plant was collected is in Brazil, but only a few meters from the boundary of Colombia; the new species should therefore be credited to the floras of both countries.

Brosimum brevipedunculatum Ducke, sp. nov. — Ex affinitate speciei *Br. lanciferum* Ducke Amazoniae partium orientalium et centralium incolae, recedit gemmis minus longis et evidentius pilosis, foliis minoribus, pedunculis brevibus. Arbor circiter 40 m. alta trunco cylindrico robustissimo. Gemmae (stipulae) vulgo circiter 20 mm. rarius usque ut 30 mm. longae, praeter tomentum tenuissimum pilis strigoso-adscentibus indutae, basi circiter 1.5 mm. latae. Folia iis speciei citatae similia at constanter minora, subtus magis

lutescentia; petiolus 3-6 mm. longus canaliculatus appresse pilosulus; lamina praeter costae medianae basin subtus pilosulam glabra, vulgo non ultra 70 mm. longa et 25 mm. lata (rarissime usque ad 85 × 35 mm. metiente), forma, consistentia et nervatione ut in citata. Receptacula ad axillas solitaria vel bina, pedunculis brevissimis (vix ultra 2 mm. longis), canopilosis, plus minus depresso-globosa, minutissime canotomentella; flores masculi numerosi, perianthio non conspicuo, staminibus solitariis; flores feminei in recepticulis examinatis maxima ex parte destructi; in semimaturis semen unicum observabatur.

Prope urbem Leticia (Colombia, Amazonas), silva terris humidis at non inundatis Brasiliae limini vicinis, 3-XI-1945, *Ducke 1918*.

The stipules of this new species are as narrow as those of *Br. longistipulatum* n. sp. and *Br. lanciferum*, but they are shorter; the leaves are like those of *Br. lanciferum*, but always smaller. The chief differential characteristic of the present species seems to be the shortness of the peduncles, more often observed in *Brosimopsis* than in *Brosimum*.

Pourouma formicarum Ducke, sp. nov. — Arbuscula paucimetralis. Ramuli mediocriter validi, parte novella pilis longis pallide flavidobrunnescentibus denum canis villoso-hispidi, vetustiores glabrati rufi. Stipulae ad 30 mm. longae, oblongae, rufobrunneae, striatae, extus glabrae, intus linea mediana excepta hispidae, cito caducae. Foliorum petiolus 10-14 mm. longus pilis longis canis hispidus, apice excepto unilateraliter in bursam circiter 6-8 mm. latam a formicis parvis habitatam expansus; lamina magnitudine in eodem ramulo valde varians, vulgo 120-300 mm. longa et 70-140 mm. lata, integra margine parum undulato, obovata, basi longe cuneata, apice breviter caudato-acuminata, tenuiter et elastice subcoriacea, supra obscura sparsius scabrido-hispida, subtus tomento albo araneoso minutissimo et denso induta, hic secus costas longe pilosa, secus venulas breviter pilosula, costis subtus prominentibus rufescentibus 11-15 per latum, parum ante marginem sursum arcuatis et anastomosantibus,

venulis transversalibus subtus prominentibus testaceis. Inflorescentia solum fructifera visa, 40-80 mm. longa, pedunculo infra primam dichotomiam 20-40 mm. longo, pedicellis vulgo binis ad 4 mm. longis, omnibus his partibus sat tenuibus longe cano-villosohispidis; fructus adulti in exsiccatis 15-18 mm. longi et 7-9 mm. lati, ovoidei (in vivis maiores et praesertim latiores, subglobosi), basi depressi apice angustati, longe et disperse canohispidi stigmate pilis brevibus fulvis densis et pilis longioribus pallidis minus densis vestito, maturi nigri pulpa albida dulci sapore grato.

Tonantins, Rio Solimões, in civitate Amazonas, silva non inundabili, 7-II-1944, *Ducke 1916;* arbor unica observata ramulis duobus solis fertilibus. Ab altera specie bursis petiolaribus munita *(P. myrmecophila* Ducke, e vicinibus Manáos) recedit pilositate hispida multo longiore, petiolo brevissimo, foliorum lamina obovata subtus alba.

The present species is the second myrmecophilous one of this genus. The other, *P. myrmecophila*, is easily separable by shorter pilosity, much longer petioles, more or less trilobate leaves not white on the under surface.

Myristicaceae

Iryanthera Tessmannii Mgf. = *I. microcarpa* Ducke (1945), fruit-bearing specimens with very small fruits. Specimens with staminate flowers recently collected near Iquitos *(Ducke 1778)* permit an easy identification of this species by A. C. Smith's very useful monograph of the American Myristicaceae.

Virola papillosa Ducke, sp. nov. – Arbuscula vix 4 m. alta ramis longis modice robustis, adultis rufis vel fuscis, rugosis, lenticellosis, glabratis praeter tomenti fusci e pilis 1 mm. longis non ramosis compositi relicta hinc illinc conservata. Foliorum petiolus 20-25 (saepius 20) mm. longus mediocriter robustus, canaliculatus, tomenti (eo ramulorum similis) relictis hinc illinc conservatis; lamina 300-500 mm. longa et 130-190 mm. lata, obovato-elliptico-oblonga, basi obtusa vel in medio subacuta, apice acuta vel brevissime

cuspidata, margine vulgo leviter undulato, tenuiter coriacea sat fragilis, in utraque pagina dense et valde conspicue ruguloso-papillosa (ut in generis *Iryanthera* speciebus plurimis), parum nitidula, subconcolor vel subtus aliquanto ferruginescens, adulta etiam in aetate juniore utrinque glaberrima, costa centrali subtus valida, costis lateralibus utrinque 22-28 parallelis sat distantibus, subrectis, in nervum marginalem valde conspicuum regulariter arcuatum terminatis, supra immersiusculis subtus prominentibus, venulis nullis. Inflorescentiae floriferae utriusque sexus ignotae; fructiferae juniores solae visae 20-40 mm. longae, pedicellis 10-12 mm. longis validis, sparsim minute strigosae; fructus in speciminibus nostris per inflorescentiam 1 ad 4, ut videtur vix semiadulti, exsiccati usque ad 23 mm. longi circiter 10 mm. lati, obovato-oblongi basi in stipitem brevem et latum constricti, glaberrimi (vivi maiores, virides, nitidi, distincte carinati).

In silva non inundabili prope Esperança (ad ostium fluminis Javary), individuum unicum observatum 17-X-1945, *Ducke 1911.*

This species is remarkable on account of its ample leaves finely papillose like several species of *Iryanthera*, a characteristic which I had never seen before in Virolae. I am not able to determine the place of this species in the system with certainty, because no staminate flowers are available; the size and shape of the leaves and fruits show probable affinity with the group Calophyllae A. C. Smith.

Rosaceae

Acioa guianensis Aubl.–This tree was hitherto known only from the Guianas; recently it has been found in the Brazilian state of Amazonas. Its drupes, like those of two other Rosaceae, are gathered floating on rivers or lakes in the central parts of that state, chiefly on the basin of the Lower Purús; they are known under the vernacular names*

*The name "Castanha de cutia" is, in the upper Solimões country, more often applied to *Scleronema praecox* Ducke, fam. Bombacaceae. The name "Cumarú-rana" is, in Belém and Manáos, more frequently given to *Taralea oppositifolia*, sometimes also to species of *Andira* and other arborescent Leguminosae with drupaceous fruits.

"coco de cutia," "castanha de cutia" or "cumarú-rana" and used for extraction of oil. One tree cultivated in the Jardim Botanico of Rio de Janeiro, from seeds planted in 1933, flowered recently.

Couepia stipularis Ducke.–Drupes collected March 1, 1946 under a tree which had flowered September 1945 *(Ducke 1755);* pericarp thin, in our specimens nearly destroyed by putrefaction; endocarp measuring 35 to 50 mm. by 25 to 35 mm., ovoid, rather thin–crustaceous, fragile, externally covered with long and coarse fibers borne on small tubercles and ramified and tapering at the end; seed with fine membranaceous testa adherent to the endocarp shell.

LEGUMINOSAE

Inga brachystachys Ducke, nom. nov., ought to replace the occupied name *I. brachystachya* Ducke; **I. crassiflora** Ducke, nom. nov., for the same reason as above, should replace *I. grandiflora* Ducke.

Bauhinia brachycalyx Ducke, sp. nov. – Ad sectionem *Pauletia* Bth. Fruticulus erectus, inermis, parum ultra 1 m. altus, multiramulosus, partibus vegetativis etiam novellis glabris. Ramuli gracilis cinerei. Stipulae parvae caducae. Foliorum petiolus 8-14 mm. longus, gracilis, canaliculatus; lamina vulgo 90-150 mm. longa 30-70 mm. lata, integra, lanceolato-ovata, basi obtusa, subacuta vel rotundata, apice longe acuminata, margine subtus tenuiter nerviformi, subcoriacea, concolor, nitidula, quinquenervis, venulis sat obsoletis laxe reticulatis. Racemi ad axillas foliorum adultorum solitarii vel superiores gemini, 30-60 mm. longi sursum curvi, pedunculo et rhachi gracilibus minute rufo-puberulis bracteis parvis persistentibus fultis; pedicelli secus rhachin sat distantes geminati 3-6 mm. longi. Alabastra adulta usque ad 15 mm. longa, non costata nec distincte apiculata. Calycis tubus anthesi 4-6 mm. longus, turbinatus, striatus, parce puberulus, apice intus inter filamentorum basin pilosus; limbus extus minime canotomentellus intus glaber, viridis, anthesi unilateraliter fissus spathaceus 6-8 mm. longus. Petala

alba (candida), modice inaequalia, maiora ad 20 mm. longa et ad 5 mm. lata, oblongo-oblanceolata apice breviter subacuta. Stamina 10, filamentis valde inaequilongis, antheris modice inaequilongis omnibus fertilibus. Ovarium glabrum, stipitatum. Legumen novellum solum visum longe stipitatum forma eum speciei *B. cinnamomea* DC. et affinium rememorans.

Habitat in silva riparia ut videtur vix inundabili medii fluminis Purús (in Brasiliae civitate Amazonas) circa ostium fluminis Pauliní; in Musaei Paraensis horto culta florebat 30-XII-1945, *Ducke 2045.* Statura humili et calyce parvo ab affinibus faciliter distinguenda.

A humble, erect, inermous shrub, pretty when abundantly flowering. The petals are of the purest white. The leaves resemble those of *B. cinnamomea* but the flowers are entirely different.

Genus **Dicymbe** Spruce ex Benth

Dicymbe was considered a monotypic genus for many years after Spruce discovered its first species; later, Sandwith described two others, apparently allied to the first. The genus was placed by Bentham, Baillon and Sandwith in the tribe Sclerolobieae on account of the free and central insertion of the ovary of the species known in their time. Three additional species recently discovered can only with doubt be placed in this genus; one has free but excentric insertion of the ovary; the other two have the ovary-stipe adnate to the wall of the receptacle, like the Amherstieae to which they are related by some other characters. All six have in common the very characteristic cymbiform bractlets, the filaments inflexed and the style involute in the praefloration, and the peltate stigma.

The insertion of the ovary can be different in species of the same genus, for example *Cynometra:* "Ovarium in fundo calycis liberum vel tubo brevi oblique affixum" (Bentham, in Martius' Flora Brasiliensis).

Synopsis of the Genuine and the Dubious Species of *Dicymbe*

A. Ovary free in the center of the straight receptacle. Bractlets at anthesis solute to the base. Petals moderately unequal.

1. *D. corymbosa* Spr. ex Bth. : Brazil (Amazonas: Rio Uaupés) and British Guiana. Wood unknown.*

2. *D. Altsoni* Sandw. : B. Guiana. "Sapwood white; heartwood reddish" (Altson); structure not mentioned by the collector, and therefore probably that of a normal Leguminosae.

3. *D. Jenmani* Sandw. : B. Guiana. Wood unknown.

B. Ovary free but excentric in the very short receptacle. Bractlets with keeled suture, at anthesis solute to the base. Petals moderately unequal. Wood structure anomalous: thin, irregularly concentric rings of phloem alternating with thick rings of xylem.

4. *D.* (?) *heteroxylon* Ducke: Brazil (Amazonas: Rio Solimões).

C. Ovary excentric, stipe unilaterally adnate to the wall of the receptacle. Petals very unequal, some of them rudimentary. Possibly a new genus to be placed in the tribe Amherstieae near the African genus *Berlinia*.

a: Bractlets at anthesis solute to the base. Receptacle turbinate, about as long as broad. Three petals large, two rudimentary. Wood structure that of a normal Leguminosa.*

5. *D.* (?) *amazonica* Ducke: Brazil (Amazonas: Rio Solimões).

b: Bractlets at anthesis solute from apex to above one third, the basal part connate in a tube which includes the narrow tubular receptacle. Normal (large) petals one or (more rarely) two, the other (two, three or four) rudimentary. Wood unknown.

6. *D.* (?) *Froesii* n. sp. : Brazil (Amazonas: Serra Tunuí near Rio Issana).

Dicymbe (?) Froesii Ducke, sp. nov. – Arbor secundum collectorem circiter 9 m. alta floribus virescenti-albis. Lignum ignotum. Ramuli adulti (soli visi) canopuberuli vel glabrati. Stipulae breves subulatae caducissimae. Folia magnitudine in ramulis sursum gradatim decrescentia, glabrata pilis canis hinc illinic in petiolo et in laminae pagina inferiore persistentibus; petiolus 2-3 mm. longus, crassus. Foliola unijuga, superiora saepe solitaria; petioluli 2-3 mm. longi, crassi; laminae 50-100 mm. longae, 25-65 mm. latae, obovatae vel oblongo- vel elliptico-obovatae, basi parum inaequilaterae

*The wood described in Record and Hess' Timbers of the New World, p. 260, is not *Dicymbe corymbosa* but *D.* (?) *amazonica*.

obtusae vel subacutae, apice rotundatae vel obtusae et saepe retusiusculae, crasse et rigide coriaceae margine revolutae, concolores, subtus nitidulae, costa centrali subtus prominente, lateralibus dissitis ut venulae reticulatae vix prominulis. Paniculae terminales vel ad axillam supremam, 1 ad 3 per ramulum (in speciminibus visis), longe et anguste corymbosae, e racemis adscendentibus parte superiore floriferis compositae, rhachidibus minime puberulis; bracteae non visae; pedicelli anthesi 8-10 mm. longi, canotomentelli. Alabastra bracteolis connatis inclusa oblongo-obovoidea apice obtusa, sutura non prominente. Bracteolae duae extus canotomentellae intus glabrae, apice extus in medio carinula brevi munitae, anthesi ab apice usqua infra medium solutae; partes solutae patentes 8-10 mm. longae oblongae concavae coriaceae; partes basales in tubum subcylindricum 4-6 mm. longum pedicello parum crassiorem receptaculum includentem concretae. Receptaculum 4-6 mm. longum anguste cylindricum, minime canotementellum, apice valde obliquum; sepala 5, vel 4 uno latiore saepe bifido, oblongo tenuia glabra bracteolis subaequilonga. Petala unum vel rarius duo magna glabra 12-15 mm. longa apice circiter 9 mm. lato, spatulata ungue longo, et 2 ad 4 rudimentaria anguste sublinearia dense pilosa. Stamina 10 libera, inaequalia, praefloratione inflexa, maiorum filamentis usque ad 23 mm. longis, basi longe villosis. Ovarium canotomentosum stylo glabro praefloratione involuto, pluriovulatum, stipite receptaculo unilateraliter longe adnato. Legumen novissimum solum visum, pilosulum (demum verosimiliter glabratum), stipiatatum, forma et consistentia legumina specie *D.* (?) *amazonica* et generis *Elizabetha* rememorans, sutura superiore dilatata et incrassata.

Serra Tunuí prope flumen Issana (Rio Negro superioris affluentem) in Brasiliae civitate Amazonas, altitudine circiter 450 m., 13-XI-1945 legit *R. L. Froes 21372*. Typus in Instituto Agronômico do Norte, Belém, Pará; duplicata herbariis variis distributa.

Speciei *D.* (?) *amazonica* affinis; foliolis unijugis vel solitariis apice obtusis, crassis et rigidis, bracteolis in parte

basali in tubum angustum receptaculum includentem concretis, receptaculo subcylindrico apice valde obliquo, petalis uno vel duobus magnis, reliquis minimis rudimentariis, ovarii stipite receptaculo unilateraliter adnato diversa et valde insignis. Inflorescentia eae specei *D. corymbosia* iconis (in Martii Flora Brasiliensis) simillima; bracteolae ut in congeneribus reliquis at basi in tubum concretae; ovarii stipes receptaculo unilateraliter adnato et petala pro parte rudimentaria (ut speciei *D. amazonica)* Caesalpinioideas Amherstieas rememorant.

Named in honor of my friend R. L. Fróes who discovered this remarkable plant on a mountain never before visited by botanists.

Swartzia tomentifera Ducke, sp. nov. *(S. Benthamiana* var. *tomentifera* Ducke, 1933).—A *S. laevicarpa* Amsh. (= *Benthamiana* auct. pro parte) differt ramulis et inflorescentiis tenuiter, leguminibus densius canotomentelis, foliolis subtus ferrugineis demum pallescentibus, opacis, aveniis, pedicellis et alabastris dense ferrugineo-tomentosis, variisque characteribus fructum. Fructus adultus e stipite crasso 4-5 mm. longo, 30-40 mm. longus, 18-22 mm. latus, 8-15 mm. crassus, obovoideus mediocriter compressus parum obliquus, basi acutus apice apiculatus, dense subferrugineo- vel canotomentellus, non rugosus, valvis lignosis maturitate ab apice dehiscentibus, suturis non dilatatis; semen unum rarius duo, subreniforme,, pallide brunneum, arillo parvo albo. Arbor mediocris; floris petalo et staminibus violaceis.

Habitat circa Manáos in terris argillosis altis silva primaria: prope Cachoeira do Mindú 10-XII-1927 florifera, *Ducke, Herb. Jard. Bot. Rio de Janeiro, 20360;* loco Estrada do Aleixo 31-III-1945 fructibus adultis *Ducke 1689,* florifera 29-X-1946 *Ducke 2025.*

This plant was first described as a variety of the common *Sw. Benthamiana* sensu "Flora Brasiliensis," which Amshoff considered different from the true *Sw. Benthamina* Miqu. and named *Sw. laevicarpa;* the recently discovered pod shows however that it is a new species. The pod of *laevicarpa* is much larger (70-100 × 45-50 × 15-25 mm.), entirely glabrous, finely shagreened to coarsely granulated after drying; the seeds are much larger (40 × 30 × 15 mm., in our specimens) and half involved in a broad, white aril. I was not able to examine the eventually present heartwood, because I would not destroy the now unique tree.

Swartzia arenicola Ducke, sp. nov.—Speciei *S. laevicarpa* Amsh. affinis, differt statura humili, ligno interiore colorato non evoluto, foliis ut videtur constanter trifoliolatis, petiolo et petiolulis crassis, foliolis rigide coriaceis margine recurvis, horum venulis crebre reticulatis supra saepe obsoletis subtus prominulis, inflorescentiis novellis in omni parte tomento densiore et magis rufo indutis, ovario glaberrimo, leguminis basi e stipitis apice abrupte rotundata rarius obtusa. Frutex vel arbuscula usque ad 3 vel 4 m. alta, pauciramosa, praeter inflorescentias glabra; foliorum et inflorescentiarum magnitudo et forma ut speciei supra citatae; stamina (in alabastro unico dissecto) maiora 6, minora numerosa; pistillum ut citatae at perfecte glabrum; legumen vulgo longius et tenuis stipitatum, saepissime uniseminatum subellipticoorbiculare, adultum usque ad 50 mm. longum 45 mm. latum, rarius biseminatum ellipticum ad 80 mm. longum, basi rotundatum vel rarius obtusum, apice apiculatum, suturis incrassatis, in vivo laeve, siccum subgranulosum.

Frequens in campina arenosa fruticetis coperta prope flumen Tarumá-mirí urbi Manáos vicinum, 19-I-1943 *Ducke 2036.*

This species is an affinity of *Sw. laevicarpa* Amsh. but is easily distinguishable by the botanical characters cited above, chiefly the constantly trifoliolate leaves, the glabrous ovary, and the round fruits. It is a shrub or treelet with hard, pale yellowish wood like many congenerics but without distinct heartwood. It has never been observed in other places than one of the "campinas" (open spots in the upland rain forest, with soil of white sand) along the river Tarumá-mirí near Manáos; it often grows together with *Taralea cordata* Ducke,

of very similar aspect when in sterile stage or bearing young fruits.

The affinity *Sw. laevicarpa* is a medium sized tree, common on flooded shores of lakes and slow rivers of the Middle Amazon country; it yields the famed "saboarana" wood of the timber trade of Manáos. Another affinity is the true *Sw. Benthamiana* Miq. (not Benth. !) of the Guianas and the northern part of the Brazilian State of Pará (Rio Erepecurú, tributary of Rio Trombetas, shore near the great cataract Cachoeira do Inferno, *Ducke, Herb. Amaz. Mus. Pará, 15013);* it is easily recognizable for having a lamellated pod.

Hymenolobium velutinum Ducke, sp. nov. – Arbor magna trunco cylindrico, non decorticante, cortice resinam rufam exsudante. Ramuli superiores crassi, petiolorum cicatricibus crebris notati, parte novella tomento rufo demum grisescente velutina. Stipulae subpersistentes, ad 8 mm. longae late ovatae convexae, pilis longis fulvis demum canescentibus velutinae. Folia ad ramulorum apices congesta, usque ad 400 mm. longa, petiolo sub foliolorum jugo infimo usque ad 50 mm. longo, ut rhachis dense fulvotomentoso; foliola vulga 15 ad 22, petiolulis et stipellis brevissimis dense fulvopilosis, inferiora brevia, mediana longa, superiora mediocria, jugi infimi vulgo 40-50 mm., medianorum usque ad 90 mm. longa, latitudine in jugis omnibus inter 25 et 30 mm. variante, oblonga vel (basalia) ovato-oblonga, basi vulgo plus minusve cordata, apice breviter acuminata vel acuta, adulta tenuiter coriacea margine revoluto, supra glabra nitida, subtus dense canopilosa costa mediana et marginibus longius fulvopilosis, costis lateralibus subtus prominentibus, venulis subtus prominulo-reticulatis. Paniculae in rami defoliati apice in inflorescentiam multifloram vulgo usque ad 200 mm. rarius 350 mm. latam dense congestae densissime fulvo-velutinae, bracteis et bracteolis lanceolato-oblongis ad 4 mm. longis sub anthesi peristentibus, pedicellis brevissimis vel subnullis. Flores odorati; calyx 12-15 mm. longus extus dense fulvo-velutinus, intus praeter marginem tomentellam glaber et

conspicue reticulatovenosus, dentibus acute triangularibus; petala circiter 20 mm. longa, glabra, uno saepe aliquanto inferiore; ovarium longe stipitatum undique dense et longe pallidosericeo-pilosum. Legumen ignotum.

Speciei *H. heterocarpum* Ducke silvae ripariae regionis Rio Negro affinis, at fructus ignotus; foliis floribusque maioribus et indumento velutino copiosissimo divergit.

Iquitos, terris altis versus San Juan in silvae primariae relicto, 19-XI-1945, *Ducke 1823*. Arbor sterilis prope Tabatinga (in Brasiliae civitata Amazonas) visa.

Up till now this beautiful species is the only one representing the genus *Hymenolobium* in the Peruvian Amazonia. This genus is remarkable for its giant trees in the middle and eastern parts of the hylaea. The species is easily recognized by the fulvous-velvet covering of the young branchlets and inflorescences; its affinities within the genus cannot be determined because fruits are lacking.

Dioclea mollicoma Ducke, sp. nov. – Ad sectionem *Pachylobium* Benth., speciei *D. reflexa* Hook. f. affinior, qua praesertim divergit ramulis, stipulis, petiolis et pedunculis dense canopilosis, foliolis subtus dense molliter subargenteo-sericeis, inflorescentiarum indumento canoferrugineo, bracteis densissime adpresse molliter canosericeis non reflexis, alabastris apice aliquanto incurvis, floribus adultis aliquanto maioribus, legumine maturo rugis prominentibus oblique transversalibus laxe subreticulato, hujus sutura superiora plus minus recta. Frutex volubilis; foliola adulta supra glabrata; nodi floriferi densi, breviter pedunculati; bracteae lanceolatae 4-5 mm. latae, suberectae vel tardius patentes (non reflexae); bracteolae oblongo-oblanceolatae circiter 5 mm. longae 2 mm. latae; petala laete violacea; legumen maturum glabratum usque ad 150 rarius 160 mm. longum et ad 65-75 mm. latum, circiter 10 mm. crassum, sutura superiore aliquanto, inferiore vix dilatata; semina vulgo 2 per legumen, circiter 40-45 × 35 × 7 mm. metientia.

Especança, ad ostium fluminis Javarí, in silvula secundaria recentiore terris altis argillosis loco humido, 26-III-1944

florifera, *Ducke 1598*, 18-X-1945 fructibus maturis, *Ducke 1829*.

Flowering specimens *(Ducke 1598)* have been distributed under the name *D. reflexa* var., but the more recently collected ripe pods show that it is a quite different species. The only one which seems to have a similar indumentum is the incompletely known *D. funalis* Poepp. et Endl. of Eastern subandine Peru; it has, however, according to Macbride's description in "Flora of Peru," suborbiculate bractlets scarcely 2 mm. long, and a 2 dm. long densely tomentose pod. *D. megacarpa* Rolfe, which is widely distributed in Tropical America, is also an affinity but has a different indumentum on all parts, long-ciliate bracts, and persistent hairs on the pods.

Linaceae

Roucheria elata Ducke, sp. nov. – Arbor circiter 30 m. alta trunco cylindrico robusto. Partes vegetativae glabrae innovationibus minime puberulis. Ramuli graciles, lenticellosi; stipulae erectae unguiformes 2 ad 3 mm. longae, sat caducae. Folia distiche alterna; petiolus vulgo 3-6 mm. longus, canaliculatus et marginatus; lamina 70-110 mm. longa et 20-28 mm. lata, lanceolata, basi in petiolum angustata apice longe cuspidato-acuminata margine evidenter crenato, tenuiter papyracea subconcolor nitida, costis lateralibus creberrimis tenuibus parallelis ante apicem nervo margini proximo conjunctis. Paniculae laterales ad foliorum axillas, 15-30 mm. longae multiflorae pluriramosae rhachidibus tenuibus minime puberulis, pedicellis brevibus, bracteis parvis ut calyces margine minute puberulo, floribus odoratissimis quam *Roucheriae calophyllae* circiter dimidio minoribus, petalis sicut in congeneribus at videter omnibus laete flavis, his staminibus pistilloque glabris. Fructus ignotus.

Speciei *R. parviflora* Ducke (circa Manáos in uno solo individuo observatae) affinis, recedens inflorescentiis elongatis et sepalis non glandulosis nec glutinosis; a specie guianensi parum nota *R. Schomburgkii* Planch., indumento minimo; a specie boliviensi *R. laxiflora* Winkl. et specibus reliquiis, foliis parvis; ab omnibus, statura magna.*

In silva terris altis prope Leticia (Colombia, Amazonas) arbor unica observata, 3-XI-1945, *Ducke 1799*.

Dichapetalaceae

Tapura singularis Ducke, sp. nov. – Arbor usque ad 25 m. alta trunco cylindrico, ramulis gracilibus tomento tenui cinereo demum canescente indutis. Stipulae 2-5 mm. longae lanceolatae vulgo acutissimae, persistentes. Foliorum petiolus vulgo 8-10 mm. longus cinereosericeus demum glabratus; lamina adulta 80-125 mm. longa 25-35 mm. lata, lanceolata, basi in petiolum attenuata, apice longe sensim acuminata, margine revoluto, subcoriacea, utrinque viridis et nitida, supra glabra saepe subgranulosa fere avenia, subtus sparsim pilosula praesertim ad marginem, costa mediana supra immersa subtus prominente et densius adpresse pilosa, costis lateralibus e mediana utrinque 5-8, ut venulae laxe reticulatae tenuiter prominulis. Inflorescentiae subumbelliformi-cymosae, cinereotomentellae, in axillis foliorum saepius juvenilium vel in ramulis brevibus et tenuibus aphyllis, pedunculo libero (non petiolo adnato ut in speciebus reliquis) 1-2 mm. longo, cymis simplicibus vel pauciramosis, bractea juxta pedunculi basin et bracteolis in pedunculi apice (inter pedicellos) stipuliformibus sat persistentibus, pedicellis subumbellatis 2-3 mm. longis. Flores suaveolentes, in exsiccatis 4-8 mm. longi; calyx extus et intus cinereosericeus (apice tenuius); corolla in vivo alba dum novissima, cito subaurantiaco-lutescens, tubo extus subglabro, intus dense albolanato, laciniis 5 minus inaequalibus et minus involutis quam in speciebus *guianensis* et *amazonica*, subglabris in utraque pagina. Staminum filamenta infra albolanata, supra subglabra, antherae saepius 3 fertiles et 2 parvae steriles, rarius 4 vel omnes 5 fertiles. Ovarium sericeum, stylo piloso, in quarto superiore subglabro, stigmatibus brevibus 3 vel

R. angulata Gleason, from Esmeralda, Venezuela, belongs to the genus *Hebepetalum*.

interdum 4. Drupa ellipsoidea vel ovoidea dense canovelutina, quam speciei *T. amazonica* brevior et latior, saepe subglobosa, pilis velutinis longioribus.

Inter omnes hujus generis et forsan familiae species adhuc notas pedunculo libero, nec petiolo adnato, insignis.

Belém, Pará, Bosque Municipal, silva primaria non inundabili, florifera 4-IV-1946 *Ducke 1930*. Arbores duae visae.

This new species diverges from all congenerics (and perhaps from all Dichapetalaceae) by its free peduncle, not connate to the petiole as in the others. The tree is also remarkable for its large size which is unusual in this family; it reaches about 25 meters in height.

Bombacaceae

Matisia bracteolosa Ducke (1945).–Flowers white with green calyx; fruits glandiform, conical-ovoid, inserted in the cupuliform calyx which shows five well-developed longitudinal crests. These (apparently half adult) fruits are of the size of those of the common *M. ochrocalyx* but of more elongated form. Tabatinga, *Ducke 1781*, with flowers and fruits, rather frequent on moist places of upland forests; Esperança, fruiting, *Ducke 1782*.

Matisia lasiocalyx Schum.–Esperança, *Ducke 962* and *1784;* rather frequent on moist places of upland forest. Fruit (apparently nearly adult) depressed obconical, 60 mm. high, 70 mm. wide, inserted in the horizontally dilated calyx which has the appearance of a slightly concave plate with 55 mm. of diameter. The finely areolate and rugulose fruit is covered with a very tenuous brown tomentum.

Ochnaceae

Krukoviella scandens A. C. Smith.–Near Tabatinga, in upland forest along the Colombian border, *Ducke 1839*. Liana climbing on a rather high tree by adventitious rootlets adherent to the bole, branching only in the uppermost part. Flowers intense yellow; valves of an old capsule preserved in one inflorescence, 30 mm. long, narrow, acuminate, hard ligeneous, resembling those of *Cespedesia* and *Godoya* in shape, but seeds unknown.

Caryocaraceae

Anthodiscus pilosus Ducke, sp. nov. – Arbor circiter 20 m. alta trunco valido cylindrico. Ramuli lenticellosi, novelli canopilosuli cito glabrati. Foliorum petiolus vulgo 40-50 mm. longus rarius brevior vel longior (usque ad 60 mm.), dense canopilosus; folioli terminalis petiolulus 10-20 mm., lateralium 3-10 mm. longus, lamina folioli terminalis 70-100 mm. longa, vulgo 40-60 mm. lata, foliolum lateralium saepius parum (rarius sat conspicue) minor, foliolorum omnium obovata, basi cuneata et sat longe in petiolulum decurrens, apice rotundata et in apice brevissime apiculata rarius retusiuscula, margine revoluto et distincte crenato, chartacea, supra magis quam subtus nitida, hic parum pallidior, supra glabra subtus submolliter griseopilosa (praesertim in nervis), costis subtus prominentibus, lateralibus e mediana utrinque 9 ad 12 longe ante marginem anastomosantibus, venulis reticulatis infra tenuiter prominulis. Racemi terminales 110-140 mm. longi, dimidio superiore floriferi pedunculo rhachidibus et pedicellis (his sparsius) canopilosis, his sub anthesi 10-12 mm. longis. Calyx 4-5 mm. latus, 2-2.5 mm. altus, subobsolete 5-dentatus, canopilosulus; petala intense flava ad 10 mm. longa, oblonga, subglabra, anthesi supra cohaerentia et caduca; stamina ad 8 mm. longa numerosa flava anthesi multiple contorta, filamentis subtuberculatis; pistillum glabrum ovario viridi stylo flavo. Fructus ignotus.

Iquitos (in Peruvia orientali, Departamento Loreto), in silvae versus San Juan Nuevo loco alto solo arenoso albo, 12-XI-1945, *Ducke 1855*.

Inter omnes hujus generis species hucusque descriptas indumento piloso bene evoluto notabilis.

This new species was discovered in a curious forest on a high and dry place with soil of white sand, where several species of the "catinga" of the upper Rio Negro are represented (among them, the little known Rutacea *Leptothyrsa Sprucei)*. Among larger trees, there are many *Taralea oppositifolia* Aubl., a species which in Brazilian Amazonia occurs almost exclusively in "igapó."

COMBRETACEAE

Buchenavia congesta Ducke, sp. nov. – Speciei *B. macrophylla* Eichl. affinis, differt statura magna, foliis ad ramulorum apices dense congestis numerosissimis lamina apice subtruncata, drupis novellis et maturis glaberrimis. Arbor ultra 30 m. alta trunco cylindrico robusto basi radicibus tabularibus parum elatis fulto. Ramuli apice valde incrassato folia 20 et ultra densissime congesta ferentes; innovationes fugaciter rufotomentellae. Folia magnitudine in eodem ramulo sat diversa, eglandulosa, epunctata; petiolus 20-30 mm. longus; lamina vulgo 80-150 mm. longa et 40-70 mm. lata, obovata basin versus longe cuneata in petiolum decurrens, apice late subtruncata et hic in medio breviter apiculata, tenuiter coriacea, cito glabrata pilis secus nervos longius persistentibus, parum nitidula, nervis et venulis ut in specie supra citata. Flores non visi. Spicae fructiferae parum numerosae, novellae rufotomentellae; pedunculus vulgo circiter 30 mm. longus, rhachis fertilis saepe usque ad 70 mm. longa. Drupae jam novissimae perfecte glabrae magnitudine et forma earum speciei citatae, adultae (siccae in herbario) ad 25 mm. longae et ad 8 mm. crassae.

Arbor hucusque unica observata circa Manáos loco Cachoeira do Mindú in silva non inundabili solo arenoso, *Ducke 1465* fructibus adultis 3-XII-1943, *Ducke 2003* fructibus novellis 4-X-1946.

This plant is closely akin to *B. macrophylla* Eichl;. a species frequent along upland brooks near Manáos. The latter is, however, a low tree seldom reaching medium size; its leaves have a different shape and are not so many and not so congested at the very apex of the branchlets; its drupes have a silk which they preserve even in adult age.

ARALIACEAE

Schefflera paraensis Huber ex Ducke.–The description (in Arch. Jard. Bot. Rio de Janeiro 3: 228 [1922]) is erroneous as to the petala; these are not connate forming a calyptra, but perfectly separated and spreading in anthesis. The tree is frequent in "igapó," along streamlets in upland forest near

Belém (Pará) and Manáos. Specimens from Belém *(Ducke 1929)* bearing staminate and pistillate flowers and young fruits have been distributed.

SAPOTACEAE

Pradosia atroviolacea Ducke, sp. nov. – Arbor circiter 35 mm. alta trunco robusto cylindrico, cortice amaro et adstringente, latice viscido parum copioso, ramulis mediocriter robustis cinereis rimosis. Partes vegetativae, exceptis innovationibus tenuissime canosericeis, glaberrimae. Folia in ramulorum parte superiore alterna; petioli 10-20 mm. longi, basi depresso-dilatati, supra tenues et anguste canaliculati; laminae vulgo 90-160 mm. longae et 40-70 mm. latae, minoribus nonnullis non raro intermixtis, oblongo- vel subelliptico-obovatae, basi breviter plicata saepissimo acutae, apice vulgo breviter acuminatae, subtus tenuissime marginatae, elastice subcoriaceae, utrinque virides et nitidulae, costis lateralibus e costa centrali subtus crassa supra immersa utrinque 12-18 saepius 14 inter se sat distantibus supra immersiusculis subtus prominentibus, ante marginem arcuatis et attenuatis, venis transversalibus numerosis at subobsoletis. Flores secus ramulorum partes inferiores hornotinas et ramos crassiores in fasciculis alternis densis multifloris; pedunculi 2-3 mm. longi, robusti; calyces circiter 3 mm. longi campanulati in phylla 4 late ovata imbricata profunde partiti, extus ut pedunculi minime canosericei, intus glabri; corollae atroviolaceae, glabrae praeter lineam longitudnalem medianum extus parce albosericeam, in alabastro adulto subcampanulatae calycem duplo superantes, sub anthesi plane radiatae diametro 9-12 mm., tubo 1 mm. parum longiore, lobis 5 vel 6 oblongis apice anguste obtusis; stamina 5 vel 6 glabra loborum basi inserta, anthesi corollam parum superantia, filamentis atrovioláceis praefloratione ut in generis reliquis speciebus flexuosis, antheris albis ovatis; ovarium 5- loculare breviter albidosericeum, stylo viridi brevi glabro alabastrio incluso. Fructus ignotus.

Prope Leticia (Colombia, Amazonas), in silva primaria non inundabili 3-XI-1945, *Ducke 1800.*

The present new species belongs to a group composed of three species whose common characteristics are the dark violaceous flowers and the bitter bark. The two others are *Pradosia verticillata* Ducke, from Manáos, and the southern *P. lactescens* (Vell.) Kuhlm.; the former with much larger rigid leaves a little sericeous beneath, forming more or less complete verticils, and with smaller flowers (diameter about 6 mm.); the latter with narrow sublanceolate-obovate leaves and small flowers borne in ample fascicles on the bole and the old and thick branches.

As to the genus *Pradosia* Liais, see: Ducke, "New and Noteworthy Sapotaceae of Brazilian Amazonia. The species of the genus *Pradosia* Liais." *Tropical Woods* 71: 10 (1942). Kuhlmann: *Archivos Jard. Bot. Rio de Janeiro* 5: 206 t. 26 (1930).

Styracaceae

Styrax bicolor Ducke, sp. nov. – Speciebus amazonicis *S. guianensis* et *S. Sieberi* affinis, differt foliorum forma et colore et inflorescentiis longioribus saepe paniculatis. Arbor parva ramulis tomento rufo in vetustis fuscescente vestitis. Folia alterna; petiolus 15-20 mm. longus tomento ut ramulorum; lamina 100-220 mm. longa, 55-120 mm. lata, ovata vel ovato-oblonga margine integro revoluto, basi obtusa vel rotundata, apice breviter abrupte caudatoacuminata, crassius papyracea, supra glabra nitida in vivo viridis, subtus opaca in vivo ut in exsiccatus pulchre rufa solum in vetustis fuscescens hic pilis microscopicis simplicibus pallidis et punctis obscure rufis sub lente conspicuis e pilis fasciculatis microscopicis compositis vestita, supra nervis omnibus plus minusve immersis, costis lateralibus vulgo 7 maioribus et 2 minoribus, subtus valide prominentibus e costa mediana crassa utrinque marginem attinentibus, venulis transversis laxis subtus plus minusve prominulis. Inflorescentiae axillares saepius binae rarius trinae vel quaternae racemosae vel paniculatae pauciramosae, usque ad 80 mm. longae, rhachidibus rufotomentosis. Flores vulgo 7-9 per inflorescentiam, usque ad 13 mm. longi, ut in specie *S. guianensis* constructi at pedicellis ad medium

bracteolis duabus linearibus arcuatis usque ad 1.5 mm. longis saepe sub anthesi persistentibus fultis, calyce 4-5 mm. alto, corollae albae tubo brevissimo subglabro, laciniis intus fere ut extus sericeis, staminum pilis ut *S. guianensis* longioribus et densioribus, pistillo glabro. Fructus ignotus.

São Paulo de Olivença (ad fluvium Solimões in civitate Amazonas), terris altis arenosis in silva "catinga," 16-X-1942, *Ducke 1113*.

This is the fourth *Styrax* species at present known in the hylaea of the Amazon and the Guianas. It is at first view distinguishable from the others by the pretty red-brown under surface of the leaves. The other species of the hylaea are: *S. guianensis* Aubl., widely distributed through the whole region and frequent in some localities of the inundable ("varzea") forest; *S. Sieberi* Perk., of upland forests near Belém (Pará) and Altamira (Rio Xingú, Pará); *S. pallida* A. DC., known only in the type collection from French Guiana; *S. Tessmannii* Perk., of the Peruvian Amazon.

Loganiaceae

Strychnos Krukoffiana Ducke, sp. nov. – Ad sectionem *Longiflorae*, speciebus *divaricans* et *tabascana* aliquanto affinis. Frutex robustus altissime scandens, trunci crassi cortice fuscescente non soluto, inermis, cirrhifer. Ramuli fuscescentes lenticellis vix pallidioribus, novelli saepe rufescentes et plus minus angulosi. Partes vegetativae glabrae ramulis et petiolis minime puberulis. Foliorum (in ramis fertilibus) petiolus vulgo 3-8 mm. longus ;lamina vulgo 40-90 mm. longa et 30-50 mm. lata, ovata vel ovato-lanceolata vel rarius oblongo-ovata, basi rotundata vel subcordata, apice acuminata et saepius complicata, margine subtus prominente, rigidius membranacea chartacea vel subcoriacea, supra vulgo nitida, subtus pallida vix nitidula, triplinervis vel rarius quintuplinervis, tenuiter et laxe reticulata supra magis conspicue quam subtus. Cymae terminales corymbosae densiflorae in parte superiore puberulae, pedunculo vulgo 10-25 mm. longo modice robusto 3-tomo, bracteis vario modo lanceolatis vel subulatis 2-5 mm. longis, bracteolis breviori-

bus, his partibus praesertim ad margines ciliatulis, pedicellis brevissimis vel rarius usque ad 2 mm. longis. Calyx circiter 1.5 mm. longus extus breviter subsericeo-pilosulus lobis lanceolatis acute acuminatis apice vulgo conspicue recurvis et distincte ciliatis. Corollae tubus in speciminibus nostris usque ad 15 mm. longus, extus praeter basin glabram papillosus et dense pilosus, intus super medium pilosulus fauce glabra; lobi (5 vel rarius 4) usque ad 5 mm. longi extus dense et sat longe pilosi, intus papillosi non barbati. Stamina glabra filamentis 2 mm. et ultra longis, antheris longe exsertis 0.5 mm. longis basi rotundatis. Ovarium et stylus glabra. Fructus ignotus.

Prope Manáos in silva primaria terris altis argillosis ultra Flores, individuum unicum hucusque visum, *Ducke 1981*, 30-VIII-1946, inflorescentiis recentius defloratis corollis nonnullis siccis sat bene conservatis.

This new species is easily recognizable for the lanceolate and recurved calyx lobes; for the corolla tube densely pilose without, glabrous at throat within; for the lobes densely pilose without, papillose within; for the greatly exserted small anthers on long filaments.

The plant is named in honor of my friend B. A. Krukoff, collector of many new species and whose monograph is a true Natural History of the American (chiefly the Amazonian) *Strychnos*.

Convolvulaceae

Dicranostyles Falconiana (L. Barroso) Ducke, comb. nov. = *Kuhlmanniella Falconiana* L. Barroso, "Rodriguesia" IX nº 18: 36 and Plate (1945).—Manáos, upland forest along the Aleixo road, A. Ducke coll. 3-X-1936, *Herb. Jard. Bot. Rio 35591*. There can be no doubt that this plant is a true *Dicranostyles* like other species with a single, not bifid, style (*D. holostyla* Ducke, *D. integra* Ducke, *D. Mildbraediana* Pilg.); it may however be a new species, related to *holostyla* but distinguishable by much larger and chiefly broader leaves with distant nervures, and by ample but looser flowered inflorescences.

Bignoniaceae

Schlegelia macrophylla Ducke, sp. nov.—Speciei *S. roseiflora* Ducke affinis, differt foliis multo maioribus (praesertim latioribus), subtus glanduloso-punctulatis, pedunculis et pedicellis canosubsericeis, his longioribus, floribus maioribus, calyce albo apice subtruncato vel breviter dentato (nec bilabiato), corolla alba limbo punctis 5 violaceis signato.

Frutex robustissimus in arborem elatam scandens, verisimiliter epiphyticus dum juvenis. Rami et pseudostipulae ut in specie citata. Foliorum petiolus 25-30 mm. longus, ut in citata at glandulis basalibus obsoletis; lamina vulgo 160-200 mm. longa et 90-150 mm. lata, late obovata, basi in petiolum contracta, apice rotundata et in centro brevissime abrupte acuminulata, margine revoluto, subcoriacea, subconcolor, utrinque nitida, supra glabra subtus glanduloso-punctulata, costis lateralibus e mediana subtus incrassata in utroque latere 7-10 subtus prominentibus ante apicem fortier arcuatis et anastomosantibus, venulis tenuibus in utraque pagina sat conspicuis. Paniculae laterales ut in specie citata, at partibus omnibus robustioribus, latiores, vix subracemiformes, usque ad 50 mm. longae et latae; pedunculi novelli, rhachides, pedicelli et praesertim bracteae pilis apressis minimis canosubsericei; bracteae lanceolatae validae; pedicelli breves robusti. Calyx in vivo inflatus, carnosus, albus (lacteus), in exsiccatis chartaceus sub anthesi circiter 8 mm. longus 6 mm. latus (in vivis multo maior), subcampanulatus, basi abrupte in stipitem brevem contractus, apice truncatus vel parum profunde sinuoso-dentatus, utrinque glaber, extus subreticulato-rugulosus apice membranaceo excepto; in alabastro clausus. Corolla alba limbi lobis intus signo parvo violaceo notatis, glabra, tubo in siccis 13-15 mm. longo cylindrico, fauce minime pilosula, lobis circiter 6 mm. longis intus papillosis anthesi reflexis. Stamina parum inaequalia, supra minime pilulosa. Pistillum glabrum. Fructus semiadulti exsiccati ad 15 mm. longi, in calyce cupulari glandiformes.

Prope Esperança (ad ostium fluminis Javary), silva non inundabili loco humido prope rivulum, 24-X-1945, *Ducke 1854*.

The present new species is the seventh one known up till now from the hylaea of the Amazon and Guianas. See: the key to the species of that region, in *Tropical Woods* 76: 30 (1943).

STUDIES OF THE TREES OF BRITISH GUIANA[1]

I. CRABWOOD *(CARAPA GUIANENSIS)*

By D. B. Fanshawe

Assistant Conservator of Forests, British Guiana

Vernacular Names

Crabwood,[2] Empire Andiroba, British Guiana Mahogany (trade); Karaba (Arawak); Karapa-yek (Akawaio); Karapa (Carib).

The Tree

Evergreen, canopy tree to 170 feet high and 6 feet in diameter, usually 80-100 feet high and 1½-3 feet in diameter. Bole 30-90 feet (short boled in marsh forest), buttressed 2-3 feet high or basally swollen, bole form moderately good except with swamp Crabwood. Crown oval or elliptical, heavy, branching erect. Bark brown or pink (especially when freshly peeled of dead bark), occasionally gray or black, smooth or with widely spaced shallow grooves. Slash from pale pink to crimson, streaked with lighter markings, soft, medium thick; pale brown gum present.

Leaves very large, paripinnate, 6-8 paired; leaflets oblong or elliptical, cuspidate, acute at apex, acute or subrounded

[1]"Published data on the trees of British Guiana are somewhat inadequate, although a considerable amount of information has been collected by the Forest Department over a number of years. It is therefore proposed to prepare a series of studies of the most important timber trees of the Colony, drawing mainly on departmental records, but also making use of other published data."—C. Swabey, *Conservator of Forests.*

[2]British Standard Nomenclature.

and slightly subequal at base on 5-10 mm. pedicels, 9-16 cm. long by 3-6 cm. broad, leathery, midrib flat above, prominent beneath, veins 12-16 per side, prominulous above and below.

Flowers in erect spike-like panicles from axils of unopened leaves, in shortly stalked cymose bunches at intervals along the spike, greenish white, tubular; calyx and corolla 4-lobed; stamens united into a tube with 8 teeth, bearing the anthers on the inside between the teeth; ovary 4-celled, each cell with 4 ovules in pairs.

Fruit oval, sometimes globose capsule, dark brown, rough, woody with 4 ridges running from apex halfway down the sides, dehiscent into 4 cocci, 6-8 cm. by 4-5 cm.; seeds 4-16, angular on two sides, rounded on the third, brown, 3-4 cm. across, 10-12 gm. in weight, 35-40 per lb. The seeds have a thin brittle shell enclosing a kernel with a light brown papery skin. The kernel weighs 9 gm. The shell forms 29% and the kernel 71% of the seed.

Habitat and Frequency

Climax species dominant on old sandreefs and sandbanks in marsh and riparian forest, locally frequent to abundant in Mora forest on alluvial flats liable to inundation, scattered along water courses on sandy or alluvial soils and occasional in climax rain or seasoned forest on well drained steep hillsides.

Stocking

One to two per cent strip valuation surveys of the forest show that the stocking of sound trees 16 inches in diameter and over, per 1000 acres is as follows:

Northwest District	120-450
North Central District	
Waini-Cuyuni R.	80-230
Cuyuni-Mazaruni R.	230-830
Mazaruni-Essequibo R.	0-600
Northeast District	0-400
Eastern District	10-120

The richest areas are:

Lower Cuyuni River	56 cu. ft. per acre
Lower Mazaruni River	48 cu. ft. per acre
Demerara River above Great Fall	36 cu. ft. per acre
Barima River (above Koriabo)	31 cu. ft. per acre
Lower Corentyne River	23 cu. ft. per acre

The last two representing the Northwest and Northeast Districts respectively are present sources, the first three future sources of supply.

Distribution

General in the Colony, more or less confined to the near interior, scattered and occasional in the far interior. Widespread from British Honduras and southern West Indies through Venezuela and Guiana to Amazonian Brazil.

Phenology

General flowering annually from October to February. In good years the odd tree will flower as early as September or late August and some will still be in flower in March. In bad years flowering is restricted to December and January. Individual trees flower annually for 3-6 weeks. Casual flowering sometimes occurs during the regular fruiting season.

General fruiting from April to July; in good years (every second year) as early as March or late February. The fruits mature in 5-6 months. Individual trees fruit annually for about 4 weeks. Casual fruiting sometimes takes place during the regular flowering season.

Under suitable conditions trees begin flowering when 6-8 years old and fruiting when 10-12 years old.

Seed dispersal

Chiefly within the zone of crown influence but extended by water and animal life. The fruits are buoyant for a short time but soon become waterlogged and sink. The seeds are buoyant until they rot. Rodents are responsible for the destruction of some 80% of the seed falling on non-inundated land and incidentally for the dispersal of a small percentage of the crop.

Survival

Seed does not store well, becoming dry very quickly and losing its viability. The best method of storing is spreading of the seed on the ground under shade.

Germination

Hypogeal, good, up to 95% under favorable conditions. Low germination results from drying out, waterlogging or insect bored seed. Germination period 3-6 weeks.

Seedlings

Nursery. Growth vigorous, fast, up to 10-12 inches before first leaves are put out. First leaves flaccid, bronze-pink, with two pairs of ovate leaflets. Growth in first year in forest nursery 18 inches, (in Trinidad 3 feet [Marshall]). Strong tap root developed to 18 inches in 6-12 months, often (branched near the foot into 2-3 parts) with side roots plentiful 1-4 inches long usually clustered just below the seed.

Natural. Seedlings thrive under light overhead shade, will succeed in the open but do not survive under heavy low cover. Growth of 2-3 feet attained in first year.

Nursery practice

Sowing (dibbling) in nursery beds in the open in rows 9 inches apart, 4-5 inches apart in the rows is recommended by Marshall. Nursery beds under light shelterwood on sandy clay are successful. No pre-treatment of seed is necessary.

Plantation practice

Transplanting. In the rainy season one year old seedlings are undercut leaving not less than six inches of tap root, allowing the leading shoot to harden up and then moving plants as soon as fresh rootlets begin to form. Balls of earth are not necessary.—After Marshall.

Stump planting. Stump planting of straight stool shoots 10-12 feet long and 4-6 inches in diameter buried 1-2 feet deep is feasible in marsh forest. Stumps are reputed to take easily but the method has not been tried out on a large scale.

Direct sowing. Dibbling of seed ½-inch deep under shelterwood of second story and undergrowth trees is successful in Trinidad. Direct dibbling on brown sand on an open north slope at Mazaruni resulted in 90% germination but seedlings were killed by drought.

Silvicultural characteristics

Moderate shadebearer, preferably side shade. Overhead shade desirable for young plants, later full overhead light with some side shade. Reasonably wind firm. Coppices freely. Naturally resistant to insect pests and diseases, only slightly troubled by *Hypsipyla*, the shoot borer. Fire resistant both naturally and by reason of its habitat.

Sociability

Mildly gregarious to occasionally almost pure stands. Occurs in small reefs of 10-50 (<100) trees of felling size along the Waini River in the Northwest District at the rate of 2-3 trees per acre. Rare concentrations of 200 trees per acre 6 inches diameter and over on sandbanks in the Corentyne River have been known but have now been exploited.

Rate of growth

Fast growing species. In Trinidad average height growth is five feet per year in early life. In British Guiana diameter growth at best is one inch per year (stool shoots in marsh forest) and on the average two inches in three years under favorable conditions. A sample plot at Mabaruma planted in 1919 had a mean diameter of 6 inches in 1927, 16-20 inches in 1944.

Trees reach felling size in marsh forest in 20-25 years, in Mora forest probably 30-50 years and in miscellaneous hill forest in perhaps 40-60 years. Maximum age is not known, perhaps 100 years.

Regeneration

No accurate data have been collected as yet.

Response to treatment

Still untried.

Pests

Rodents and occasionally pigs eat the seeds; deer browse on the young seedlings and pigs root them up but probably bury seeds at the same time.

Plantation grown Crabwood is often severely attacked by a shoot borer, larva of the moth *Hypsipyla grandella* which tunnels the leading shoots, forcing side shoots to become leaders and producing malformation of the stem. Forest trees have a natural immunity. Seeds are sometimes found bored by another species of *Hypsipyla*. Leaf cutting ants *(Atta)* are particularly fond of flaccid young Crabwood leaves.

Logs are susceptible to pinhole borer damage and the sapwood of seasoned timber to attack by powder-post-beetles (Lyctidae).

Morocot, paku and occasionally cartabac fish are known to feed on the seed.

Uses

The bark is bitter, containing an alkaloid carapina, used medicinally for dysentery, diarrhoea, rheumatism, eczema and ulcers. The bark is also used locally in a small way for tanning. Percentage of tannin in the bark varies from 1-10%.

A cream colored, intensely bitter oil with high acidity and an unpleasant smell can be extracted with solvents or expressed from the seeds. The oil forms 59% of the kernels or 39% of the seeds. Constants for Carapa oil are as follows:

Specific gravity at 100/15° C.	0.857-0.922
Refractive index at 40° C.	1.4560-1.4593
Solidifying point of fatty acids °C.	32.8-37.8
Acid value	22-75
Saponification value	195.5-198.5
Iodine value, per cent (Hubl. 17 hrs.)	57-65
Unsaponifiable matter, per cent	0.6-1.1

Locally the oil is expressed by boiling the seeds till soft and pulpy, allowing them to rot under shade for 2-3 weeks, mashing them and placing them on an inclined zinc sheet in the sun. The oil oozes out and is caught in a container. It is used by the Indians for anointing the skin and hair as a preventative against maiyubuli ticks, bete rouge, sandflies, eyeflies and lice, as an illuminant and industrially for the manufacture of soap, candles and insecticidal washes, medicinally for skin diseases, dressing wounds on stock and for treating wood to repel insect attacks. Residual cake left after oil is expressed from seed kernels by industrial process is too bitter for feeding stuff but could be used for low grade fertilizer.

Wood

Macroscopic characters. Sapwood pale brown or oatmeal colored 1-2 inches wide scarcely distinct from the heartwood in the white variety; heartwood light to dark reddish brown, somewhat darker than Honduras Mahogany; lustrous on radial surface, scarcely so on other surfaces. Irregular growth rings visible on the cross section due to bands of terminal parenchyma. Pores visible to naked eye, open. Rays occasionally storied in oblique lines, faintly visible on the tangential surface, distinct on the radial surface.

Microscopic characters. Pores diffuse, open, 0.15 mm. diameter, 3-8 per sq. mm. single or in groups of 2-3. Perforations simple; intervascular pits minute, crowded, borders polygonal, apertures slit-like. Fibers subcircular in section, lumina septate and filled with red gum, pits simple. Parenchyma not abundant, vasicentric and terminal, the latter prominent, 1-3 cells wide, lumina gum-filled. Rays 4-6 per mm., 3 (1-5) cells wide, 2-50 cells high, heterogeneous, gum-filled. Vessel elements 0.33-0.46 mm. long. Fibers 0.83-1.30 mm. long.

Timber types

Three well marked varieties occur.

1. Black Crabwood from the hill lands is darker, heavier, denser, non-floating with interlocked grain something like Bullforehead Greenheart or Brown Silverballi. It is very rare.

2. The normal type of Crabwood from the hill lands and Mora forest is reddish brown floating wood with straight grain.

3. White Crabwood from the swamp lands is softer, paler, coarse, often woolly wood which floats high out of the water.

Physical properties

Odorless, tasteless. Density medium-low, sp. gr. (air-dry) 0.6-0.75, weight 37-47 lbs. per cu. ft. Texture medium to rather coarse, occasionally woolly especially when swamp grown. Grain fairly open, usually straight, sometimes interlocked, occasionally with a fiddle-back mottle. Tough, moderately hard (black variety) to fairly soft (white variety), firm, strong. Immune to white ants; fairly resistant to fungus attack; durability in contact with ground poor (In sandy clay not liable to inundation it rots in 3 years, in clay periodically inundated it rots in 5 years.); classed as fire-resistant.

Working properties

The timber works moderately easily with both hand and machine tools. It is 25% harder to cut than Honduras Mahogany. Straight-grained material finishes smoothly. The wavy and interlocked grain causes a fair amount of picking up in quarter-sawn material, even to removing complete crescent-shaped chips, and requires considerable sanding for a smooth finish. A cutting angle of 15° should be used in planing. It has a tendency to split when nailed but takes screws and glue well, stains readily and will take a high polish. A wax filler must be used first on the softer variety. It peels well for veneer but the end-splitting of the logs causes a certain amount of loss. In the rough it tears easily with a ragged fracture.

Mechanical properties

Air-dry the timber is 30% stronger in bending and in resistance to suddenly applied loads, 40% more resistant to splitting, 50% stiffer and 60% harder on the side grain than Honduras Mahogany. It is comparable with Black Walnut in resistance to gradually applied and shock loads. In strength it is equivalent to Black Cherry and Black Walnut.

Mechanical Properties of Crabwood

	F.P.R.L. ENGLAND	F.P.L. CANADA	P.W.D. GEORGETOWN
	AT 12% MOISTURE CONTENT		
Modulus of rupture, lb. per sq. inch.	14,600	17,200	14,100
Modulus of elasticity, lb. per sq. inch	2,120,000	2,197,000	2,125,000
Impact–Toughness, energy consumed, in. lb.	115	—	—
Max. crushing strength parallel to grain, lb. per sq. inch	8,590	8,980	—
Resistance to indentation–side grain, lb.	1,130	—	—
Resistance to indentation–end grain, lb.	1,550	—	—
Resistance to splitting–radial plane, lb. per inch width	410	—	—
Resistance to splitting–tangential plane, lb. per inch width	470	—	—

Seasoning properties

The timber air seasons rather slowly with little distortion but wtih a strong tendency to split and check. It kiln seasons fairly well but slowly, with a tendency to split in the initial stages. The shrinkage in kiln drying from green to 10% moisture is 6% in the tangential and 3% in the radial direction. Kiln schedule (iii) of the Forest Products Research Laboratory, Princess Risborough, is recommended.

Boards and planks have been successfully air seasoned locally under open-sided sheds. During the rainy seasons, the wood is liable to reabsorb moisture and seasoning is retarded. Moisture is reabsorbed quickly but lost again slowly. On the average 1-inch lumber dries out from a 48% m.c. to 19% m.c. in 25 days and to 14% m.c. in 62 days. At the Forest Station, Mazaruni, 1-inch lumber dried out from 60 to 15% m.c. in 6 months.

Uses

Building construction: Flooring, interior partitions, door and window stock, shutters, jalousies, bannisters, lattice work, panelling, mouldings, ceilings, weather boarding, shingles.

Boat building: Interior work only.

Land communications: Coach and motor vehicle, cart, dray and freight wagon body building.

Furniture: Display cabinets, cupboards, cheap furniture, drawer linings, instrument cases, switchboards, domestic articles by turnery.

Veneers: Furniture veneer, commercial plywood.

Trade substitutes

The following timbers can be intermixed with Crabwood: Karababalli *(Guarea guara)* and Yuriballi *(Trichilia* spp.) of the same family; both are lighter in color and with more figure. Kurokai *(Protium decandrum)* and Haiawaballi *(Tetragastris* spp.) of the incense family; these are very similar in the rough to the paler Crabwood and after treatment with potassium bichromate the finished material can scarcely be distinguished. Kirikaua *(Iryanthera* spp.) is similar in the rough.

Exploitation

As much as 30% of the timber felled in marsh forest either never leaves the forest or is useless by the time it reaches the mill. Felling shakes and splits are the cause. Trees occasionally burst along their length. The damage is not so great with trees grown in Mora and hill forests. As a result

of this tendency to split and check, shipments abroad of unseasoned lumber degrade as much as 40%.

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Notes on 42 Secondary Hardwood Timbers of British Honduras. Forestry Dept. Bul. 1. 1946.

CURRENT LITERATURE

The cork oak tree in California. By WOODBRIDGE METCALF. *Economic Botany* (New York Bot. Garden, New York 58, N. Y.) 1: 1: 26-46; 4 figs.; January-March 1947.

A survey of existing Cork Oak trees and groves in California, the development of nursery practice and field planting, harvesting of bark, and the quality and quantity of bark are discussed.

"There are about 5,000 trees more than ten years old in the state.

"Cork oak acorns produced in California average 70 per pound, have a high germinative capacity which can be maintained for twelve months or more by moist cold storage at 38° F., and during most years it should be possible to obtain from five to ten tons of cork oak acorns from California trees.

"During the past six years about 200,000 seedling trees of cork oak have been grown and distributed to land owners under the cooperative cork oak project. Where carefully planted, protected from animal damage and given adequate irrigation, shade and care, many of these plantations have shown excellent survival and growth."

"Regrowth of cork after stripping has been rapid and satisfactory with trees, usually regaining the diameter before stripping in five years. Indications are that the reproduction cork is of excellent quality. Trees 25 to 30 years of age when stripped have put on a growth of 100 pounds of reproduction cork in five years.—*From author's summary.*

The palo verde forest type near Gonaives, Haiti, and its relation to the surrounding vegetation. By J. T. CURTIS. *Caribbean Forester* 8: 1: 1-12; January 1947.

"The palo verde forest type, an example of the Thorn Woodland formation, was investigated near Gonaives, Haiti. The stand was located on the coastal plain among low calcareous mountains, with a rainfall of only 20.24 inches per year. Quadrat analysis of forest composition

revealed that *Cercidium praecox* and *Prosopis juliflora* were the dominant species with frequencies of 46.2 per cent and 76.2 per cent respectively. Basal area dominance was greatest for *Cercidium*, with a value nearly equalling that of all other species combined. Three species of arboreal cacti were prominent in the community, as was *Phyllostylon brasiliensis*. A consideration of neighboring vegetation types indicated that the palo verde forest properly could be termed the *Cercidium-Prosopis* faciation of the *Prosopis-Acacia* association. In many respects it was transitional community between the Thorn Woodland formation and the Cactus Scrub as described by Beard."—*From author's summary.*

Growth in the lower montane rain forest of Puerto Rico. By Frank H. Wadsworth. *Caribbean Forester* 8: 1: 27-35; January 1947.

This is a discussion of forest growth as related to tropical forests and as exemplified by measurements of a plot in the lower montane forest.

A Spanish-English glossary of forestry terminology II. By Carmen García-Piquera. *Caribbean Forester* 8: 1: 45-64; January 1947.

This is the second group of 100 words for the glossary begun in Vol. 7, No. 2.

The second year in the Cambalache Experimental Forest. By Frank H. Wadsworth. *Caribbean Forester* 8: 1: 65-70; January 1947.

An account of the administration of the forest and the experimental work in progress.

A new species of *Terminalia* from Cuba. By Joseph Monachino. *Caribbean Forester* 8: 1: 79; January 1947.

Terminalia orientalis Monachino is described as new.

"Of the species described in *Terminalia* from the West Indies, *T. angustifolia* and *T. molineti* are placed in synonymy with *T. spinosa*, and *T. buceras* are referable to the genus *Bucida*. *T. capitata* is referable to the genus *Buchenavia*; *T. erecta* (and its var. *procumbens*), to *Conocarpus*. Of the species still recognized in *Terminalia*, the much smaller leaves of our plant readily separate it from *T. catappa* L. and *T. latifolia* Sw.; *T. chicharronia* (Griseb.) Wright and *T. domingensis* Urban are placed in synonymy of *T. intermedia* (A. Rich.) Urban; this latter species, together with *T. arbuscula* Sw. (and var. *xanthica* Gomez) and *T. eriostachya* A. Rich. are easily distinguishable from *T. orientalis* by the pubescence clearly observable on their branchlets (new growth), inflorescence-rhachis, and hypanthiums."

The mora forests of Trinidad, British West Indies. By J. S. Beard. *Jour. Ecology* (London) 33: 2: 173-192; 6 figs.; July 1946.

"The mora forests of Trinidad in which *Mora excelsa* Benth. is dominant and gregarious occupy restricted areas. No environmental factors appear to account for the alternation of mora forest and mixed crappo-guatecare *(Carapa-Eschweilera)* forest. Mora is believed to be a recent arrival in the island and to be actually invading the mixed forests.

"Mora is of wide distribution in Guiana, where it is occasional in most types of rain forest, becoming gregarious only on swampy flats where competition is lessened. Mora is thought to have become gregarious in Trinidad because the moist forests are not typical rain forests, but have a more open structure. Shade is sufficiently thin to enable mora readily to become established, after which its great reproductive power makes it gregarious and its greater height suppresses the mixed forest.

"Mora is believed to have crossed over to Trinidad from Guiana by a land bridge in late Pleistocene to subrecent times."—*Author's summary.*

The natural vegetation of Trinidad. By J. S. Beard. Publ. Clarendon Press, Oxford (Oxford University Press, New York) 1946. Pp. 152; 43 figs., 1 folded map. $6.00.

This scholarly work represents a very complete study of the flora, plant communities, and ecological relationships of

climax vegetation types of Trinidad. It is based upon the extensive surveys used by R. C. Marshall *(Physiography and Vegetation of Trinidad and Tobago*, 1934), a complete set of land utilization and vegetation maps, and other extensive surveys and studies.

"The local flora appears to show affinities of a remote nature to the flora of West Africa, agreeing with the geological view of a possible land connection across the middle Atlantic during the Tertiary era. A consideration of tree species alone showed that of 155 genera and 239 species in Trinidad, 47 genera and 12 species occur in West Africa. Six of the species are littoral, of the kind propagated by ocean currents.

"As regards nearer relations, the affinities of the local flora are South American rather than Antillean, again in accordance with geology. There may have been a land bridge with the southernmost Antilles as far up as St. Vincent (but no farther) during the Pliocene, whereas Trinidad has certainly been united to Venezuela comparatively recently.

"The Lesser Antilles belong to a separate and quite distinct floristic region. Tobago belongs with Trinidad and Venezuela, but there is a sharp floristic boundary between Tobago and Grenada."

Annual Report — Jamaica Forest Department. Pub. Forest Department, Kingston, Jamaica, 1946. Pp. 10.

Timber products amounting to 77,626 cubic feet were cut from Crown and Reserve Lands during the year. The principal species utilized were: Cedar *(Cedrela odorata)*, Broadleaf *(Terminalia latifolia)*, Shadbark *(Pithecolobium alexandri)*, Bullet, Black, White and Red Naseberry (Sapotaceae spp.), Mastic *(Sideroxylon foetidissimum)*, Santa Maria *(Calophyllum antillanum)*, Goldspoon *(Antirrhoea jamaicensis)*, and Yacca *(Podocarpus purdieanus)*.

Revista Agricola (Guatemala) 2: 21-26: 266-454; illus.; 1946.

This number is dedicated to the Forest Service of Guatemala and contains many short articles, notes, and illustrations

on many subjects pertaining to forests and forestry of this country. Included are accounts of fire control, soil erosion, tree species, nurseries, timbers, forestry in other American countries, and the exportation of Guatemalan timbers.

Report of the Forest Department for the year ended 31st December, 1945. Pub. British Honduras Forest Department, Belize, 1946. Pp. 21.

"Although the demand for mahogany did not diminish, the United States Government ceased buying, and steps were taken within the Colony to conserve the remaining stocks of mahogany. These steps consisted of the introduction of rotational cutting by area on the Crown Lands and the passing of a law giving Government control of cutting on private estates. The result will be a reduction after the 1945-46 season in the output of mahogany logs and it is hoped that as a consequence more attention will be paid to secondary hardwood species and pine."

"The new Ordinance for the Conservation of Private Forests means in effect that the Forest Department has undertaken the management of mahogany felling on private estates. . . . . The law prohibits the felling of any mahogany tree without a permit from the Conservator of Forests who must give a reply to each application within thirty days of receiving it. The Conservator may impose such conditions as seem necessary and the applicant has the power of appeal to the Governor in Council. As over fifty per cent of the exploitable timber on private estates is mahogany, and as little secondary hardwood timber has yet been felled, this law provides means of preventing the destruction of much valuable forest by overcutting of mahogany, but it will inevitably mean a reduction of output from private lands for several years to come. Records have been kept of the fellings on private estates in 1945, these have been entered in a register for each estate which will assist in the compilation of management plans for the estates after the new maps have been completed. Each application for a felling permit has been investigated on the ground by a

Forest Officer and a girth limit set according to the forest type. In this way all estates will eventually be graded on the basis of their potentialities."

Old and new mix in Costa Rican logging. By ARTHUR C. HART. *Wood* (Chicago) 2: 4: 18-19, 42; 4 figs.; April 1947.

The methods of logging are described and a brief account given of the principal woods cut and utilized in the clearing of land for the American Cinchona Plantation.

The genus *Strychnos* in Venezuela. By B. A. KRUKOFF and J. MONACHINO. Reprint from *Darwiniana* (Buenos Aires) 7: 2: 185-193; 1946.

"In the present paper we have enumerated the species that occur in Venezuela and have compiled a key to these species. Of the ten species collected up to the present date in Venezuela six are of recent collections by L. Williams, Killip, and Felix Cardona. We have also included in this paper four species of *Strychnos* that have not been collected in Venezuela as yet and which, however, in our opinion occur there."

"Although the first report on the arrow-poison of the aborigines of the Orinoco and Rio Negro reached Europe in 1595, our knowledge of the plants entering into the composition of Curare and the methods of its preparation by various tribes of Indians in Venezuela is remarkably incomplete."

La Guyane Française: terre d'avenir. By L. MARCHENAY. *Rev. Internat. Bois* (Paris) 13: 114: 198-201; December 1946.

A brief description of French Guiana is followed by an enumeration of the agricultural and industrial possibilities. The forests and the value of their woods (enumerated) are discussed.

"In resumé it is painful to have to state that even at the present moment, there is such a territory which could be

put to so much valuable use, which is still waiting to be taken advantage of, waiting for a large population of workers to create domains and thus contribute to the better well-being of the individual in the production of useful products. For this reason I conclude: French Guiana, Land of the Future."—*Mary Record.*

Forest resources of western Ecuador. By EUGENE F. HORN. *Agric. Americas* (Washington) 7: 3: 46-49; 4 figs.; March 1947.

"A survey made in 1943 by the U. S. Forest Service in cooperation with the Office of the Coordinator of Inter-American Affairs showed the coastal forest to be extremely varied in composition and to contain woods suitable for many commercial and industrial purposes. Woods ranging in weight from 5 pounds per cubic foot for balsa *(Ochroma lagopus)* to 80 pounds per cubic foot for cascol *(Libidibia corymbosa)* are found in these forests. Cascol is proving suitable for making the frames and wheels of pulleys because of its hardness, interlocking fibers, and great strength. Some kinds, such as guayacán *(Tabebuia chrysantha)*, madera negra *(Tabebuia* sp.), pechiche *(Vitex gigantea)*, guachapelí *(Pseudosamanea guachapele)*, coquito colorado *(Erythroxylon glaucum)*, and moral fino *(Chlorophora tinctoria)* are extremely durable when exposed to the weather and are valued for such uses as for poles, foundation timbers in buildings, and railway cross ties. Moral fino is the fustic wood of the dyewood trade, but none is exported from Ecuador for this purpose. Guachapelí is widely used in ship building, pechiche for tight cooperage, and the purplish-brown heartwood of coquito colorado appears suitable for knife handles, hand-saw handles, billiard-cue butts, brush backs, and similar articles."

"A few Ecuadorean woods, such as bálsamo *(Myroxylon balsamum)*, laurel de cerro *(Cordia* sp.), laurel negro *(Cordia alliodora)*, and amarillo de Guayaquil *(Centrolobium* sp.), are highly figured and possess undulating grain. They are capable of receiving a brilliant polish, making them highly

suitable for cabinet work, interior trim, fixtures, and similar purposes. The bálsamo fixtures, interior trim, and furniture of the Hotel Metropolitano in Guayaquil have caused much favorable comment because bálsamo resembles Cuban mahogany in a finished condition. . . . Much of the better office furniture in Guayaquil is made of laurel de cerro. In a finished state it is not unlike Circassian walnut. Laurel negro or laurel de montana is somewhat darker in color and resembles North American black walnut after finishing."

The Amazonian varieties of *Lonchocarpus nicou*, a rotenone-yielding plant. By Frederick J. Herman. *Jour. Wash. Acad. Sciences* (Menasha, Wisconsin) 37: 4: 111-113; 1 fig.; April 15, 1947.

Three varieties are described and an argument for the preservation of the generic name *Lonchocarpus* presented.

Plantas de cultura precolombiana na Amazonia Brasileira. By A. Ducke. Inst. Agron. do Norte (Belem), Tech. Bul. No. 8, June 1946. Pp. 24.

Notes accompanying each of a list of cultivated plants indicate the forms that have developed and their probable origins.

Estatistica Florestal. Classificação das madeiras. By Gil Sobral Pinto and Demétrio Rodriques Alves. Serviço Informação Agricolo (Rio de Janeiro) No. 553.

Included in this bulletin are the results of a survey to determine the relative values, occurrence, and economic importance of the woods of Brazil. The data are segregated by states, municipalities, and species. Maps are given for the areas covered and one shows occurrence of principal species.

A industrialização dos eucaliptos. By Guilherme de Almeida. *Revista Florestal* (Rio de Janeiro) 4: 1: 2-9; 4 figs.; 5 tables; September 1945.

A study of the checking (cracking) of the timbers of *Eucalyptus saligna* Smith is followed by a compilation of other experience with plantation grown *Eucalyptus* woods.

Tinguaciba da restinga. By Othon Machado. *Revista Florestal* 4: 1: 16-20; 10 figs.; September 1945 and 4: 2: 8-13; 10 figs.; December 1945.

An account is given of the Restinga *(Fagara arenaria* Engl.) in the coastal region of Rio de Janeiro and Espirito Santo. This species is indicated as correct for inclusion in Farmacopéia Brasileira. It is contended that Tinguaciba *(Zanthoxylon tingossuiba* St. Hil.) is properly of the genus *Fagara.*

A identificação do angicos. By Otavio Silveira Melo. *Revista Florestal* 4: 2: 14-17; 4 figs.; December 1945.

The common names and methods of identifying the Brazilian *Piptadenia* species are given.

Combate ao cupim. By Djalma de Almeida. *Revista Florestal* 4: 2: 24-42; 34 figs.; December 1945.

The comparative resistance of a number of woods to attack by wood destroying cupins (primitive ants), Rhinotermitidae, was determined by field tests. Included were woods treated with preservative.

Pata de vaca. By Othon Machado. *Revista Florestal* 5: 1: 48-49; 3 figs.; March 1946.

A very brief account of *Bauhinia forficata* Link. with two photomicrographs and a photograph of herbarium specimens.

Instrucciones practicas para el cultivo del eucalipto. Direccion Forestal (Buenos Aires) Misc. Publ. No. 196, 1945. Pp. 15; 8 figs.

Recommended nursery and planting practices for *Eucalyptus* seedlings are described. The site requirements are noted for a number of species.

Contribucion al estudio del cedro misionero. By Raimundo R. Martin. Direccion Forestal (Buenos Aires) Misc. Publ. No. 232, 1946. Pp. 19; 10 figs.

The Cedro Misionero *(Cedrela fissilis* Vell. var. *macrocarpa* C. DC.) is described from the standpoint of its appear-

ance, silvical characteristics, forest types in which it occurs, growth; bole form, utilization of the wood, artificial propagation, and timber production costs.

Evolucion de la industria tonelera Argentina a base de maderas indigenas. By Jose C. Tinto. Direccion Forestal (Buenos Aires) Pub. Tec. No. 8, 1946. Pp. 47; 6 figs.; 10 photog.

The economic factors, history, and processes of the cooperage industry are explained. The use of native woods is discussed and the results compared with North American Oak.

Resoluciones forestales de la III[a] conferencia Interamericana de agricultura reunida en Caracas. By Lucas A. Tortorelli. Direccion Forestal (Buenos Aires) Pub. Tec. No. 6, 1946. Pp. 12.

The author, who was the Argentine delegate, reports the recommendations and resolutions of the conference on Interamerican Agriculture that relate to forests.

Forest resources of Chile as a basis for industrial expansion. By I. T. Haig, L. V. Teesdale, P. A. Briegleb, B. H. Payne, and M. H. Haertel. Pub. by U. S. Forest Service (Washington) and Corporacion Fomento Produccion (Chile), 1946. Pp. 256; 18 plates; 20 figures; 1 folded map.

"The forests, plantations and woodlands of Chile occupy an area of 16 million hectares, or 22 per cent of the Republic's land surface, and represent a natural resource of great potential value. This resource, protected from fire and placed under crude forest management, is capable of sustaining, on a permanent basis, several times the industry now based upon it. The immediate expansion of the forest industries is promising. Such expansion should only be the first step toward longtime developments which will use the resource in full as one of the permanent mainstays of Chile's industrial economy."—*From author's summary.*

Notes on two species of *Araucaria* in New Guinea and a proposed new section of the genus. By C. T. White. *Jour. Arnold Arb.* (Jamaica Plain, Mass.) 28: 2: 259-260; 1947.

A new section "Intermedia" is proposed for *Araucaria Hunsteinii* K. Sch., *A. Schumanniana* Warb., and *A. Klinkii* Lauterb.

New and noteworthy Chinese Fagaceae. By Woon-Young Chun. *Jour. Arnold Arb.* 28: 2: 230-244; 1947.

Nine new species and three new combinations are given for *Lithocarpus*. Six new species are described for the genus *Quercus*.

Check list of British vascular plants. By the British Ecological Society. *Jour. Ecology* (London) 33: 2: 308-347; July 1946.

"The purpose of this Check List is not to provide an authoritative statement on the content and taxonomy of the British flora, but to secure uniformity of nomenclature in contributions to the Biological Flora. Contributors will be asked always to use the names appearing in the List unless they can give adequate reasons for doing otherwise. This will obviate the necessity for citing the authorities for names, since it will be understood that the authorities are those cited in the Check List."

"The criterion for inclusion of a name in the List is that it is believed to be the best *binary* name for a taxonomic unit which is at least frequently regarded as having 'specific' rank. It should not be inferred that contributors are bound to recognize all included units as full species. In order to emphasize this point it has been felt useful to set in from the margin names of units whose claim to specific rank is not generally conceded. Contributors may treat such units as subspecies or varieties if they so choose (citing authorities for the names used), but if binary names are used they must be those given in the List."

"Long-established names are retained, even when known to be invalid, in certain instances where there is still doubt as to the correct name under the Rules."

Dichtung und Wahrheit um die Welwitschie. By G. Boss. *Natur und Volk* 69: 7: 323-331; 5 photographs; July 1939.

Some 80 years ago the German botanist Welwitsch discovered in Mossamedes (Angola, Southwest Africa) the plant which today bears his name. *Welwitschia* is unable to grow in the dune belt along the coast because of lack of water, but occurs in a narrow desert strip some 35 to 50 kilometers inland. The range of the plant extends from the Kuizeb River on the south into Mossamedes on the north.

There appears to be no danger of *Welwitschia* being exterminated because it has no value to either the native or white population. Even when dead the plump woody trunks do not make good fuel as they smoke excessively. The only animals that eat the leaves are zebras and locusts. Leaves that have been eaten to the ground by locusts may show new growth of 30 to 40 cm. within 5 months.—H. J. Lutz, *Yale School of Forestry*.

Beitrag zur Systematik und Phylogenie der Gattung *Tecoma*. By H. Melchior. *Berichte Deutsch. Bot. Ges.* 59: 1: 18-31; 2 figs.; 1941.

The genus *Tecoma* Juss. (= *Stenolobium* D. Don), which is wide-spread in South and Central America and even appears in southern North America (Texas, Arizona and Florida), has developed, especially in the Andes region, a larger number of species. Among the presently known types of the genus, to which belongs the wide-spread *T. stans* (L.) H.B.K., Nov. Gen. Spec. Plant. (1818) p. 144, there are some certain doubtless very natural relationships which the author could designate as the Section *Eutecoma* Melch., sect. nov., and which, especially through the form of the corolla among others, exclusively characterizes the *Tecoma* species restricted to the Andes.

Stenolobium castanifolium (D. Don) Melch. is dealt with in detail, including description, collections, relationships, and phylogeny.—M. Record.

Unterschiede zwischen Fichtenholz verschiedener Herkunft. By Herbert Lommatzsch. *Beihefte Bot. Centrabl.* 60: 1 & 2: 97-134; 11 figs., 9 tables; 1940.

Spruce wood from different latitudes was studied anatomically and chemically. Growth rings of the "native" woods were found to be much more variable than those from more northerly latitudes. Single tracheids were studied to determine size, shape, cell wall arrangements, and lignin color reactions; the native woods showed extreme variation. Moisture absorption and loss tests, lignin solubility and modification tests, cellulose solubility, and viscosity modification tests were also conducted. Tharandt spruce possessed the most strongly lignified "middle layer" and the highest lignin content. Western Norway samples were least lignified, and may have longer cellulose molecules.

Southern Kalahari. By O. B. Miller. *Empire Forestry Rev.* (London) 25: 2: 225-229; 2 figs., 1 text map; 1946.

"Southern Kalahari—is the country west of a point forty-five miles west of the large African village of Kanye. It is that part of the Kalahari sand sheet which has been invaded by the more diverse woody flora found to the east and to the north."

"In the east [Kanye area], tree and shrub species number about sixty; in Kalahari the larger trees are represented by four only—*Acacia giraffae* (Camel thorn, Mokala), *Acacia gillettiae* (Mokwelekwele), *Acacia detinens* (Mongana), and *Boscia albitrunca* (Motlopi). The Camel Thorn is the largest of these, up to 2 feet d.b.h. and a total height of 30 feet, well distributed over the whole area . . ."

"The commoner shrubs seen were *Acacia stolonifera* (Sitshi) a most useful sand-stay, *Zizyphus mucronata* (Mokgalo), *Rhigozum brevispinosum* (Morokwana) and *Terminalia sericea* (Mogonono) which was always dwarfed

or a bushy coppice. Only occasional were *Ehretia hottentotica* (Morobi), *Grewia* spp., *Gymnosporia buxifolia* (Motono). Near Kue the following were seen: coppice of *Ochna pulchra* (Monyelenyele), *Acacia retinens* (Mhahu) and *Royena* sp. like *R. pallens* but with crimson, not slate-colored fruits (Letadjwa). The one or two stunted *Acacia heteracantha* (syn. *A. litakunensis)* (Mosu), had doubtless been brought in by cattle from further east, for they are fond of the pod of this common tree.

"At Maokane on shallow soil overlying limestone four or five stunted *Acacia karroo* (Mookana) were seen. These shrubs which under favorable conditions would have been fair-sized trees ('Mooka' without the diminutive suffix) had developed spines up to fifteen centimeters long. A very occasional *Rhus* and a *Bauhinia* complete the lists of shrubs seen."

Il est nécessaire de standardiser les dénominations commerciales des bois du Congo. By F. Peche, *Bul. Comptoir Vente Bois Congolais* (Brussels) No. 7: 2-6 February 1947.

The need for standard trade names for Belgian Congo woods is discussed and a name proposed for each of fifty-five species. The scientific name is given for each and additional common names as well. The British standard name and the South African Timber Control names are included when available.

Following are the standard names proposed:

1.	Limba Blanc	*Terminalia superba*
2.	Limba Noir	*Terminalia superba*
3.	Iroko	*Chlorophora excelsa*
4.	Agba	*Gossweilerodendron balsamiferum*
5.	Limbali	*Macrolobium Dewevire*
6.	Acajou Tiama	*Entandrophragma angolense, E. platanoides, E. macrophyllum*
7.	Acajou Sapele	*Entandrophragma cylindricum, E. pseudo-cylindrique*
8.	Acajou Sapo	*Entrandrophragma utile, E. roboroides*
9.	Acajou Kossipo	*Entandrophragma Candollei, E. congolensis*
10.	Khaya	*Khaya anthoteca*

11.	Diambi	*Guarea Thompsonii*
12.	Bosse	*Guarea cedrata*
13.	Opepe	*Sarcocephalus Diderichii, S. esculentus*
14.	Dibetou	*Lovoa Klaineana, L. trichilioides*
15.	Azobe	*Lophira alata, L. procera*
16.	Carnarium	*Canarium Schweinfurthii*
17.	Niove	*Staudtia gabonensis*
18.	Mukkulungu	*Autranella congolensis*
19.	Agboin	*Piptadenia africana*
20.	Abura	*Mitragyne stipulosa, M. macrophylla*
21.	Mubala	*Pentaclethra macrophylla*
22.	Lolako	*Pycnanthus kombo*
23.	Avodire	*Turreanthus africanus*
24.	Tsonguti	*Alstonia Gilletii, A. congensis*
25.	Sanga Sanga	*Ricinodendron africanum*
26.	Kassa	*Erythrophloeum guineense*
27.	Manil	*Symphonia globulifera*
28.	Moabi	*Mimusops Djave; Baillonela toxisperma*
29.	Musasa	*Albizzia fastigiata, A. gummifera, A. sassa*
30.	Boleki	*Ongokea Klaineana*
31.	Minzu	*Combretodendron africanum*
32.	Moamba	*Polyalthia suaveolens, P. Oliveri*
33.	Ozigo	*Pachylobus pubescens*
34.	Olon	*Fagara macrophylla*
35.	Danta	*Cystanthera Leplaei*
36.	Okoto	*Carapa procera*
37.	Padouk	*Pterocarpus Soyauxii*
38.	Wenge	*Milletia Laurentii*
39.	Ole	*Afrormosia elata*
40.	Kapokier	*Ceiba pentandrum*
41.	Samfi	*Uapaca guineensis*
42.	Wamba	*Tessmania* sp.
43.	Alumbi	*Baikiaea minor*
44.	Mutobo	*Berlinia niembaensis*
45.	Kumunu	*Coula edulis*
46.	Afzelia	*Afzelia africana*
47.	Sagna	*Corynanthe paniculata*
48.	Bokoli	*Mammea africana*
49.	Bomanga	*Macrolobium coeruloides*
50.	Parasolier	*Musanga Smithii*
51.	Bubinga	*Cipaifera Demeusei*
52.	Ikele	*Klainedoxa longifolia*
53.	Ebene	*Diospyros* spp.; *Maba* spp.
54.	Bofale	*Parinarium glabrum*
55.	Angu	*Cynometra Alexandri*

L'utilisation rationnelle des forêts tropicales. By M. Pierre Terver. *Bul. Comptoir Vente Bois Congolais* No. 7: 8-11; February 1947. (Extracts from *Marches Coloniaux*, December 28, 1946.)

The problems connected with the exploitation of tropical forests are discussed in detail. The ultimate goal is said to be the gradual transformation of the tropical forests, by economical silvicultural methods, into reasonably homogeneous forests of utilizable species.

Vers une utilisation rationnelle des forêts tropicales. By M. Pierre Terver. *Rev. Internat. Bois* (Paris) 14: 115: 8-11; January 1947.

From a report presented to the International Congress of Wood, September 23, 1946. See above review.

L'exploitation forestière au Congo Belge. By Noel Huart. *Bul. Comptoir Vente Bois Congolais* No. 9: 2-4; April 1947.

The demands for reconstruction have created a strong market for Belgian Congo woods. When these needs are met there can be a rational organized production based upon a continuing normal demand. Species previously unknown can now be exploited on the market.

La reforestation naturelle des savanes du Kwilu. By R. P. Mathieu Renier. *Bul. Agri. Congo Belge* (Brussels) 37: 4: 801-808; December 1946.

In the region of Leverville, at the confluence of the Kwilu and the Kwenge, is found the most varied flora in all Kwilu. The species *Leptoderris congolensis* is recommended for reforestation of the extensive denuded areas.

The region of Kikwit, an extension of Leverville along the Kwilu, has much more extensive forests. The city and mission of Kikwit are in primitive forests without equal. *Dalhousiea* is proposed for reforestation in this region.

The Kisanji (and Kahemba) region, on the Kwilu some 300 kilometers south of Kikwit, has limited forest areas

and extensive savannas. This is the country that the State has decided to transform into a region of silk-worms, with the introduction of the Mulberry tree. *Daniellia* (close to *D. Oliveri* Hutch.) is the only tree that occurs in quantity in this region. Known as "Mulombe", it produces a hard translucent copal and a liquid varnish from the seeds.—M. Record.

Cinquantenaire de Madagascar. *Rev. Bot. App. & d'Agr. Tropicale* 26: 286 bis: 333-504; 10 plates; 1946.

This number with 23 articles by 15 authors, is devoted to Madagascar. The subjects include accounts of botanical work, agriculture, and useful plants.

Le Service des Eaux et Forêts à Madagascar. By P. Saboureau. *Rev. Bot. App. & d'Agr. Tropicale* 26: 286 bis: 475-490; 1946.

Included in this account of the Service and its work are brief descriptions of the forest regions (see also pp. 370-377) and forest species.

Les arbres à kapok et les autres producteurs de soies végétales. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* 26: 287 & 288: 517-524;1946.

The kapok (vegetable silk) producing trees of Asia, Africa, and tropical America are reviewed. The species discussed are in the genera *Eriodendron* (= *Ceiba*), *Bombax* (= *Gossampinus*), and *Chorisia*.

Nouvelle Sapotacée du Gabon à graines oléagineuses. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* 26: 287 & 288: 550-554; 1 plate; 1946.

The new genus *Walkeria* Chev. (C. R. Acad. Sc., t.222, p. 1 153; 1946) and the species *W. Nogo* Chev. are described in detail.

Sur diverses Légumineuses Caesalpiniées à feuilles multi et parvifoliolées dans les forêts de l'Afrique tropicale et donnant des bois recherchés. By AUG. CHEVALIER. *Rev. Bot. App. & d'Agr. Tropicale* 26: 289 & 290: 585-621; 9 plates; 1946.

The genera of Caesalpiniaceae that have small leaflets are of interest because many of them also have fine woods.

The African genera that contain species with small leaflets include: *Berlinia* Soland, *Scorodophloeus* Harms, *Monopetalanthus* Harms, *Talbotiella* Bak.f., some *Cynometra* L. and *Branchystegia*, some *Tessmannia* Harms, *Tamarindus (T. indica* L.), etc. Four new genera of these "Caesalpiniées microfoliolées" and four new species from each of two known genera are described. The new genera are: *Microberlinia* Chev. (2 spp.), *Dipetalanthus* Chev. (2 spp.), *Tripetalanthus* Chev. (2 spp.), and *Zingania* Chev. (1 sp.). The new species are in the genera *Cynometra* and *Monopetalanthus*.

Il problema forestale nell' Africa Orientale Italiana. By GUGIELMO GIORDANO. *Quaderni Italiani* XV, I.R.C.E., Rome 1942. Pp. 41.

The forest formations, their species, and areas are briefly described, following the system proposed by Senni and De Phillipis. The importance of the forests, for water run-off control and in the economy of the country, is discussed.

The vegetation of some hillsides in Uganda. By A. S. THOMAS. *Jour. Ecology* (London) 33: 2: 153-172; July 1946.

"There are great differences between the plant formations of the zones of each hill. In general, the two most southerly catenas show belts of short grassland on the hillsides, with closed evergreen forest on the tops of the hills and at the bases of the hills; the two central catenas are remarkable for the thickets of elephant grass on the hillsides; the two northern catenas have woodlands on the tops and the sides

of the hills, and more or less open grassland in the valleys."—*From author's summary*.

Plywood and Veneer in South Africa. By ROBERT W. RINDEN. *Southern Lumberman* (Nashville) 173: 2177: 306; December 15, 1946.

Production of plywood in South Africa now amounts to about 14,000,000 square feet per year, most of which is produced by a Capetown plant.

"Species of timber employed in making plywood are chiefly hardwoods, of which okoume, imported from French West Africa, is the leading type. Next in volume of use is kiaat, a product of the Belgian Congo and British East Africa. Other species include limba, iroko, agba, African walnut, stinkwood, birch, and teak. Philippine mahogany was used extensively before the war . . ."

A monograph of the genus *Streblosa* Korthals (Rubiaceae). By C. E. B. BREMEKAMP. *Jour. Arnold Arb.* 28: 2: 145-185; 2 figs.; April 1947.

"In this paper a detailed analysis of the generic characters is given. Twenty-five species are described, and an attempt is made to arrange them in a more or less natural sequence. Eleven of the twenty-five species are new . . ."

The preservation of well known binomials. By H. A. GLEASON. *Phytologia* (New York Bot. Garden) 2: 7: 201-212; April 1947.

"The current code of nomenclature is intended to achieve a definite stated purpose; it is based on certain general principles; the use of these principles to attain the goal is implemented by a long series of rules.

"The purpose is the establishment of a stable nomenclature. The rules do not distinguish between stability of the past and stability of the future. On the contrary, the rules clearly intend to maintain the stability of the past and to project it into the future. This is evidenced by the general principle that no one should change names except for

serious reasons, by the use of different dates of departure, by the abolition of tautonyms, by the adoption of nomina conservanda, and (what may seem strange to some botanists) by the homonym rule, which often permits the segregation of a genus without the publication of a new generic name.

"A careful study of the opening clauses of the Code will convince any impartial reader that the Code is intended to effect stability just as far as possible by maintenance of names and just as little as possible by change of names. The definite rules which follow and which constitute the bulk of the Code should therefore be used to justify maintenance. Only when maintenance is impossible should they be used to determine the nature of the necessary change."

Examples relating to the names of five well known plants are discussed and the preferred name selected.

A new species of *Daphnopsis* from Ecuador. By JOSEPH V. MONACHINO. *Phytologia* 2: 7: 212-213; April 1947.

Daphnopsis espinosae Monachino is described as new.

Notes on new and noteworthy plants. I. By HAROLD N. MOLDENKE. *Phytologia* 2: 7: 213-242; 1 fig.; April 1947.

"The present paper is the first in a series of notes on plants of various parts of the world, based in part on field studies and in part on herbarium studies in the herbarium of the New York Botanical Garden and elsewhere. Numerous new species, varieties, forms, and hybrids will be described and several new names and combinations proposed."

Additional notes on the genus *Petrea*. III. By HAROLD N. MOLDENKE. *Phytologia* 2: 7: 248; April 1947.

Data are given for two lianas and one shrub.

The structure of wood. By H. E. DESCH. *Wood* (London) 12: 3: 78-81; 6 figs.; March 1947.

A well illustrated elementary discussion of wood structure as used for identification purposes.

Cell walls and synthetic fibres. By WANDA K. FARR. *Economic Botany* (New York Bot. Garden, New York 58, N. Y.) 1: 1: 98-113; 2 figs.; January-March 1947.

"In the production of man-made fibers the art has preceded the science, and the structure and composition of both native and processed materials are not clearly understood. Accumulated information has led to the development of the 'molecular' and the 'colloidal interpretation.'

"The molecular interpretation holds that the cellulose molecule is the functional unit which determines the properties of native cell walls as well as their synthetic derivatives. The colloidal interpretation explains the same properties upon the basis of a heterogeneous chemical system, established through the vital activity of the colloidal protoplasm, and persisting, in varying degrees, throughout the treatments involved in industrial processing.

"Examples from various parts of the plant kingdom reveal the fact that the properties of plasticity and deformability are achieved in native cell walls through the use of non-cellulosic materials; that membranes rich in cellulose are no longer plastic; and that extraordinary procedures are involved in reversing this state of rigidity in the mature cell wall. Industry relies upon more or less drastic chemical and physical processes; the cells themselves bring about such a reversal through the use of enzymes."—*From author's summary*.

Key to the microscopical identification of the principal softwoods used in Great Britain. Timber Development Assoc. (London) Ref. No. 25; 1946. Pp. 7, 30 text figs.

An illustrated key based upon anatomical characters.

Zur Ontogenie des Xylems in Stengeln mit sekundärem Dickenwachstum. By A. FREY-WYSSLING. *Berichte Deutsch. Bot. Ges.* 58: 4: 166-181; 1940.

The xylem of the stem with secondary growth arises in three detached stages that can be differentiated by their historical development but not morphologically. The protoxy-

lem arises at the conclusion of embryonic growth, before the growth in length begins. It consists of short narrow tracheal elements, which by passive growth in length become stretched and dismembered. The metaxylem is formed at the end of and in connection with the growth in length. It consists in examined cases of unusually long spiral tracheids; in certain instances fused vessels with short, pitted vessel members are attached. The definition of metaxylem in the "Glossary of Terms Used in Describing Woods" (*Tropical Woods* 36, December 1, 1933) is criticized and rejected. In metaxylem strength-giving elements arise frequently near the conducting elements. Such vast differences in metaxylem appear, especially in herbs and lianas, in which cambial activity and with it the formation of the secondary xylem is deferred, that such Dicotyledons while in development stages of the metaxylem show an undoubted harmony with the monocotyledon type.

The ontogenetic and phylogenetic development of the xylem elements leads from the short meristem cells, from which the *hydrozyten* arise to long embryonic or meristem cells, which either show an almost unlimited tip growth and lead further to a succession of tracheids, or else discontinue their growth in length, proceed to grow in width and so produce the fused vessel-members of the trachea.—*Translation of author's summary.*

The structure of wood, II. Mahogany. By Frank W. Jane. *Timber News* (London) 55: 2092: 52-54; 9 figs.; February 1947.

The woods of the mahoganies and several similar timbers are compared. *Swietenia*, *Entandrophragma*, *Aucoumea*, and *Shorea* are described and illustrated with photomicrographs.

The structure of wood, 12. Retrospect. By Frank W. Jane. *Timber News* 55: 2093: 94-95, 97; March 1947.

A summary of a series of articles devoted to the identification of 30 common woods. A key for the identification of these timbers is included.

Commercial timbers of the world. *Wood* (London) 12: 2: Ff.p. 52; February 1947.

A folded map of the world showing the forest regions of the world, separated into four classifications. A list of the principal commercial species (vernacular names) is given for each country.

What is roble? By R. W. *Wood* (London) 12: 3: 75-76; March 1947.

"The word Roble—of Spanish origin—at first meant oak, but now, alone or qualified by an adjective, it is applied to a large number of species belonging to a score or so of genera. The accompanying notes clarify some of its applications."

Tropical veneer woods. By Joseph L. Stearns. *Wood* (Chicago) 2: 4: 23, 43, 44-47; 1 fig.; April 1947.

Brief descriptions of the woods, their uses, and origins are given for several species. A chart of general properties is included.

M.M. CHATTAWAY.

Price 25 cents

Yale University School of Forestry

TROPICAL WOODS

NUMBER 91 SEPTEMBER 1, 1947

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Yale University School of Forestry

TROPICAL WOODS

NUMBER 91 September 1, 1947

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.*

Subscription price One Dollar for four consecutive numbers. Remittances should be made payable to TROPICAL WOODS.

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

EUCALYPTS AND THEIR USE IN SEMI-TROPICAL PLANTINGS

By FRANK R. MOULDS*

Research Officer, Forests Commission, Victoria, Australia

Myrtaceae, the family to which the genus *Eucalyptus* belongs, has its principal development in Australia and in Tropical America. Some of the genera possess edible fruits (e.g. *Jambosa*), others succulent ones (e.g. *Eugenia*), and others, including *Eucalyptus*, have dry and capsular fruits which may persist on the tree for some years. The section Leptospermoideae of the family Myrtaceae is a characteristic Australian development and constitutes the principal feature of the forest flora of that continent. As well as *Eucalyptus*

*Graduate student (Forestry) Yale University.

it includes *Backhousia, Tristania, Angophora, Leptospermum, Callistemon* and *Kunzea* all of which have the typically dry, usually capsular, fruits.

Angophora is a genus restricted to Australia and forms an interesting transition between the *Tristania* type and *Eucalyptus*. It has the sepals reduced to small teeth and the petals free while in *Eucalyptus* the sepals are usually absent and the petals united to form a cap or operculum which falls off when the bud opens. *Angophora intermedia* DC., the "Gum Myrtle," has a range in Australia from Victoria to Queensland. Apparently it has not been widely planted outside this country although it is generally of shapely habit and should be useful as a shade tree in some semi-tropical regions.

Eucalyptus is a large genus comprising more than 300 species ranging from small desert-land shrubs to massive forest giants of great commercial value. In dimensions and rate of growth it reaches its maximum development in the southern half of the continent, where heights of over 300 feet in the species *E. regnans* F.v.M. are recorded in Victoria. *E. diversicolor* F.v.M. in southwest Australia also approaches this figure. With the exception of one tropical species, it is an evergreen hardwood, and has extensive range of form. The genus includes representatives of desert, tropical and alpine regions.

The botanical separation of *Eucalyptus* is based on the nature of the anthers. The three classes are Parallelantherae (anthers parallel and opening by long slits), Renantherae (anther lobes kidney-shaped), and Porantherae (anthers opening by terminal pores). Transition stages occur in some species, however, and add to the difficulties which have always been inherent in the identification and classification of the eucalypts. Other more obvious factors are used in broad class separations, such as the character of the bark which permits division into five main groups: (1.) Gums—which have a smooth, rather thin and generally light colored bark decorticating in ribbons or flakes—e.g. *E. globulus* Labill. (Blue Gum), *E. rostrata* Schlechtendal (Red Gum),

E. viminalis Labill (Manna Gum), etc. (2.) Stringybarks—with a thick fibrous brownish-colored bark, e.g., *E. obliqua* L'Heritier (Messmate Stringybark), *E. Muelleriana* Howitt (Yellow Stringybark), *E. capitellata* Sm. (Brown Stringybark), etc. (3.) Ironbarks—distinguished by a hard, thick, corrugated, dark-colored bark, e.g. *E. sideroxylon* A. Cunn. (Red Ironbark), *E. paniculata* Sm. (Gray Ironbark) etc. (4.) Boxes—possessing a fairly thick hard bark but not generally as dark and corrugated as in the ironbarks, e.g. *E. hemiphloia* F.v.M. (Gray Box), *E. melliodora* F.v.M. (Yellow Box), and (5.) Peppermints—whose bark is rather like the stringybark group but is not so fibrous, e.g. *E. australiana* Baker & Smith (Narrowleaf Peppermint).

As with other characteristics, the bark may vary somewhat, even in individual species, according to the locality in which grown. Between typical species of the above groups, however, the differences in tree appearance are quite striking.

Eucalypts as Exotics

The planting of eucalypts outside Australia began in the late years of the 18th century. The first planting was in 1774 at Kew in England from seed gathered on Captain James Cook's second South Pacific voyage. Eucalyptus planting in the 19th century took a number of species into Mediterranean countries including Spain, portions of North Africa, southern France, Italy, Greece, and Turkey, and also into North and South America. In most of these regions the main purpose of such plantings, at first, was to use the quick-growing character of some of the eucalypts to produce shelter and shade trees, wind breaks, etc. Sometimes the production of timber for fuel, and for such products as fence posts, poles, was the principal consideration.

The introduction of eucalypts into the United States seems to date between 1855 and 1860[1] when an American Methodist minister who was on a lecture tour in Australia sent seed of several species to his home in California. Between 1888 and 1890 more than fifty *Eucalyptus* species were set

out in an experimental forest station at Santa Monica, California.

The period 1900 to 1910 can be regarded, however, as the historic *Eucalyptus* boom time in California. During this period much was written about the wonderful future for eucalypts as wood-producers in that state. From the point of view of present-day results, a great deal of this was wishful thinking and was apparently based on the results of a few very good responses on exceptionally favorable sites. As regards saw-timber, most of the really valuable Australian species are not growing in California, and those which have made the best growth there, e.g. *E. globulus* (Blue Gum), are from the Australian standpoint of limited commercial value.

Apart from the United States (particularly California and Florida), the list of countries in which eucalypts have been cultivated, with varying degrees of success, is long. Some of them are included among the following: Algeria, Argentina, Anatolia, Bechuanaland, Belgian Congo, Brazil, Ceylon, Chile, East Africa, Ecuador, England, Fiji, Greece, Hawaii, India, Italy, Jamaica, Kenya, New Zealand, Nigeria, Paraguay, Peru, Portugal, Puerto Rico, Scotland, South Africa, Spain, Turkey, Uganda, and Uruguay.

As examples of some of the recent plantings and experimental work with eucalypts, may be mentioned the following results taken from various forestry publications and reports:

Species showing promise in Bechuanaland (South Africa) in experimental plantations are *E. rostrata*, *E. paniculata*, *E. melliodora*, and *E. saligna*. *E. citriodora* Hook. has suffered somewhat from frost.[2]

In afforestation trials in the Upcountry dry patana grassland areas of Ceylon it has been found that, except on the poorer soils, the timber eucalypts (*E. citriodora* and *E. maculata* Hook.)are better developed when grown in mixture with 50% *Callitris* and 25% *E. robusta* Sm.[3] *E. saligna* and *E. alba* tests have not been satisfactory on degraded soils. On wet patana grassland areas *E. robusta* has been found

most successful. It requires, there, a wide spacing (12′ x 12′). (*E. saligna* is reported to be satisfactory in parts of East Africa for the production of poles.[4]

In Chile, *E. globulus* plantings are an important feature of the national forestry program. By 1946 the total area planted had reached 44,561 hectares of which 18,000 hectares are now exploitable. The largest stands are between Valparaiso and Arauco, close to the centers of demand. In 1946 the Chilean *Eucalyptus* plantations were calculated to contain 202.7 million cubic feet of timber.[29] The principal uses of this material are as mine timbers, rough construction wood, firewood, and in charcoal production. It is used only to a limited extent as lumber.

In the dry sierra of Ecuador, the timber shortage, especially for fuel, seems to have been overcome to a large extent by the introduction (in 1865) and cultivation of eucalypts, especially *E. globulus*.[5] As an example of the growth obtained, one particular specimen at Ambata is stated to be 2.5 meters in diameter at 1 meter above the ground. In Ecuador, *E. globulus* is growing now between 1600 and 3500 meters above sea level with optimum development bteween 2000 and 2700 meters. In this zone the prevailing temperature is between 10° and 20° C.; although precipitation varies considerably it does not exceed about 43 inches. In the drier valleys the eucalypts are benefitted by irrigation given other crops. The species has been found to grow quite well even on degraded soils in this region. Its future seems to be assured in the Sierra of Ecuador and also in parts of Brazil where it satisfies an urgent timber need. It is reported[6] that in the Ecuador Sierra about 80-85% of the Blue Gum grown is used for house construction and the remainder for domestic fuel consumption. Plantings in that country are as isolated trees, small groups, single rows, and in huge groves. *E. globulus* in the Ecuador Sierra seems to be able to survive within wide ranges in rainfall, those reported varying from 30 cms. per year to 200 cms. annually.[7]

A large number of *Eucalyptus* species have been used in plantings in India. Included is *E. globulus*, which in a classi-

fication of drought resistant species is called "conspicuously resistant."[8] In some low rainfall areas in India where irrigation can be used, *E. rostrata* has proved very successful, both as cuttings and as "pot" plants. It is, however, very susceptible to inadequate irrigation in the young stage, and also to shading. At least one week of irrigation has been found necessary in the first year. The young *E. rostrata* plants were not very susceptible to frost damage. Plantations of this species have been utilized for fuel at five years of age.[9] Eucalypt trials in the Simla Hills in India have found *E. regnans* satisfactory for plantings above 6000 feet as it can stand the affects of snow.[10] *E. Gunnii* Hook. and *E. coriacea* A. Cunn. are also satisfactory under such conditions. It might be mentioned that *E. Gunnii* has withstood some severe winters and frosts (1940-41-42) in plantings in England. This species planted at the Royal Agricultural College has reached, at the age of twenty-four years, a height of 60-70′ with a girth of from 3′8″ to 5′5″ at 3 feet from the ground.[11]

Some of the eucalypts which have been recommended[12] for the plains of North West India, after planting trials, are *E. alba*, *E. citriodora*, *E. crebra* F.v.M., *E. hemiphloia*, *E. microtheca* F.v.M., *E. paniculata*, *E. rostrata*, *E. saligna*, *E. siderophloia* Benth., and *E. tereticornis* Sm. There also seemed to be good prospects for *E. Baueriana* Schauer, *E. Bosistoana* F.v.M. and *E. odorata* Behr.

F. A. Kahn[13] states that for elevations about 5500 feet and rainfall of 25 inches in the Northwest Frontier Province of India, *E. globulus* and *E. tereticornis* have been found satisfactory, while *E. rostrata* was unsuccessful. At lower elevations (below 4000 feet) and with a rainfall of 45 inches, *E. rostrata* gave best results with *E. globulus* showing but little promise.

In Jamaica a number of species have been cultivated in experimental plantations. *E. globulus* and *E. citriodora* are reported to be growing exceptionally well.[14] In Nigeria *E. rostrata* is giving a good account of itself, according to the Forest Administration,[15] which also reports (1943) that in

the Cameroons *E. Maideni* F.v.M. (a species closed related to *E. globulus*) bore fruit and fertile seed for the first time since its introduction in 1930.

Paraguay has been successful in its introduction of the genus[16] and some twenty species are now in the country, the more important being *E. citriodora*, *E. globulus*, *E. rostrata*, *E. paniculata*, *E. diversicolor*, *E. tereticornis*, *E. amygdalina* Labill., *E. Stuartiana* F.v.M., *E. resinifera* Sm, and *E. goniocalyx* F.v.M. Local experience has indicated the species among the above which are best adapted for particular localities in that country.

Peru seems likewise to have met with success in its cultivation of a number of species. The forest areas of the Sierra (which is the main timber producing region of the country), are largely composed of introduced eucalypts, *E. globulus* now being the chief timber tree cut in Peru.[17] In the past, eucalypt wood was chiefly used for mining timber, though small quantities have for some time been used for box shooks. A later development has been its use as railway sleepers (cross-ties). Preservative treatments given to the woods are stated to have opened up the possibility of drastically reducing imports of cross-ties from the United States. The Sierra, with 16 million board feet annual production of eucalypt wood produces more than half the total annual timber yield of Peru.

Experimental plantings in Scotland have shown[18] that, in reasonably sheltered sites even though severe frosts occasionally occur, *E. Gunnii* can survive and in fact grow into good straight pole timber thirty years after planting. The trees average 30 inch girth at breast height and thirty to thirty-five feet in height. It was found that, as would be expected, 15-20° of frost killed *E. globulus*, but strangely enough, *E. coriacea* and *E. regnans* also suffered severely from the climate.

Afforestation combined with agriculture in Puerto Rico has demonstrated the value of *E. robusta*.[19] Uganda has also been using *E. robusta* together with *E. rostrata* for afforesting poor land. Complete hoeing at the time of planting and

keeping the soil in a cultivated condition until a canopy is formed, has been found desirable in the Uganda plantings.[20]

In Turkey, *Eucalyptus* (species ?) plantings have been made in swampy regions near Tarsus, after previous attempts to cultivate the swamps had failed.[21] Difficulties were experienced, but finally overcome, in getting the seedlings established. The objectives are two fold, (1) to drain malarial marshes, and (2) to provide pit-props and other timber. One plantation alone in that region is expected to produce ultimately 172,000 cubic meters of pit-props per annum.

Similar plantings of fast-growing eucalypts have been made in Uganda for assisting in the drainage of swamps and the control of mosquitoes, as well as supplying timber.[22] *E. saligna* has been found best for general planting, but *E. robusta* is recommended where long periods of flooding occur. The mean annual increment per acre of eucalypts in Uganda is stated to vary from 300 cubic feet (stacked) in poorish papyrus swamps to 500 cubic feet on better soils.

E. globulus and some other eucalypts have also become well established in Uruguay.[23]

Pests have occasionally been reported as more or less severely attacking introduced eucalypts. In South Africa for instance, the eucalyptus snout beetle *(Gonipterus scutellatus)* was at one time a menace to young plantations. In 1926, as a control measure, the egg parasite *Anaphoidea nitens* was introduced from Australia and was first found established in 1927.[24] Between 1928 and 1931, 620,000 individuals were bred in the laboratory and liberated. It is now believed established in every plantation in infected areas. Control is reported to have been excellent in all areas except the dry high veldt where it is still somewhat erratic. *Phorocantha semipunctata* has also been the source of attacks in some South African *Eucalyptus* plantations.

In India occasional trouble has been reported from a Hepialid boring in the main stems of young red gum *(E. rostrata)*.

As well as for the purposes already mentioned, *Eucalyptus* plantations have yielded additional products. In Puerto Rico,

for example, steam distillation of the leaves of *E. citriodora* has yielded 1.3% of oil containing 78.42% citronellal.[25] The yield of oil is reckoned to be nearly double that from the same species grown in most other countries although these other oils frequently showed a citronellal content (by acetylation) of 80-90%.

Oil from the same species grown in the Belgian Congo has been found to have characteristically high citronellal content,[26] but on account of its low dextro-rotatory activity was found unsuitable for the manufacture of laevo-menthol for which Java citronella-oil is employed. It would, however, be suitable for use in perfumery and a ready market could be expected for that purpose.

The oil content of the leaves and twigs of *E. globulus* is not as high as many other eucalypts (usually less than 1%) although it was one of the first species used for oil production. *E. polybractea* for instance produces double, and *E. australiana* nearly four times, the yield of oil of the same general character as that of Blue Gum (i.e. a cineol oil). *E. polybractea* (Blue Mallee) is a dwarf eucalypt, but *E. australiana* normally develops into fairly tall straight trees.

The composition of the leaf oils usually remains essentially unchanged in eucalypts cultivated outside their natural Australian habitat, although the yields may be increased by cultivation.[27]

The oil of *E. dives* Schauer contains about 50% of piperitone and 40% of phellandrone and is consequently a potential source of thymol and menthol. The oil of *E. macarthuri* Deane & Maiden which contains some 75% of geranyl acetate together with a little free geraniol is an abundant source of this valuable ingredient of perfumes. *E. dives* is probably not a species worthy of cultivation outside of Australia because of its poor form and inferior timber, but *E. macarthuri* has been extensively planted in the vicinity of Rotorua in New Zealand where it is valued for general and farming purposes.

As evidence of a further product, *E. microcorys* F.v.M. is being cultivated for tanning materials in the Belgian Congo. Satisfactory tests have already been obtained.[28]

In Portugal, *E. globulus* has for some time been used in pulp manufacture and recently additional tests (1943) have been made with a view to increasing the quantity used for this purpose.

Suggestions for Future Plantings

It is obvious that a relatively small number of eucalypts among the great number that are available, have become recognized outside their native country as suitable for the establishment of plantations. The ones most commonly used, where rapid growth is the principal criterion, are *E. globulus*, *E. citriodora*, *E. saligna* and, especially in moist or even swampy sites or where some irrigation water is available, *E. rostrata* and *E. robusta*. For the production of saw-timber, however, these species are not among the best that might be employed, although it must be admitted that for rapidity of growth they serve their purpose admirably.

For plantings from which it is desired to produce utilisable saw-timber more emphasis might be placed upon *E. regnans*, *E. gigantea* Hook., *E. nitens*, and perhaps *E. Gunnii* in elevated regions (3500-600 feet at least), with a rainfall of not less than 40 inches.* Of the commercially valuable eucalypts, the species occurring in Australia at the highest altitudes is *E. gigantea*. It has a range of approximately 3500 feet to 5500 feet above sea level. Only one eucalypt occurs at elevations above *E. gigantea*, namely *E. coriacea* var. *alpina*, (Snow Gum) which is a dwarf, twisted alpine tree of no commercial value. See Figure 1.

Ascending the mountains from about 2000 feet elevation to nearly 4000 feet is *E. regnans* which, together with *E. gigantea*, is among the finest of the Australian hardwood species. The timber is pale-colored, fissile, and free-working, and is widely used for all building construction purposes and especially interior work, e.g. floorings, linings, windows and doors, furniture, cabinet work, etc. It can be seasoned

*If protection forest only are required at high elevations, *E. coriacea* could also be used.

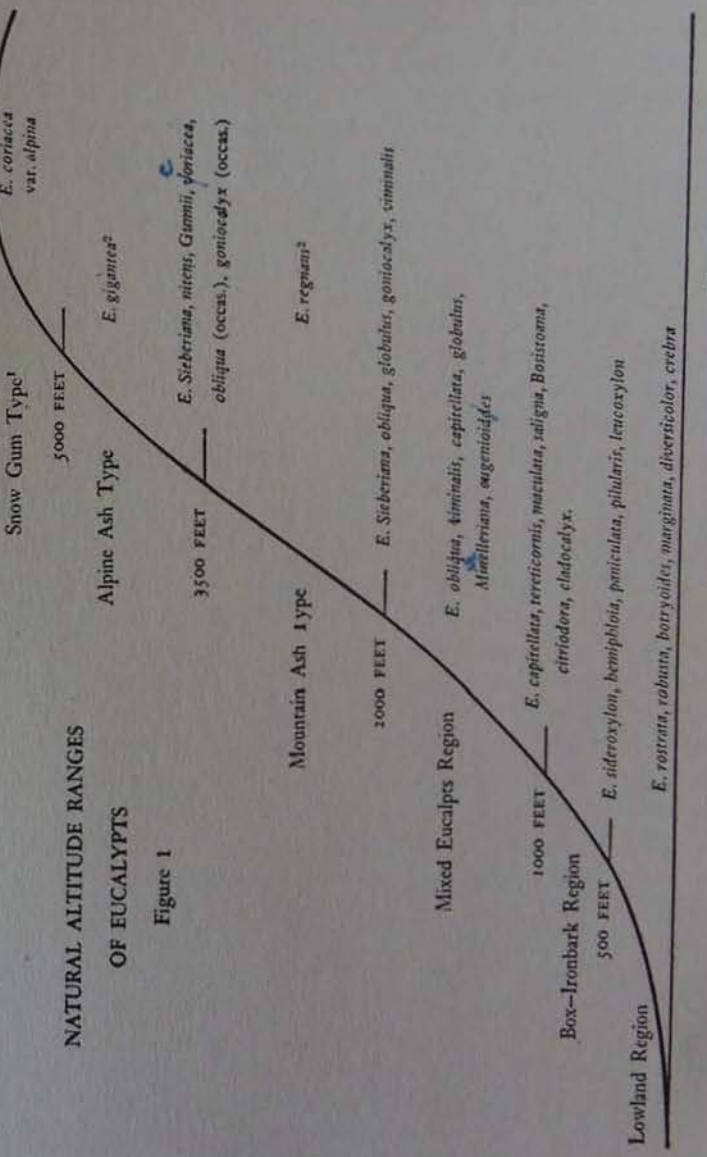

Figure 1

[1]Not a commercial type.
[2]Usually in pure stands.

quickly and well. In their natural range of elevation and rainfall (40 inches to over 80 inches) and in a deep soil these two species grow at a rapid rate. *E. regnans*, in particular, is among the fastest growing of the eucalypts. It has been known to reach heights of 120 feet with a diameter of 14-15 inches (b.h.) in 20 years. In Victoria and Tasmania specimens have been found with a height of over 300 feet, easily out-classing in size any other hardwood in the world.

E. obliqua, *E. Sieberiana* F.v.M., *E. viminalis*, and *E. maculata* are species which should make satisfactory progress on fairly good sites at lesser elevations. The first of these in particular (Messmate Stringybark) occurs over a wide geographical range in the southeastern part of the Australian mainland and in Tasmania,[30] (mixing in some areas with the Blue Gum) and is worthy of planting as an alternative to the widely established Blue Gum. Growth may not be quite as rapid but it will yield a product of superior saw-timber quality. The timber of *E. obliqua* is pale brown, fissile, fairly open-grained and somewhat harder and denser than that of *E. regnans*. It is suitable for all construction work and is durable.

Some of the other stringybarks might also be considered, for instance, *E. capitellata*, *E. eugenioides* Sieber, and *E. Muelleriana* (Brown, White and Yellow Stringybarks respectively), and also the Mahogany Gum, *E. botryoides* Sm., and Blackbutt, *E. pilularis* Sm.

On the drier sites, *E. sideroxylon*, *E. crebra*, *E. marginata* Sm., *E. leucoxylon* F.v.M., *E. paniculata*, and *E. diversicolor*, should be among the best to plant. Each of these produces a timber of great strength and durability in its native habitat—a timber ideally suited for fence posts, poles, bridge-beams, cross-ties and fuel. Of course the growth rate is considerably less than that of the earlier mentioned species.

E. rostrata, as would be expected from its Australian sites, and as experience in planting in a number of countries has confirmed, is the best species for use in localities liable to periodic inundation by flood waters. These inundations are not harmful to this species, provided the site thoroughly

dries out between each wet spell. *E. rostrata* is also one of the best species for withstanding heat. It can be grown successfully in hot, dry climates, if irrigation water is available during its early growth. Its timber is red-colored, dense, and durable.

CLASSIFICATION OF THE TIMBERS

(a) Wood characterized by lightness (about 40 pounds per cubic foot air-dried), fissibility, ease of working and particular suitability for interior work: *E. regnans* and *E. gigantea*.

(b) Timbers suitable for general building and construction work, poles, posts, bridge-work, and fairly good for fuel. Their weights (air-dry) range from about 45 pounds/cubic foot *(E. obliqua)* to about 55 pounds per cubic foot. In this class are *E. obliqua*, *E. Sieberiana*, *E. viminalis*, *E. nitens*, *E. capitellata*, *E. goniocalyx*, *E. Muelleriana*, *E. marginata*, and *E. diversicolor*. This would also be the class of *E. globulus*, although its timber is normally slightly denser than that of the other species here mentioned.

(c) Hard, tough, heavy, and durable timber suited for heavy construction work, bridge beams, fence posts, cross-ties, and fuel: *E. sideroxylon*, *E. crebra*, *E. hemiphloia*, *E. leucoxylon*, *E. paniculata*, *E. botryoides*, and *E. rostrata*. The latter two species in this list are normally somewhat less dense than the remainder, and could be regarded as belonging part way between groups (b) and (c).

All of the eucalypts mentioned above regenerate well from seed, and most of them can be managed on some type of coppice system as they produce vigorous coppice shoots from the cut stump (provided it is not too old). The notable exceptions to this are *E. regnans*, *E. gigantea*, and *E. rostrata*, which are not suitable for a coppice type of management. Each of these, however, is a very free seeder and normally can be relied upon to provide ample seedlings on the ground for the succeeding crop. It should be noted here that *E. regnans* and *E. gigantea* are among the most intolerant of

shade of all the eucalypts, and require a clearcutting system of management, with retention of seed trees if necessary.

The size of eucalypt planting stock is normally from 6 inches to 12 inches in height. On adverse sites ball planting, using small baskets or pasteboard boxes, has frequently been found an advantage. The spacing would depend on the product desired. Fuelwood planting generally should be not more than 6 feet, but 7- or 8-, or even 9-foot spacing is more suitable for longer rotations.

Small seedlings of *E. regnans* grown in metal tubes in the nursery beds have been successfully used for planting stock in Australia. The tubes used are about 1½ inches in diameter, and 6 inches long. The young seedlings in the cotyledon stage are pricked out into the tubes containing nursery soil and standing erect in framed nursery beds.

Root development is helped materially by such a situation. When planting out, the tubes which are held in shape by a small crimped section of the metal edge are unclipped for use again, and the cylinder of soil and matted roots is inserted into its final position in the ground thus causing the minimum of disturbance to the young root system. Considerable areas of *E. regnans* country in which the forest crop has been destroyed by forest fires, and mountain areas unwisely cleared for settlement, have already been reafforested in southern Australia by this method.

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Explanation of Figures

No. 1. Approximate relative altitude distribution of some of the more important eucalypts in their natural range in southern Australia. Overseas planting has indicated that the altitudes shown can be safely increased by 1000 feet or more with many of the species (*E. regnans, globulus, saligna, citriodora, rostrata*, and probably others).

No. 2. *Eucalyptus gigantea* (Alpine Ash), growing at approximately 4000 feet elevation in central Victoria. Average height approximately 170 feet, and diameter (b.h.) up to 36 inches. This is a valuable lumber species.

No. 3. *Eucalyptus regnans* (Mountain Ash) at about 3000 feet altitude. Rainfall approximately 65 inches per annum. Occasional specimens of this species attain a height of more than 300 feet in Tasmania and Victoria. It produces one of the finest eucalypt timbers for interior construction, furniture, joinery, etc.

No. 4. Mixed eucalypt forest comprising *E. criminalis, E. obliqua*, and some *E. globulus*. Average diameters (b.h.) approximately 30 inches. Rainfall is about 38 inches per annum.

No. 5. *E. obliqua* (Messmate Stringybark) at an elevation of 2800 feet in central Victoria. Diameters (b.h.) approximately 28 inches. Age 40-50 years. Rainfall about 40 inches. A valuable timber species in Victoria, Tasmania and New South Wales.

No. 6. *E. sideroxylon* (Red Ironbark) principally of coppice origin, showing thinning operation producing cordwood and fencing material. A species naturally occurring in fairly low rainfall areas (about 20 inches) in New South Wales and Victoria.

No. 7. *E. rostrata* (Red Gum) on Murray River flats; a young pole and pile stand on land subject to periodic flooding. This species is indigenous to New South Wales, Victoria and South Australia.

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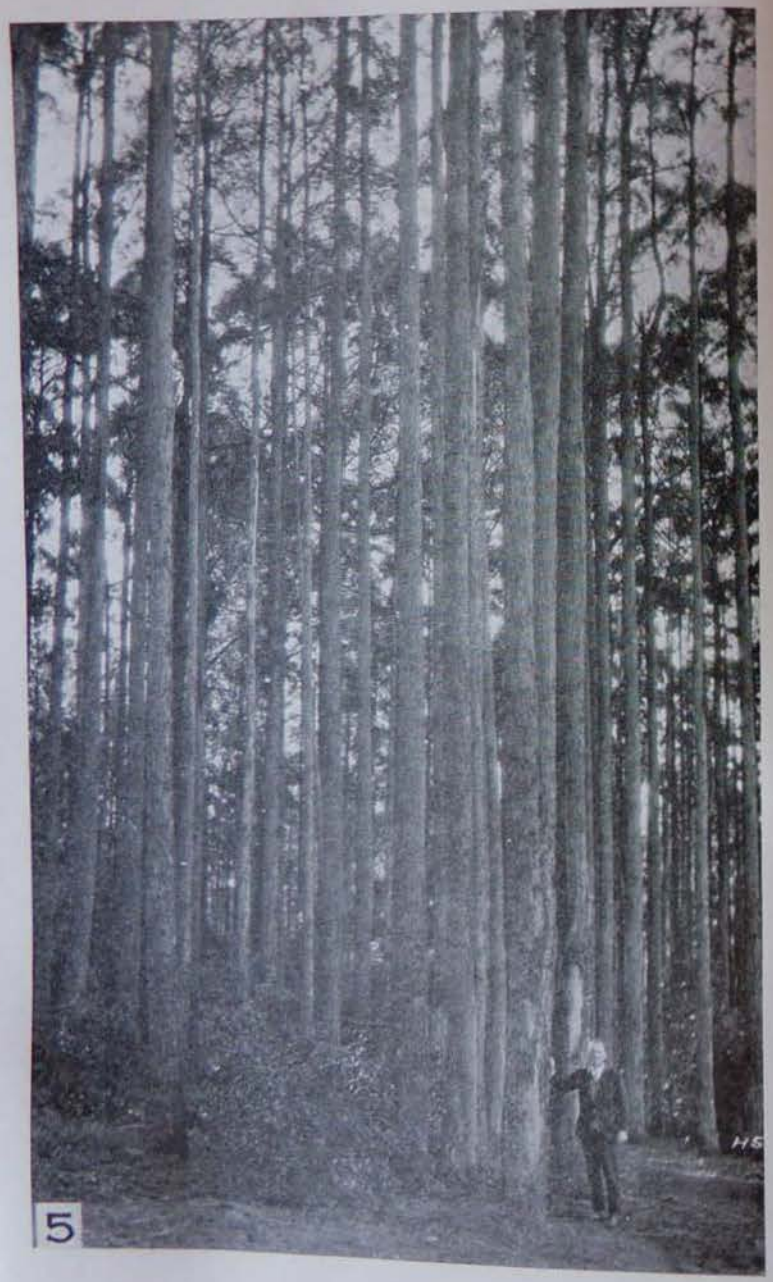

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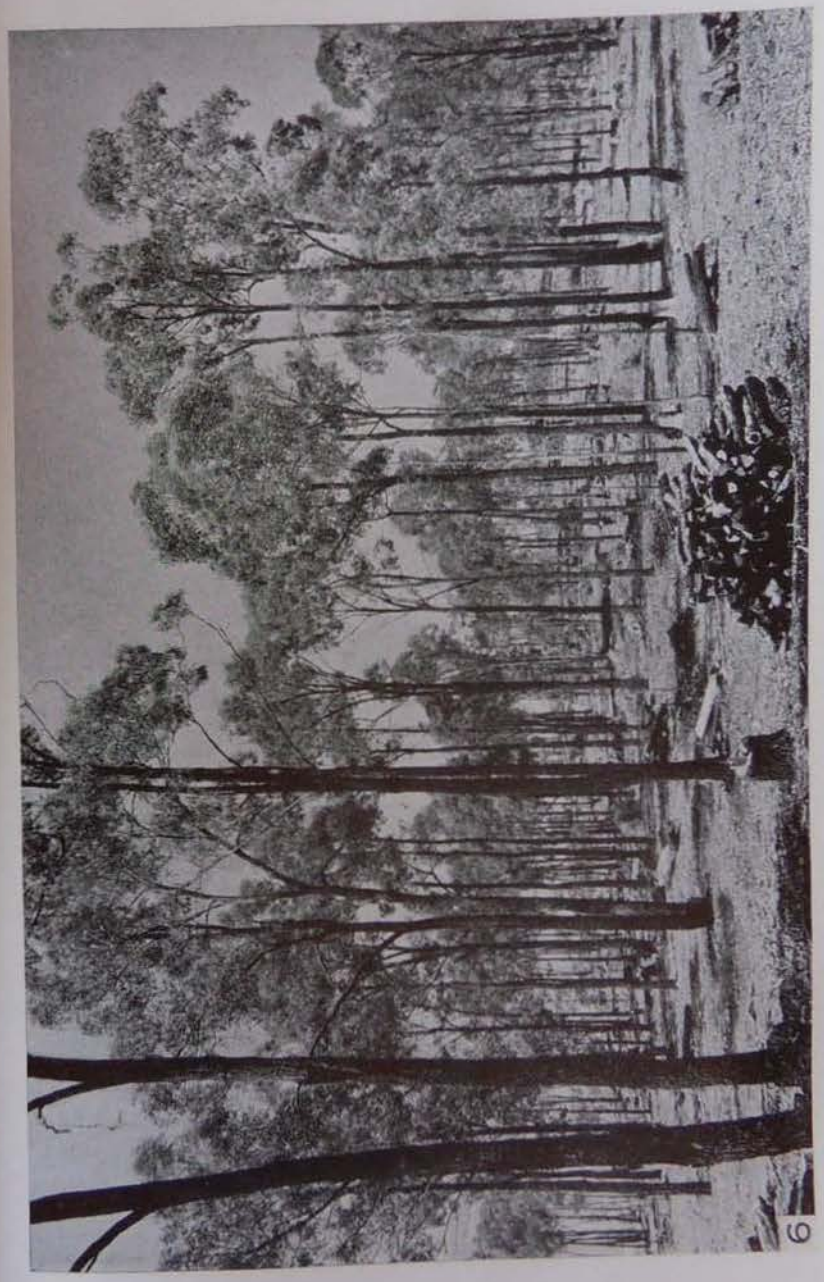

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FORESTS OF THE UPPER ORINOCO

By Llewelyn Williams
Chicago Natural History Museum

"Of all the South American countries," wrote Michelena y Rojas in his *Exploración Oficial*, "none is less known and so little explored than . . . the Orinoco, Casiquiare and Río Negro, which form the territory of the Venezuelan Guayana." This statement is almost as true today as it was when written in 1857. The most famed expedition to the region is that of Humboldt and Bonpland in 1799-1800, in search of the source of the Orinoco and to study the Casiquiare canal. Prior to this the territory had been investigated in some branch or other by Caulin and Gumilla, Fraile Juan Rivero (1729-35), and Solano (1756-61). In 1838 Robert H. Schomburgk explored the area between Roraima and the Orinoco, and in 1853-54 Spruce traveled up the Río Negro and Casiquiare, thence down the Orinoco as far as the rapids of Maypures. In recent years several expeditions, interested in the natural history of the upper Orinoco and its many affluents, have brought back a wealth of materials and information, but despite these efforts no attempt had been made until lately to study the forest types and economic resources of this remote and extensive region, representing a link between the flora of northern South America and the Amazon hylaea.

In continuation of botanical investigations made by the writer in the Caura valley in 1939 and the lower and middle Orinoco in 1940 (see *Tropical Woods* Nos. 62, June 1940, and 68, December 1941), the Ministry of Agriculture of Venezuela, in collaboration with the Chicago Natural History Museum, sponsored a similar expedition in 1941-42 for the purpose of studying the forests and assembling a representative collection of woods and herbarium material of the region extending from the rapids of Atures south to the Brazilian frontier.

Now known politically as the Federal Territory of Amazonas, this region has an area of approximately 167,000

square miles, the greater part of it covered by rain forest. Its northern and eastern borders extend from the rapids of San Borja on the Orinoco, a short distance above the estuary of the Meta River, along the mountain ranges Payaraimu and Tuapu, thence southward along the cordillera Maigualida and Parima. To the South it adjoins Brazil along the Unturán and lesser ranges, while the Piedra de Cocuy indicates the limit with Brazil on the Río Negro. To the West the rivers Orinoco, Atabapo, Guainía and Río Negro denote the frontier with the Republic of Columbia.

Puerto Ayacucho-Isla Ratón Region. The northern part, around Puerto Ayacucho, present capital of the Territory, and along the banks of the famed rapids of Atures and Maypures, is characterized by flat or slightly rolling savannas, in part brown with coarse gravelly soil, elsewhere grass-green, and interspersed by extensive open slabs or massive, rounded, dark granitic boulders. Intermingled with these are low gallery forests, concentrated along the banks of the Bagre, Cataniapo and smaller streams. On the southern outskirts of the settlement there is a distinctive landmark, El Perico, a conical hillock rising up to 500 feet. From its summit one obtains a magnificent view of the rapids of Atures, with huge boulders rearing above the swirling torrent. The lower slopes of El Perico are clothed with such trees as *Xylopia aromatica*, *Guatteria maypurensis* var. *attenuata*, and a species of *Swartzia*, in addition to low shrubs, particularly *Siparuna guianensis* and *Miconia monostachya*. In the gravelly soil at the summit grow tough, wiry grasses–*Paspalum carinatum*, *Andropogon Selloanum*, *Leptocoryphium lanatum*–and other herbaceous plants, including *Desmodium adscendens*, *Polygala variabilis*, *Chamaecrista serpens* and *Phaseolus gracilis*.

In the savanna of Puerto Ayacucho the most distinctive tree is "picatón," recently identified by Steyermark and Woodson as a member of the Loganiaceae and probably a new genus. It attains a height of up to 40 or 45 feet, is usually solitary, has a heavy, light brown wood, and when

dry the valves of the fruit fold backward, suggesting *Aspidosperma*. Scattered through this savanna we also find *Tabebuia cassinoides*, a spreading tree up to 15 feet high, with short, twisted trunk and smooth twigs, soapy to touch; "zapatero," *Peltogyne pubescens*, a deciduous tree 30 feet or so in height, with a light-colored sapwood and a purplish heart; "matapalo," a new species of *Ficus* (*F. ayacuchensis* Standl.), of low stature and with wide-spreading crown; "melero," *Byrsonima nitidissima*, up to 9 or 12 feet tall; a species of *Eugenia;* and "salado," *Vochysia*, a tree of medium size, readily distinguishable by its yellow flowers in upright spikes, appearing when the leaves are absent.

Farther north, in the flood-free forest along the bank of the Orinoco and especially in the vicinity of the rapid San Borja, there are extensive stands of "áme," *Zamia*, its farinaceous tubers being used by the Piaroa Indians to prepare a type of bread.

Immediately south of El Perico is the small stream El Bagre, flanked by a low, fairly dense forest. The most common trees found in this periodically flooded area are: *Eugenia pubescens*, up to 36 or 40 feet tall, with white, highly fragrant flowers and rough, brown bark; *Couralia pentaphylla*, with wide-spreading crown and growing usually in rocky sites; *Parinarium* sp.; *Sickingia tinctoria*, distinguished by its light-colored wood soon turning to a deep pink on exposure to light; *Calophyllum brasiliense; Connarus Patrisii*, up to 35 feet or more in height, with yellow sapwood and a pinkish heartwood; *Heisteria ovata; Combretum frangulaefolium; Byrsonima nitidissima; Cynometra parvifolia*, of medium size, with thin, pale yellow sapwood and dark brown, almost black, heart used for house posts; *Cathedra caurensis; Ecastophyllum monetaria*, of medium to tall stature, the trunk often ramified from near the base; and *Coccoloba guianensis*, about 18 feet in height, with pale yellow flowers.

Since the rapids of Atures and Maypures are not navigable by launches or even large canoes the only way to reach the upper reaches of the river is along a gravel road, built about

20 years ago and running almost parallel for about 45 miles along the right bank of the main stream, thus by-passing the most dangerous section of the entire Orinoco system. Beyond the Bagre River this road leads through grass-green savannas, and a few miles farther is the Cataniapo, a turbulent stream of clear, cold water rising in the Cerro Sipapo to the southwest. On its left bank stands a solitary hut, on the site of Atures, once the capital of the Territory. The road continues through flat or slightly undulating, well-drained meadows covered with a lush growth of grass. Along the margin of the forest fringing this grassland grows the "seje" palm, *Jessenia bataua*, its crown topping even the tallest trees, with a slender gray stem and bearing large clusters of fruit, rich in edible oil. The road ends a short distance above the confluence of the Sanariapo with the Orinoco, and immediately above the rapids of Maypures. The seasonally-flooded banks of the Sanariapo are flanked with a moderately dense forest of medium stature, composed principally of "arepito," *Macrolobium flexuosum molle*, with white sapwood and light brown heartwood, which derives its vernacular name from the flat, semi-rounded fruit; *Maprounea guianensis; Apeiba Tibourbou; Inga Thibaudiana; Parkia discolor*, up to 30 feet tall, with moderately flat crown, a short, twisted trunk and pendent, clustered fruit; *Ormosia dasycarpa; Tovomita Spruceana* var. *obtusa; Duroia Sprucei; Himatanthus attenuata; Protium ferrugineum; Sweetia nitens*, with white sapwood, sharply defined from the darker heartwood; *Coumarouna polyphylla*, especially common in the forest along the rapids of Maypures; *Bombacopsis* sp.; a species of *Couma*, with flexible twigs, the fruit of which contains a luscious, edible pulp; *Machaerium cristacastrense*, and an aquatic species of *Pithecolobium*, a slender tree growing in midstream.

Immediately beyond this riparian forest, and sometimes reaching down to the river, are open savannas, dominated by "salado," a species of *Vochysia*, up to 60 feet in height, with small crown and straight, cylindrical trunk, clear of limbs for more than half the total height. In low patches,

subject to floods, the most common tree is "saladillo sabanero," *Caraipa tereticaulis*, up to 30, at times 45, feet in height, with much twisted branches, light-colored sapwood and reddish heart, employed for carpentry and general construction.

A short distance above the estuary of the Sanariapo is the long, narrow island of El Ratón. This heavily-wooded island is significant in that it coincides with the northern limit, at least in the upper Orinoco, of the genus *Hevea*, represented by two species—*H. Benthamiana* and *H. pauciflora*. The former grows in dense forest exposed to seasonal floods and usually close to the river banks. It attains a height of up to 90 feet, and yields a high grade of rubber. The other species, known locally as "caucho morichalero" or "c. colombiano," is a smaller tree, less abundant and commonly found in humid, fairly open areas beyond the reach of floods. Its fairly smooth, light gray bark yields a latex of inferior quality. Other trees typical of this forest are: *Trattinickia burseraefolia*, a small tree with irregularly-shaped crown, small reddish flowers in terminal panicles, whose wood has a spicy odor; *Iryanthera Hostmannii; Tapirira guianensis; Himatanthus articulata*, a lactiferous tree up to 60 feet, usually found along the edge of the forest; *Micrandra heterophylla*, with a straight, cylindrical trunk, and wide-spreading crown of relatively few branches; *Ficus Ernestiana; Myrtus calophylla; Helicostylis tomentosa*, at times up to 60 feet tall, whose fairly smooth bark exudes a small quantity of creamy white latex when cut; *Sloanea sinemariensis; Duguetia quitarensis;* and *Protium trifoliatum*, with a straight, round, slender trunk and a narrow crown, the bark of which exudes a whitish resin.

Atabapo River. The village of San Fernando is situated on the right bank of the Atabapo River, opposite the estuary of the Guaviare, flowing through Colombia, and a short distance above its confluence with the Orinoco. Until about thirty years ago San Fernando was the principal center for the gathering of *Hevea* rubber in the forests to the south,

along the Orinoco and Casiquiare, but with the decline of the wild rubber industry the village, like the rest of the territory, lost its importance and reverted to an almost deserted state. The forest in the immediate vicinity of the village has been cleared and supplanted by low, fairly open, shrubby growth of *Tococa lancifolia*, *T. longisepala* and *T. guayanensis*, *Ouratea Spruceana*, *Clusia columnaris*, *Miconia eugenioides*, *Palicourea obscurata* and *Remijia firmula*. One of the unusual and among the tallest trees in the high forest, periodically flooded and covering the triangle between the Atabapo and Orinoco rivers, is "jigua," a species of *Caryocar*, up to 80 feet high, with a straight, cylindrical trunk, unbranched for more than two-thirds the total height. Its wood has a pale yellow sapwood and a thick, deep purplish heart.

As one enters the Atabapo River there is a complete change from the vegetation and general environment of the Orinoco. While the waters of the main stream are turbid, the Atabapo is a black water river, although by transmitted light the color varies between blue and dark brown. Unlike the heavily forested, high banks of the main stream those of the Atabapo are low, and almost throughout their entire length, as far as the junction with the tributaries Guasacavi and Atacavi, are populated with fairly dense stands of "palo de boya," *Ambelania laxa*, almost to the exclusion of other species. This lactiferous tree seldom exceeds 20 feet in height, and its white, flexible, light-weight wood is used to a limited extent for rafts. It is one of the most characteristic trees of black water rivers. The most distinctive palm along this river is the "morichito," a species of *Mauritiella*, with a long, slender, white trunk, often arched over the water.

Yavita-Pimichín Forest. By following the stream Temi for a few hours we reached the tiny village of Yavita, from which point an ancient path leads for about 10 miles through lofty forest to Pimichín. Like those of the Atabapo, the waters of the Temi are black, but the vegetation in general is denser, more varied and 30 to 45 feet high. Interesting

trees collected along the Temi include *Vatairea guianensis*, 30 to 36 feet tall, with conspicuous inflorescence in terminal racemes, and whose wood has a fetid odor when fresh; a species of *Licania*, with mottled brown fruit containing an edible pulp; *Ouratea Williamsii* and *O. venezuelensis*, *Parkia discolor*, *Cassia moschata*, *Clusia Planchoniana*, *Moronobea riparia*, with rough, scaly bark, exuding a yellowish resin, turning black with age, which is used by the Indians for caulking canoes; *Senefeldera inclinata*, with fairly smooth bark and white wood; and *Virola calophylla*, with slender, round bole and erect branches. The commonest palms are "volador," a species of *Desmoncus*, with stout, recurved spines, and *Bactris actineura*, small, slender and armed with numerous, black spines.

Along the right bank of the Temi, and gradually merging into the riparian forest, are extensions of low, shrubby growth, or what the natives call 'sabanetas." The outstanding trees in these semi-open patches are "caruto sabanero," *Capirona decorticans*, up to about 30 feet in height, with a narrow crown, smooth, round trunk and small, white flowers; a species of *Vochysia;* "pastora" or "cacheta vieja," *Aspidosperma*, with large, flattened, mottled brown fruit and many large, appressed, winged seeds: "niña," *Humiria floribunda* var. *subsessilis*, with one-seeded, bluish to almost black fruit, containing a fairly sweet, edible pulp; and "pendarito sabanero," *Zschokkea microcarpa*, a small lactiferous tree with white flowers and deep red, globular fruit.

The terrain from Yavita to Pimichín is moderately flat and almost entirely covered with dense rain forest of uniform stature, averaging 50 feet. Among the commonest trees forming the upper story are: "yahuana," *Eperua leucantha*, upwards of 70 feet high, with white sapwood and a sharply defined reddish heart, used for the construction of bridges; and "yevaro," *E. purpurea*, often 90 feet tall, with irregular crown and its durable wood also is used for heavy construction. In low, periodically-flooded areas, close to the river bank, we find "goma rebalsera," *Hevea minor*, with small crown, long, cylindrical trunk, and the thin, gray

bark yields, when tapped, a yellowish latex of inferior quality for rubber. Other trees forming the upper canopy are: *Pourouma* sp., *Himatanthus phagedaenica, Inga alba, Vochysia* sp., *Xylopia frutescens* var. *ferruginea, Mouriria anomala, Simaruba amara* var. *opaca, Carpotroche amazonica, Erisma floribunda, Virola surinamensis, Iryanthera Hostmannii* and *Aldina latifolia.*

The understory is likewise dense, consisting of a wide variety of trees, but nowhere do we find any preponderance of one particular species. Principal of these are: *Ouratea Spruceana, Isertia verrucosa, Miconia lepidota, Alchornea columnaris, Macrosamanea leucophylla, Aparisthmium cordatum, Pagamea plicata, Picramnia tristamina, Loreya ovata, Palicourea nigricans* and *Protium Aracouchili.*

Of the palms, the one most frequently encountered in well-sheltered sites is "mábi," *Iriartea setigera,* up to 15 or 20 feet high, with slender trunk, armed with numerous fine black spines, and used by the Indians for making blowpipes. In low, humid areas the "chiquechique," *Leopoldinia Piassaba,* at times abounds to such an extent that it forms stands of appreciable size. Not only are the leaves of value as the source of a long, tough fiber, used in the manufacture of brooms, but they are also utilized by the Indians for thatch. Along the river banks or on the margin of the forest we find another species of *Leopoldinia—L. pulchra*—a smaller palm with clusters of reddish fruit, but of no economic value.

In the immediate vicinity of Pimichín, now a solitary, deserted Indian hut, the forest is low, consisting in the main of straggly trees and shrubs, such as *Drepanocarpus inundatus, Clusia reducta, Matayba inelegans, Coccoloba guianensis* and *Ouratea Spruceana.*

Guainía River. From Pimichín one can travel in a few hours by canoe down a narrow stream to Maroa, principal Baniba Indian village on the left bank of the Guainía River. A fruit tree commonly planted near habitations throughout this area is the lactiferous "temare," *Lucuma Temare,* of medium stature, whose ovoid, one-seeded, yellow fruit contains an edible pulp of agreeable taste. Also, the tall, slender "pijiguao" palm, *Guilielma gasipaes,* is frequently planted as an ornamental and for its edible, nutritive fruit, as is the "manaca de Pará," *Euterpe oleracea.*

Both banks of the Guainía, for its entire length from the Colombian border to its junction with the Casiquiare, are lined with high rain forest. Conspicuous elements of this type are: *Diplotropis nitida,* 70 or more feet in height; "chígua," *Campsiandra laurifolia,* a straggly tree with a broad crown usually overhanging the water, and characteristic of rocky sites; *Pagamea plicata; Ferdinandusa guainiae; Ouratea pulcherrima,* with white, highly fragrant flowers, and a thick light-colored sapwood, sharply demarcated from the darker heartwood; *Parkia igneiflora,* with deep yellow flowers, and *P. discolor; Eperua leucantha; Caraipa faveolata; Buchenavia suaveolens; Caryocar glabrum; Genipa ameriana; Hevea minor; Macrolobium flexuosum molle; Hymenolobium alatum,* known as "anzuelito"—little fish-hook—alluding to its recurved seed; *Mollia tomentosa;* a species of *Panopsis;* and *Ormosia nobilis.*

In the closed forest beyond reach of seasonal floods the most distinctive element is the "piasaba" or "chiquechique" palm, referred to above. It is found in greater abundance in the Guainía basin than elsewhere in the Amazonas Territory, and often forms extensive stands, "chiquechiqueales." It attains a height of 22 to 30 feet, with leaves measuring up to 12 feet. The upper part of the trunk is usually clothed with a dense mass of long, dark brown fiber—remnants of old leaf stalks. This is cut and baled for export, mainly through Manaos, and in normal years constitutes the only forest product exploited in this region. This palm is limited in its distribution to the black water areas, and is most abundant along the Guainía, upper Río Negro, lower Casiquiare and their affluents. Another characteristic palm of the dry-land forest is "temiche," *Manicaria saccifera,* notable for the size of its trunk and length of the leaves, up to 25 feet, and attains its best development in humid, well-shaded areas.

The forest of the tierra firme merges into patches of small savannas, well beyond the reach of periodical inundations, and covered with low trees and scrubby growth, represented by *Pagamea guianensis* and *P. hirsuta, Macairea stylosa*, a species of *Poicilandra, Clerodendron Thomsonae, Doliocarpus, Coccoloba excelsa* var. *glabra, Mimosa Andreana, Loreya Spruceana, Retiniphyllum pilosum* and *Myrmidone macrosperma.*

Victorino, an Indian village on the border of Colombia, is notable for its salubrious climate and freedom from mosquitoes and other insect pests. The forest here is similar in its general aspects to that around Maroa, although many trees were encountered in flower or in fruit, material of which had not been gathered previously. Among these were: *Ouratea venezuelensis*, a small to medium-sized tree with long, much twisted limbs; *Ocotea guianensis*, its leaves dark green on the upper surface and lustrous golden brown underneath; *Ryania speciosa; Heterostemon cauliflorus*, common in flood-free forest; *Qualea macropetala; Pourouma tomentosa*, with dark purplish fruit, containing a juicy and highly agreeable pulp; *Quiina longifolia*, with a heavy, hard wood; *Ladenbergia amazonica*, with straight, round, slender trunk and grayish bark; *Miconia planinervia*, its reddish fruit, turning dark brown at maturity, in long, pendent racemes; and "cupana" a species of *Paullinia*, frequently cultivated by the Indians of this region for its seeds, reputed to have medicinal properties.

During the rainy season it is possible to travel by canoe from the Guainía to the upper Casiquiare by way of San Miguel, a small stream with black water. Its banks in part are flanked by stands of the soft-wooded "palo de boya," *Ambelania*, characteristic of the Atabapo. Elsewhere the seasonally-flooded forest is composed of many species intermediary between the types of the Guainía watershed and the upper Orinoco. Representative of these are *Ouratea mucronata*, with soft fruit, almost black when ripe; "balata," *Manilkara* sp., yielding a viscous latex, exploited in former years; *Clusia Planchoniana*, a small epiphytic tree; *Psychotria vasivensis;* "reventillo," *Amanoa cupatensis*, with long, arcuate branches; "coco de mono," *Lecythis* sp., with dehiscent, pendent fruit; "huacapú," *Diplotropis nitida*, its trunk often bifurcated at the base, has a hard, dark-colored wood, used for construction of houses; "arepillo," *Arthrosamanea marginata; Caraipa faveolata*, usually found in clearings in high forests; *Tovomita Spruceana* var. *obtusa*, with many erect superficial roots; and *Macrolobium flexuosum molle*, bearing the common name "arepillo" in allusion to its flattened, rounded fruit.

After spending several days exploring the caño San Miguel we continued by canoe down the Guainía, making frequent stops to collect in the high forest along both banks. Two days later we reached the mouth of the Casiquiare, which appears to be about equal in width to the Guainía. From the confluence of the Guainía and Casiquiare the river is known as Río Negro. We continued downstream for a few hours until we reached San Carlos, largest and principal village in this area.

San Carlos - Cocuy - Lower Casiquiare Region. The most distinctive tree in the public square of San Carlos is the "juvía," *Bertholletia excelsa*, tall and stately, with a dense crown, and of prime importance in the Brazilian Amazon for its seeds, the Brazil-nuts of commerce. The species is said to be common in the forests of the upper Orinoco, above the estuary of the Padámo. Spruce, in his account of observations on the Amazon and Andes, mentions the difficulty Humboldt and Bonpland experienced in securing the flowers of this tree, for which they offered an ounce of gold.

In the immediate vicinity of the village the forest has been cleared for the planting of manioc, *Manihot*, source of the staple food of the natives. Because of its great height and small crown, the most conspicuous tree in the high forest is "tanare," *Vochysia splendens*. Its trunk is straight, cylindrical, topping all other trees, and its dark green leaves are golden brown underneath. Other trees forming the top story include "temara montañero," *Ecclinusa* sp.; "guaco," which

suggests a species of *Alexa;* "guabadaro," as yet an unidentified member of the Apocynaceae; "cachicamo de altura," *Calophyllum brasiliensis;* "sarrapia mona," *Coumarouna polyphylla;* "palo de cuyure," a species of *Vochysia;* "mure" or "achapo" (Moraceae), the largest tree in this forest, attaining a height of 90 to 120 feet, has an immense round trunk, with large buttresses; "caucho yapi," *Hevea brasiliensis* var. *marginata,* often 75 or 80 feet tall; "pendare," *Couma macrocarpa,* with comparatively small crown, has a grayish bark, which yields an abundance of sweet latex; *Qualea casiquiarensis; Caryocar crenatum,* found usually along the margin of the forest; *Coussapoa* sp.; and a new species of *Rudgea–R. carolina.*

Along the periodically flooded river banks the forest consists of "marupa," *Simaruba amara* var. *typica;* "caucho fino" or "c. legítimo," *Hevea brasiliensis;* "cudo," *Virola pavonis; Parkia igneiflora; Anaxagorea brachycarpa;* a species of *Luehea;* "cachimbo," *Gustavia* sp., with salmon pink flowers; "yócoro," *Mouriria anomala,* with coriaceous leaves and a yellowish fruit containing a sweet pulp; the lactiferous "ucuquirána brava," *Ecclinusa spuria,* with round, corpulent bole; "arepillo," *Macrolobium acaiaefolium;* "masarandú," *Manilkara* sp.; and "laurel," *Aniba rosaeodora.*

Of the palms, the most common are "sejíto," *Oenocarpus bacaba,* attaining its best development on dry, open sites in the forest, "albaríco" *(Astrocaryum),* tall, corpulent, copiously armed with long, sharp spines and usually found in areas where there is a mixture of brown and black waters; "pijiguao;" *Guilielma gasipaes,* commonly planted around abodes for its fruit, used for preparing a refreshing beverage; and "cumare," *Astrocaryum* sp., whose trunk is abundantly armed with pointed spines and whose young leaves furnish a fine, strong fiber employed for making hammocks.

Small patches of savanna, interspersed with high forest, are populated by small or medium-sized trees, represented by "macuca," *Bellucia circumcissa; Palicourea obscurata; Pagamea sessiliflora; Guatteria Spruceana; Macrosamanea leucophylla; Couepia* sp.; *Miconia minutiflora; Macrolobium*

gracile; Ouratea Spruceana; Anaxagorea dolichocarpa; Ormosia nobilis; and *Trattinickia burseraefolia.*

The area between San Carlos and the Brazilian frontier is covered almost uninterruptedly by dense, high forest, similar in composition to that found above San Carlos. In general, however, it appears to be taller than the forests bordering the upper Guainía and Atabapo. The outstanding landmark in this region is the famed Piedra de Cocuy, rising to an elevation of 1500 feet above sea-level, on the left bank of the Río Negro. Although surrounded by dense forest the face fronting the river is destitute of vegetation and appears to be deeply cleft. The lower third of the mountain is clothed with straggling shrubs, among which are *Psychotria Spruceana, Virola elongata, Lophanthera longifolia* and *Solanum molle.*

From Cocuy we returned to San Carlos, thence ascended the Casiquiare to Solano, a small Indian village and site of one of the early missions established by the Spaniards during the colonial period. A little used path leads in a southwesterly direction through the forest from Solano to San Carlos. One of the tallest trees in this flood-free forest is *Iryanthera sagotiana,* with stout, erect, cylindrical trunk, dehiscent green fruit and reddish seeds. Alongside of this grows *Blastemanthus paniculatus,* with a small crown of few, elongated branches and a bluish fruit; a species of *Lecythis,* often 90 feet or more in height, with an irregular crown of dense foliage; and *Virola elongata,* with globular fruit in small racemes, whose seed is enveloped in a yellowish pink aril. Here also we encountered minor stands of an attractive small palm "morichito," a species of *Lepidocaryum,* with vermilion flowers and deep pink fruit in pendent racemes.

Along the river banks, subject to seasonal inundations, abounds "cimbra potro," *Pithecolobium amplum;* "palo de boya negro," a species of *Ambelania;* "palo de machete," *Apoucouita acuminata,* a corpulent tree with a short, twisted bole and long, often arcuate limbs. The most common orchid, readily distinguished by its large, deep purplish flowers, is *Cattleya violacea.*

From Solano we returned down the Casiquiare, thence continued up the Guainía to Maroa, along the stream Pimichín, and afterwards overland through the forest to Yavita. The large collections assembled at the various centers on the outward journey had to be repacked and shipped in canoes down the Atabapo to San Fernando, thence along the Orinoco to Sanaripao, at which point they were transferred to a truck for shipment overland to Puerto Ayacucho.

Ventuari - San Antonio Region. About the middle of April we left Puerto Ayacucho and proceeded in canoes along the Orinoco, for the purpose of studying the forests along the main stream south of San Fernando de Atabapo. Our first collecting center was the delta of the Ventuari, formed by a large number of small, heavily-wooded islands and a series of dangerous channels, difficult to negotiate. Among the taller trees observed in the forest at this point were: *Vitex compressa*, up to 90 feet high, with few stout limbs, a trunk 3 feet in diameter and tall, thick buttresses; a species of *Gustavia*, usually in flood-free areas; *Alibertia obidensis*, known as "caruto" or "saranda," with dense, irregular crown; *Cordia scabrida*, its white flowers in terminal racemes; *Heterostemon mimosoides;* and *Alchornea discolor*. The understory consists of such small trees as *Lindackeria latifolia*, with thin, rough bark and white flowers; a species of *Rinorea*, with cone-shaped crown; *Randia armata*, its branches amply armed with sharp spines, in pairs; while along the edge of the water one finds an occasional "palo de boya," *Ambelania*. Woody vines are especially abundant in these islands, particularly *Distictis guianensis*, with a long pod; *Clitoria javitensis*, with stiff, dark green leaves; *Homalium Racoubea;* and *Cranocarpus Martii*.

Continuing for two days along the river we reached San Antonio, the first habitation above San Fernando. The riparian forest here is low and often straggly, consisting of *Vismia guianensis*, with rough bark exuding a reddish resin; *Zygia inaequalis*, up to 15 or 18 feet high, with a closed crown of overhanging branches; *Syzygiopsis sericea;* a

Sapotaceous tree upwards of 30 feet, with a slender, round trunk; *Clusia viscida; Macrolobium limbatum*, with thin, smooth bark and a light-colored wood; "salado" or "pese," *Vochysia ferruginea*, among the tallest trees, often 70 feet in height, with a crown covered with a mass of yellow flowers in erect spikes; and *Bellucia grossularioides*. The dominant tree throughout this region is a species of *Hevea*, at times in small stands of 5 to 10 individuals, at other times solitary, but attaining its best development in dense growth along the edge of the seasonally-flooded area, at a distance of one-half mile or more from the banks.

A short distance above the delta of the Ventuari there are fairly large extensions of savanna, at times reaching down to the water, elsewhere separated from the river by narrow belts of riparian forest. The vegetation encountered in these savannas varies from one area to another. Sometimes they are open and covered with a tall, coarse grass, in places dominated by the "moriche" palm, *Mauritia*, or some particular tree, especially *Vochysia*, while elsewhere they may be covered with dense scrubby growth. In the last type we find such small trees as: *Poraqueiba guianensis, Saccoglottis guianensis, Retiniphyllum Schomburgkii*, a species of *Hecatostemon, Qualea cyanea, Matayba scrobiculata, Casearia sylvestris, Isertia rosea*, and a species of *Dimorphandra*. Shrubs mixed with these include *Ternstroemia discoidea, Hirtella racemosa, Clidemia umbonata* and *C. tococoidea, Rourea glabra, Humiria floribunda* var. *subsessilis*, and *Protium guianense*.

Tamatama. Three days after leaving San Antonio we reached the estuary of the Cunucunúma, a large stream flowing from the southeast and skirting the Duida range. A few miles farther south is the entrance to the Casiquiare, a natural canal uniting the Orinoco basin with the Amazon, by way of the Río Negro. The main stream at the bifurcation is about 1,000 feet wide, but a short distance beyond the confluence, at Tamatama, it narrows into a constricted rocky passage.

Two weeks were spent at Tamatama, a small settlement on a slight slope on the right bank of the Orinoco. Back of this village there is a small coffee plantation, surrounded by a fairly open growth of low or medium-sized trees, represented by *Bellucia grossularioides*, *Alchornea orinocensis*, *Protium ferrugineum*, *Mabea subsessilis*, *Miconia macrophylla*, *Cassia multijuga*, *Neea tristis* and *Casearia brasiliensis*. This merges gradually into rolling terrain, clear of seasonal floods, and covered with a dense forest of tall trees, many of them esteemed for their hard wood. Among these we find "jigua," *Caryocar glabrum*, up to 70 feet in height, with flexible twigs and a light-colored wood; "laurel de tierra firme," *Acrodiclidium pichury*, 65 to 80 feet tall, with a small crown of slender branches and its wood is utilized for making canoes; "trompillo," *Guarea cuspidata*, 50 or 60 feet tall, with a dense, irregular crown; *Trymatococcus* sp., up to 30 feet, with a yellow, globular fruit. In the periodically-flooded forest one of the dominant trees, and the most important economically, is *Hevea Benthamiana*, although not as abundant as in the middle Casiquiare region.

The riparian forest consists of *Henriettea Spruceana*, *Crepidospermum rhoifolium*, *Ficus corpulenta* and *F. ramiflora*, *Oreopanax* sp., *Parkia discolor*, and a species of *Triplaris*.

Above Tamatama the Orinoco again spreads out to a great width with many sandbanks, among which it was not always easy to find a channel. As we progressed we had frequent views of Duida, an impressive massif that always seemed to be covered, from midmorning until sunset, with great cumulus clouds floating below its summit. From the south it appears wedge-shape, with escarpments facing southeast and a long slope inclining to the northwest. Along its side seams are disclosed, whereas elsewhere the mountain is forest clad to its very tip. The sharp ridges and broken cliffs are in sharp contrast with the flat or rounded curves of the summit.

Esmeralda. In his *Notes of a Botanist on the Amazon and Andes* Spruce described Esmeralda as "a village of six houses scattered round a square plaza." Today no village exists, and the site is totally uninhabited, except by nomadic Guaharíbo or Maquiritare Indians who make occasional trips during the dry months in search of food. A short distance from the Orinoco and back of the site where the settlement once stood there is a low, semi-circular ridge of granite blocks, cutting off a small, open savanna flanking the river from a larger savanna extending to the foot of Duida on the west and the mountains of Padámo and Guapo to the east. The most conspicuous element in this meadow-land is the "moriche" palm, *Mauritia*, forming long, narrow stands, "moricheales," concentrated along the banks of stagnant pools and slow-flowing streams. The small savanna around the site of Esmeralda is covered with a coarse, dense grass, dried up by the heat, mixed with *Cyperus Luzulae* and *C. diffusus* var. *umbrosus*, *Homolepis aturensis*, *Smilax spinosa*, *Desmodium barbatum* and *Phaseolus linearis*. The rocky ridge, already mentioned, is populated with a species of *Byrsonima*, a small shrub with a much-twisted trunk; *Grimaldia orinocensis*, *Pitcairnia patentiflora*, *Bulbostylis junciformis*, *Tococa nitens*, *Xylopia aromatica*, a tree at times 30 feet high; *Perama galioides;* a species of *Miconia;* a shrub, *Zanthoxylum*, with small reddish flowers; *Matayba fallax*, a shrub about 6 feet high and with round, pinkish fruit;; *Vismia dealbata*, a small tree or tall shrub yielding a yellowish brown resin; *Protium Aracouchili* and *P. guianense*, both small trees exuding from their bark a translucent, fragrant oleo-resin.

Scattered through the large savanna we find isolated stands of gallery forest, usually concentrated along the banks of large lagoons. These consist of *Tapirira guianensis; Byrsonima* sp.; *Quiina longifolia*, a small tree with yellow flowers and coriaceous leaves; *Apoucouita hymenaefolia*, a medium-sized tree with a fairly round trunk, often bent; *Anisomeris paniculata*, a tall shrub with white flowers; an unidentified species of *Albizzia; Zygia inaequalis*, of small stature, with a

much twisted trunk; and *Macrolobium flexuosum*, up to 25 feet tall, with a flat crown.

The banks of the Orinoco at Esmeralda are low and covered in parts with a narrow belt of straggly trees, elsewhere the forest is tall and dense. Prominent in this riparian growth are: *Pterocarpus Rohrii*, 60 to 70 feet high, with a leafy crown and a bark exuding an abundance of reddish resin, whence the common name "sangre de drago;" a species of *Jacaranda*, its lower limbs often arcuate; *Amaioua guianensis*, with a heavy, light brown wood; *Dialium guineense*, 40 to 50 feet in height, whose trunk is slender and cylindrical; *Lophanthera longifolia*, a small tree with an open, round crown; *Ouratea thyrsoidea*, with a thin, pale yellow sapwood and deep pinkish heartwood; *Duroia Sprucei*, of small or medium stature and much twisted branches; *Humiria floribunda* var. *laurina*, a tree 12 to 15 feet tall; *Chalepophyllum pungens*, a small, stunted tree or shrub, usually with a flat crown; and *Pagamea coriacea*, a shrub up to 10 feet in height.

Upper Casiquiare. From Esmeralda we continued down the Orinoco, thence followed the Casiquiare. At its bifurcation with the Orinoco the canal has a width of about 750 feet, but almost immediately below the entrance there is a sharp turn and the channel narrows down to about 150 feet. Its banks are high, perpendicular, heavily forested and typical of white water areas. Conspicuous trees in the flood forest flanking the entrance are: "pilón," *Andira retusa*, about 50 feet in height, with a fairly flat crown of stout branches; *Amaioua guianensis*, of medium stature and with white flowers; "saladillo," *Vochysia ferruginea*, up to 60 feet in height; "temare rebalsero," a Sapotaceous tree constituting the most characteristic element of this forest, with a broad crown of stout branches; a species of *Lecythis*, up to 60 feet, with a straight, cylindrical trunk clear of limbs for more than two-thirds the total height; a species of *Zygia*, of small stature, its long branches overhanging the water; *Cordia scabrida*, its globular, pale green fruit in clusters; and

a species of *Vitex*, distinguished by its blue flowers in terminal panicles.

Humboldt estimated the length of this natural canal to be 180 miles, while Hamilton Rice computed it at 227 miles. Almost throughout its entire length the Casiquiare flows through flat, densely wooded area and is fed by four large rivers—the Pacíba, Pamóni, Siapa and Pacimóni—and many small streams, mostly with black water. At many points along its course slabs of rocks, *lajas*, jut into the channel, often striking each other from opposite banks, forming narrows with fords above and below. In some parts the river bed is strewn with rocks, forming rapids difficult to negotiate, especially from January to March. At the height of the wet season the canal is deep enough for large launches to traverse the entire length from the Orinoco to the Río Negro, but in the dry months the water in parts is so shallow that large canoes can scarcely pass through.

An interesting tree observed along the high river banks and conspicuous in April-May, due to its masses of lavender-colored flowers, is *Taralea casiquiarensis*. It has a moderately round crown, cylindrical trunk 20 to 25 inches in diameter, and light-colored wood. A day and a half after leaving Tamatama we reached the small Indian village of Capihuara, one of the most picturesque spots of the canal. About 30 years ago it was the most important center for the gathering of *Hevea* rubber along the Casiquiare and upper Río Negro. Although abandoned in Spruce's time it was noted for the Indian picture-writing on horizontal slabs of rock, which can still be seen hidden among low trees about half a mile from the river. A short distance above the village, close to the left bank, stand two large rocks, riven apart as described and drawn by Spruce.

In the dry land forest back of Tamatama there is a large variety of trees, mostly of medium size. Among the most common are: *Hevea minor*, up to 60 feet in height, with a small crown, which yields a fair quantity of latex of inferior quality as a source of rubber; a species of *Heterostemon*, with slender trunk and small crown; *Patrisia monsoana*, a

small tree or tall shrub, with vermilion-colored fruit; *Miconia scrobiculata*, with a short, much-twisted trunk; *Caryocar glabrum*, commonly known throughout the Territory as "jígua," and attaining a height in dense forest of 75 to 90 feet; *Leandra cuspidata*, with small white flowers; *Protium Aracouchili*, a slender tree of medium size and with a narrow crown; *Isertia rosea*, seldom exceeding 30 feet in height; *Clusia Planchoniana*, its open crown formed of slender, almost upright branches; *Eperua leucantha*, of medium stature and irregular crown; *Warscewiczia coccinea*, a tree of small to medium stature, with fine-textured wood; also *Coussarea grandis*, *Pourouma cucura* and *Virola sebifera* usually found in association with "chiquechiqueales," stands of *Leopoldinia Piassaba*.

About a mile above Capihuara the stream Macasi comes in on the left bank. Its headwaters are close to the source of the Pamóni, which debouches into the Casiquiare a few miles farther down. The heavily wooded banks of the Macasi are low and flooded over for a considerable distance inland during the wet season. Here we find "carutillo rebalsero," *Alibertia obidensis; Duroia Sprucei*, up to 40 or 45 feet and with sparse crown; "pilón," *Andira retusa*, with a short, stout bole; a new species of *Cecropia–C. nigra;* "palo de boya," *Ambelania*, usually associated with black-water streams; *Caryocar riparium*, its subrounded fruit clustered at the tip of the twigs; a species of *Inga;* "palo de machete," *Apoucouita acuminata*, with round trunk often bifurcated close to the base; *Protium unifoliatum* var. *subserratum*, of medium size and with an irregular crown of slender branches; "chicle-masarandú" and "chipón" or "purguo," both Sapotaceous trees of medium height; *Cunuria casiquiarensis*, a small tree with arcuate branches; *Coussarea paniculata; Vitex triflora*, with light-colored sapwood and bluish heartwood; *Apeiba glabra*, known commonly as "peine de mico," in allusion to its compressed, spiny fruit; *Tovomita Spruceana* var. *obtusa*, the heartwood and bark of which exude a deep yellowish resin; *Ficus capihuarana*, a corpulent tree of medium stature and very dense crown; *Henriettea succosa*,

up to 60 feet, with a small crown and dark brown heartwood; *Styrax guianensis*, a small tree with yellowish flowers and smooth bark; *Mabea nitida*, its branches usually hanging over the water; *Cynometra Spruceana*, its trunk often arched and ramified almost from the base; and *Guatteria riparia*, with reddish fruit grouped in large clusters.

The most common palms in the forest of the upper Casiquiare are: "sejito" or "cudidí," *Oenocarpus bacaba*, unarmed, up to 50 or 60 feet in height, with a bluish gray fruit used by the natives for preparing a beverage; *Leopoldinia Piassaba*, distributed through the forest beyond reach of seasonal floods, although not as frequent or forming large stands as in the lower reaches of the canal or in the Guainía basin; *Leopoldinia pulchra*, in low humid areas, often near river banks; and "albaríco," a species of *Astrocaryum*, the most abundant palm along heavily wooded banks flooded over during the wet period, especially where there is a mixture of white and black waters. Vines are also well represented along the banks by *Prestonia acutifolia*, *Odontadenia grandiflora*, *Securidaca Warmingiana*, *Dioclea glabra*, *Passiflora* spp., *Paullinia rugosa*, *Schwenkia glandiflora*, *Mucuna urens*, *Philodendron myrmecophilum*, and *Peritassa primosa*.

The dry season is much shorter in the upper Orinoco than on the lower River. Rains begin to fall about the middle of April and vapor hangs over the forest like a pall. The rainy season advances with rapid strides and by the end of May or middle of June the main rivers and their affluents begin to leave their banks, flooding large areas for several miles inland, and making it almost impossible to enter the forest except in canoe.

We left Capihuara early in June and returned to Tamatama for further explorations before shipping the materials down the Orinoco to our main base at Puerto Ayacucho. Here the entire collections made during the first period along the Atabapo, Guainía, Río Negro and lower Casiquiare, and those gathered in the upper Orinoco and Casiquiare regions were crated and shipped by boat to Ciudad Bolívar, thence overland for several hundred miles through the Llanos, reaching Caracas by the middle of July, 1942.

EXPLANATION OF FIGURES

1. Trunk of *Hevea Benthamiana* M. Arg.; El Porvenir, lower Casiquiare.

2. Fiber attached to the trunk of Chiquechique palm *(Leopoldinia Piassaba* Wallace); Maroa, Rio Guainía.

3. The lower Casiquiare, at Solano.

4. The Orinoco River above the bifurcation of the Casiquiare canal, with Duida range in the background.

5. Savanna of Esmeralda and Orinoco River, as seen from site where village once stood.

6. The entrance into the Casiquiare canal as seen from the Orinoco, below Tamatama.

A NEW SPECIES OF *COUMA* FROM COLOMBIA

By JOSEPH MONACHINO
New York Botanical Garden

When the late Prof. S. J. Record discovered the Cow Tree in Guatemala in 1926, which was in the same year described as *Couma guatemalensis* by P. C. Standley in *Tropical Woods*, attention was focused by North American botanists on this valuable laticiferous tree. Yet *Couma* in the state of Bahia had been noticed by a naturalist in 1587, as seen by Gabriel Soares de Sousa's "Tratado Descriptivo do Brasil," and had from time immemorial been highly prized by the aborigines of South America.

Recent extensive field investigations under the auspices of the Chicle Development Company have been of incalculable aid in clarifying the distribution and taxonomy of *Couma*. It was through this generous assistance that the author of the present article was placed in a position to revise the genus *(Lloydia* 6: 229-247. 1943. Also supplement, *Lloydia* 9: 293-309. 1946). Study showed that the *C. guatemalensis* of Guatemala and British Honduras is conspecific with the widely distributed *C. macrocarpa*, which is also known from Panama south to the Amazon. The genus was seen to com-

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prise five species, and extensive explorations did not disclose any additional species. It began to appear as though all the existing species of *Cuma* had been discovered and no novelty in the genus was to be expected. However, the little-known area of eastern Meta in Colombia, drained by the Vichada, Tuparo, and Tomo Rivers, had not been open for exploration until lately, because of the hostility of the Indians who protected the *Couma* trees for their fruits which they value very highly. Before operations in the Vichada River area were abandoned a botanical specimen representing the trees which are reported seen in large stands along these rivers was obtained for study. Unfortunately, the material is sterile, but it is all that can possibly be expected for a long time to come, at least from the original collector. Inasmuch as the genus can be recognized unmistakably even from its foliage, and comprises merely five hitherto published species, each of which is rather easily distinguishable, it is not a difficult matter to present diagnostic characters for the new species of *Couma* described below.

Couma multinervis Monachino, sp. nov. Arbor, ramulis puberulis; foliis ternate verticillatis; laminis ellipticis, ad apicem angustatis acuminatisque, ad basin valde angustatis subsessilibusque, 15-22 cm. longis, 3-7 cm. latis, subtus puberulis; venis secundariis utroque 20-24, venis tertiariis manifestatis, reticulo non uniformi.

Tall tree, the branchlets triangular, more slender than those of *C. macrocarpa*, closely puberulent with short spreading hairs; leaves ternately verticillate, the blades chartaceous, elliptic, narrowed and bluntly acuminate at apex, greatly narrowed and subsessile or sessile at base, about thrice as long as broad, 15-22 cm. long, 3-7 cm. broad, closely puberulent with short erect hairs beneath and on midrib above, the secondaries (principal lateral nerves) 20-24 pairs, the tertiaries manifest, the reticulation not uniform; flowers and fruits not seen. Type: *Pacheco s. n.* (Krukoff Herb. *12879*), Laguna Casanare, Rio Vichada, Meta, Colombia;

received in April, 1947. "Pendarito." "Naipiani" (Guahibo). (N. Y. Bot. Gd.)

Couma multinervis occupies a position apparently between *C. guianensis* and *C. macrocarpa*. It is easily distinguished from *C. macrocarpa* by its leaf shape. It bears a closer resemblance to *C. utilis* and *C. guianensis*, but there is little difficulty in separating the Vichada species from these by its more numerous secondaries, as well as by its pubescence. Also, its leaf size is much greater than that of *C. utilis*, its petiole shorter than that of *C. guianensis*, and its leaves are more narrowly elliptic and more narrowed at base than those of *C. guianensis*. There is no fear of confusing *C. multinervis* with the remaining two species, *C. catingae*, which has long-petioled quaternately verticillate leaves, and *C. rigida*, which has closely sessile, black-punctate coriaceous leaves.

SUMMATIVE ANALYSIS OF QUEBRACHO WOOD

By Louis E. Wise and Evelyn K. Ratliff
The Institute of Paper Chemistry, Appleton, Wisconsin

Frequent references in the chemical literature to Quebracho emphasize the very high extractives content of the wood, which frequently contains 20-30% tannin.[4] The literature is replete with studies of quebracho tannin extracts and their uses, but few comprehensive studies have been made on extractive-free quebracho wood (i.e., the wood remaining as a residue after tannin extraction). Virasoro[7] removed the lignin from extractive-free white quebracho wood with ethyl acetate and hydrochloric acid. After purification, this lignin fraction contained 17.2% methoxyl, which is lower than that found in the more common hardwood lignins. On the other hand this investigator showed that the quebracho lignin fraction gave absorption spectral curves very similar to those of other hardwood lignins obtained by other methods. For example, the absorption maximum at 2800Å was slightly higher than that of willow

lignin (2790Å). The utilization of extracted quebracho wood waste is referred to very briefly by Belani.[1] Levi[5] showed that pulp obtained by alkaline digestion of quebracho wood was not suitable for the manufacture of paper or rayon but might perhaps be used in special card board.

Experimental

A stick of quebracho wood (probably *Schinopsis lorentzii* or *Schinopsis balansae)* was Wiley milled and the woodmeal prepared for analysis. The sample was divided into two fractions: one which was milled and screened in order to obtain samples for the quantitative determination of extractives (I), and a much larger sample which, prior to milling, was used in a large-scale extraction, the wood residue from which served other subsequent analyses (II).

In the case of the extractives, duplicate determinations were made using 2 grams air-dry samples of (I), and extracting successively with ethanol, benzene, ethanol, and water. The water extraction was not carried out by the usual method, but by the use of a Soxhlet extractor, in which the solvent in the flask was renewed *five* times. The combined water extracts (about 625 cc.) were evaporated, dried at 100° C., and weighed. The alcohol and benzene extractives were at first dried to constant weight *in vacuo* at 60° C., but subsequently were dried at 100° C. (an operation which caused a marked loss in weight).

After the final extraction, the wood residue was dried at 105° C., and the loss in weight due to loss of extractives was computed. Whereas the direct summative weighing of extractives (cf. Table I) gave an average figure of 37.8%, the extractives found by difference were only 36.7%. This difference in summations and the marked differences in the duplicate runs shown in Table I were not unexpected. The difficulties in making quantitative extractions in the case of tropical woods rich in extraneous components is well known.

TABLE I
TOTAL EXTRACTIVES OF QUEBRACHO WOOD

SOLVENT	EXTRACTION PERIOD, HR.	EXTRACTIVES, %	
95% ethanol	9	33.58	32.44
Benzene	6	0.09	0.05
95% ethanol	15	0.69	0.74
Water (boiling)	20	3.27	4.78
Total		37.63	38.01

Sample (II), after successive extractions in a large-type Soxhlet extractor with ethanol, benzene, and ethanol, was air dried, milled, and screened to 40-60 mesh. Evidently, in this case, the extractions were less effective than with the small Soxhlet because, even after an extraction period of several days, the residual wood still contained 7.0% water-soluble extractives, and 0.6% acetone-soluble extractives. Correction was made for these additional extractives in computing the percentages of alpha-cellulose and hemicelluloses on the basis of "extractive-free" wood. Lignin determinations, however, were always made on wood that had been completely extracted.

The Klason lignin content was found to be 23.7% (using 72% sulfuric acid) but the methoxyl content on this appeared to be quite low (18%). Klason lignin determinations were then repeated, using 68.9, 72.0, 73.6, and 77.9% sulfuric acid. The respective lignin percentages were: 23.5, 23.7, 23.9, and 24.7; the methoxyl content of these fractions was 17.9, 18.0, 18.0, and 17.4%, respectively. The color of these Klason lignins (with the exception of the one isolated with 77.9% sulfuric acid) was atypical–it verged towards a red or purplish brown.

From the data obtained in these experiments, the methoxyl content of quebracho wood lignin appeared to be considerably lower than that found previously in most hardwood lignins, the range of which is 20.5-21.5% methoxyl.[6] It was

suggested that, if the extraction of the woodmeal had been incomplete, some of the extractives might have been precipitated with and calculated as lignin, giving a spurious result for the methoxyl content.

Accordingly, the following experiment was made: Two samples of extractive-free woodmeal (1 gram each) were each treated with 50 cc. 1% potassium hydroxide. These wine-colored suspensions were allowed to stand at room temperature for 48 hours and then filtered. Each residue was washed successively with 250 cc. water, 50 cc. of 3% acetic acid, and 500 cc. water. The samples were dried at room temperature for approximately 24 hours and a lignin determination was made, using 73.6% sulfuric acid. In either case the lignin content found was 21.3% (computed on the basis of wood extracted with neutral solvents). Apparently the caustic had removed either lignin and/or extractives and some polysaccharides, thus decreasing the percentage of lignin found and the results are probably too low; no correction for material extracted by the alkali could be made. The methoxyl content of this lignin had increased to 18.7% (from 18.0%), supporting the belief that small amounts of nonlignin extractives had been removed by the alkali.

In another experiment, a mixture of the Klason lignins originally isolated (which averaged 18.0% methoxyl) was treated at room temperature for 44 hours with an aqueous solution of potassium carbonate. The brown suspension was filtered by suction and the lignin residue washed thoroughly with water, acetic acid, and water until the washings were neutral. The dried residue contined 18.2% methoxyl, indicating that no great change in the residue had been caused by the alkaline extraction, despite the fact that a part of the original Klason lignin had dissolved. It is possible (although not proved) that quebracho Klason lignin is lower in syringyl groups than are the more common hardwood lignins.

Because some lignin was probably removed by the alkaline treatment of the woodmeal, the percentage of lignin found in the experiment, in which the wood was pre-extracted with potassium hydroxide, was presumably too low. Fur-

thermore, a correction for material extracted by the alkali could not be made. In the summative analysis which follows, the highest lignin value with the highest methoxyl content (obtained on the original woodmeal extracted only with neutral solvents) was used in making the summation.

The summation obtained for quebracho wood on the total extractive-free ovendry basis is given in Table II.

TABLE II

SUMMATIVE ANALYSIS OF EXTRACTIVE-FREE QUEBRACHO WOOD

	%
Ash	0.75
Lignin	23.9
Methoxyl in lignin, 18.0	
Alpha-cellulose	45.3
Hemicelluloses	25.9
Acetyl	1.6
Total	97.45

The hemicelluloses, when hydrolyzed by means of dilute sulfuric acid, followed by neutralization with barium carbonate, filtration, concentration *in vacuo*, treatment with alcohol, refiltration, evaporation and crystallization from glacial acetic acid, gave appreciable amounts of xylose, which was identified by conversion into the characteristic, silky, crystalline *dimethyl acetal dibenzylidene derivative*, melting at 211° C.[2] Qualitative tests for uronic acids were positive.

It is evident that, when extractives have once been removed, the composition of quebracho wood (with the exception of the methoxyl in the lignin and the acetyl value) resembles that of other hardwoods. Like the wood of other angiosperms, it is rich in xylans. Whether or not quebracho Klason lignin is contaminated with small amounts of extraneous materials that cannot be completely extracted, or whether it actually contains less methoxyl than do the common hardwoods, cannot be decided at present.

Klason lignin was determined in accordance with the TAPPI Standard T 13 m (excepting that varying strengths of acid were used); the methoxyl content of the lignin was determined by TAPPI Standard T 2 m. Hemicelluloses and alpha-cellulose were determined by the methods of Wise, Murphy, and D'Addieco.[8] Freudenberg and Harder's method[3] was used in the determination of the percentage of acetyl.

Summary

Extractives were determined in a sample of quebracho wood; the total extraneous materials was about 37%. The extractive-free wood residue was subjected to a summative analysis (lignin, alpha-cellulose, hemicelluloses, acetyl, and ash). Analytically the wood resembles the common hardwoods, except in two respects: (1) the methoxyl content of the lignin was lower than that ordinarily found in the wood of angiosperms of the United States and Europe, and (2) the acetyl content was also atypically low. Xylose (wood sugar) could be isolated in quantity from the hemicelluloses of the wood.

Acknowledgment is made to Mr. Lawrence Bublitz who made the methoxyl and acetyl determinations on our samples and to Messrs. James Higgins and William Martin who made the tests for uronic acids in the hemicelluloses and the dimethyl acetal dibenzylidene derivative of xylose.

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3. Freudenberg, K., and Harder, M. *Ann.* 433: 230 (1923).
4. Kurth, E. F. The Extraneous Components of Wood. In Wise, "Wood Chemistry" p. 424. New York, Reinhold, 1944.
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7. Virasoro, E. *Anales asoc. quim. argentina*, 30: 54 (1942).
8. Wise, L. E., Murphy, M., and D'Addieco, A. A. *Paper Trade J.*, 122, no. 2: 35-43 (Jan. 10, 1946).

ERRATA IN RECORD & HESS' *TIMBERS OF THE NEW WORLD*

Part of these corrections were incorporated in the volumes of the Second Printing. All will be corrected in the Third Printing, expected late this summer.

PAGE	COL.	PAR.	LINE	CHANGE	TO READ
8	2	2	9	Hook,	Hook.,
19	2	3	8	8000	800
51	1	4	1	Thrysodium	Thyrsodium
57	2	3	1	*laxa*,	*laxa* (Benth.) Muell. Arg.
97	2	2	7	41:45	37:52
119	2	2	10	(Gr.G.)	(Br.G.)
179	1	1	2	*Haploclathera*	*Haploclathra*
189	2	3	8	Costa Rica	Ecuador
189	2	3	19	581-582	58:1-2
199	2	2	8	million	thousand
249	2	3	2	*trifoliata*	*trifoliolata*
310	1	4	4	add:	v. castanho
334	1	1	11	chrysobin	chrysarobin
372	2	1	22	Hernanadez	Hernandez
430	1	1	3	beet	sorrel
457	2	3	8	*Retinophyllum*	*Retiniphyllum*
468	1	2	4	(Br.G.)	(Br.H.)
559	1	3	11	*P.* Engelm.	*P. angustifolia* (Engelm.) Gray
579	2	1	1 & 2	Italicize: *Lista preliminar de las plantas de El Salvador*	
582	2	BRAZIL		After line 12 add: Bol. 8, Escola Polytechnica, São Paulo, 1932.	
604	1	–	29	Coraçao	Coração
610	1	–	34	Guao, 42, 44	Guao, 42, 45
611	2	–	19	Italicize: *Hæmetiopsis*	
612	1	–	50	Add: Huanacaxtle, 266	
621	1	–	12	Add: Mogno, 374	
625	3	–	14	Add: 182,	
626	3	–	9	Add: Picrodendraceae, 426	
626	3	–	10	Add: *Picrodendron*, 426	

PAGE	COL.	PAR.	LINE	CHANGE	TO READ
628	2	–	31	Add: *Psidium*, 409	
630	1	–	12	Add: 170,	
635	1	–	23	Add: Tepecacao, 175	
639	3	–	29	Delete: Yao, 26, 27	
640	1	–	15	Add: Yew, 26, 27	
275	1	2	24	Move down between present line numbers 26 and 27	
171	2	3 and 4		Transfer the two paragraphs in the middle of column two (beginning with *Common Names* and **Banara** respectively) to between the last two lines of column one, following paragraph beginning with **Azara.**	

CURRENT LITERATURE

Liste complementaire des arbres et arbustes des Petites Antilles. By HENRI STEHLÉ & MME. STEHLÉ. *Caribbean Forester* (Puerto Rico) 8: 2: 91-111; April 1947. (English, pp. 112-117.)

"In a recent study, J. S. Beard, Conservator of Forests at Trinidad and Tobago published in the Caribbean Forester (Vol. 5, No. 2, pp. 48-67, Jan. 1944) a provisional list of the trees and shrubs of the Lesser Antilles, from Anguilla to Grenada. As that statement included the French Antilles and as we have studied their flora and forests during 13 years, it is of much interest to us. Between 1934 and 1946 it has been possible for us to visit and collect specimens in nearly all of the Lesser Antilles, including English and Dutch possessions from St. Martin to Barbados. To date all our collections, comprising 7,000 specimens, have been studied not only by us but confirmed or revised by the specialists in various herbaria and museums of the botanic research centers in Europe and America.

"These conditions enable us to make a worthy contribution to the provisional list published by Beard and to modify

slightly the distribution table in his article."—*From English translation.*

El pino macho, *Pinus caribaea,* en las lomas de Trinidad, Cuba. By ALBERTO J. FORS. *Caribbean Forester* 8: 2:125-129; April 1947. (English, pp. 130-133.)

The regional characteristics, forest types, and occurrence of "pino macho" *(Pinus caribaea)* are discused. Planting projects for this and other species are mentioned briefly.

The development of *Swietenia mahagoni* Jacq. on St. Croix. By FRANK H. WADSWORTH. *Caribbean Forester* 8: 2: 161-162; April 1947. (Spanish, pp. 162-164.)

"Dominican mahogany, although slow-growing, still must be recognized as one of the best tree species for forest lands in the dry regions of the Caribbean Islands. It is relatively easy to establish and produces a wood almost unsurpassed in value."

Notas a la flora de Colombia, IX. By JOSÉ CUATRECASAS. Reprint from *Rev. Acad. Col. Cienc. Ex., Fis. y Nat.* (Bogotá) 7: 25 & 26: 47-52; 4 figs., 1 plate.; December 1946.

Described as new are two species of *Vismia*, one of *Matisia*, one of *Anomospermum*, four of *Trianaeopiper*, and two of *Hieronyma*. A new genus, *Phragmotheca*, and species (*P. siderosa* Cuatr.) are described in the Bombacaceae.

Divagaciones sobre la flora de Colombia. By HERMANO DANIEL. *Caribbean Forester* 8: 2: 145-53; April 1947. (English, pp. 153-160.)

"*Hymenaea courbaril* (Algarrobo, American copal).—This tree with corpulent trunk and wide crown is found in temperate and warm valleys from Mexico to Southern Brazil. Algarrobo does not grow generally amidst dense vegetation; it chooses open not too humid sites. Its trunk may attain 2 meters in girth at the base and a height of 25 or

even 30 meters. The flowers are large, white, or purplish corymbs; the fruit is an indehiscent brown pod containing several reddish seeds covered with a powdery substance slightly sulphorous in color. The massive trunk of algarrobo provides a timber used in construction and cabinet work. Unfortunately the wood splits easily, probably due to abundance of resin and variations in the fibers. The specific gravity of the wood is 0.95. The trunk and roots of this tree exude a resin which accumulates in the soil and persists even after cutting the trees."

Species of *Jatropha* and *Cassia* are also discussed.

Notes on Venezuelan timbers. Timber Development Assoc. (London) Ref. No. 32, 1947. Pp. 4, mimeo.

The species (sometimes several) involved, brief descriptions of the woods and their uses are given for some twenty-one common names.

The grasslands, savanna forests, and dry forests of Brazil. By EUGENE F. HORN. *Caribbean Forester* 8: 2: 135-138; April 1947. (Spanish, pp. 138-142.)

"The grasslands (campos) of Brazil are the most extensive in the world, and none, except possibly Africa, equal them in the number of species of grasses. They are widely distributed and of many types from the pure grasslands (campo limpo) of the plateau region of south-central Brazil which grade into the 'campo sujo' (dirty campo) type, with scattered shrubs, or in Mato Grosso, southern Goiaz, and western Minas Geraes, they merge into 'campos cerrados' (savanna forests) with low wide-topped trees. In southern Rio Grande do Sul the prevailing type is 'campo limpo,' which is a continuation of the grassy plains of Uruguay."

A vegetação no município de Ilhéus, Estado da Bahia. By HENRIQUE P. VELOSO. Reprints from *Memórias Instituto Oswaldo Cruz* (Rio de Janeiro) 44: 1946.

I—Estudo sinecológico das áreas de pesquisas sôbre a febre amarela silvestre realizado pelo S.E.P.F.A. 44: 1: 13-103; 34 figs.; March 1946.

II—Observaço a ligeiras considerações acêrca de espécies que ocorrem na regiao. Chave analítica das espécies arboreas. 44: 2: 221-268; June 1946.

III—Caracterizaçao da vegetaçao pelo valôr dos índices das espécies. 44: 2: 323-341; June 1946.

—Chave analítica das especies arbóreas. 44: 2: 269-293; June 1946.

The flora of the region is analyzed in this study, indices and ecological types are selected, and the species generally described and classified. An analytical key is given for the tree species and collection numbers are listed.

Madeiras imunes ou muito resistentes ao cupim. By DJALMA GUILHERME DE ALMEIDA. *Revista Florestal* (Rio de Janeiro) 5: 2: 13-23; 8 figs.; June 1946.

The test methods are given for determination of the resistance of woods to attack by cupins (primitive ants). A list of species found to be resistant is appended.

Forest products from Latin America. By LYALL E. PETERSON. *Jour. Forestry* (Washington, D. C.) 45: 6: 423-427; 1 fig.; June 1947.

The great forest resources of the tropical Americas and the difficulties of their exploitation are discussed. General recommendations are given and the problem of the Upper Parana River region development is outlined.

A new genus in the Chinese flora. By WOON-YOUNG CHUN. *Sunyatsenia* (Canton) 6: 3 & 4: 195-198; 2 figs.; November 1946.

The new genus and its species *Zenia insignis* Chun, gen. et sp. nov. are described for the family Leguminosae.

"This tree attains a large size, grows rapidly at least when young, possesses ornamental foliage and inflorescence, besides yielding a high-quality timber suitable for cabinet making."

Rubiaceous plants in the Chinese flora (1). By FOON-CHEW HOW. *Sunyatsenia* 6: 3 & 4: 231-261; 4 figs.; 1 plate; November 1946.

"This preliminary paper is confined to the tribe *Naucleeae* of which 10 genera have been recognized for the whole world. As the result of a critical examination of available material, 7 genera, 30 species, and 1 variety of this tribe are now recorded in China. Two extra-Chinese genera, *Anthocephalus* and *Mitragyna*, have been added our flora, and five species and one variety are described as new."

The genera of Chinese woody plants. By HAO KIN-SHEN. Chung Hwa Book Co. (Shanghai) 1945. Pp. 244.

This volume (Vol. I) consists mainly of a key for the identification of the genera and species. (In Chinese.)

Mechanical and related properties of Chinese timbers.

I. By CHUNG-FOY YEE, HWANG PUN-CHEUNG, and CHEN CHI-LING. Tech. Rep. No. 28, Bu. Aeronautical Research (Chengtu) 1946. Pp. 27.

The important mechanical and physical properties are given for the principal timbers of southwestern China.

The genus *Podocarpus* in the Netherlands Indies. By JACOB WASSCHER. *Blumea* (Leiden) 4: 3: 1-481; 4 figs., 2 plates; 1941.

Each species is dealt with in detail. Keys for sub-genera and sections, and species are included.

The price-age gradient of Bori (Hoshangabad, C. P.) teak. By Bakhshi Sant Ram. Indian Forest (Dehra Dun) Bul. No. 132 1942 (1946). Pp. 15; 8 figs.

"This determination of the price-age gradient of Bori teak is the outcome of a former conflict of opinion regarding the future management of the teak areas of the Bori forests in the Hoshangabad division of the Central Provinces. It was believed that the value per unit of the larger sizes of Bori teak was much higher than that of the smaller sizes."

"The results obtained are summarized as follows:

(1) That the net price per tree for teak in the Bori forest of Hoshangabad division, Central Provinces, varies directly with age.

(2) That the price-age gradient of Bori teak is steep, i.e. larger trees fetch a much higher value per cubic foot than the smaller trees; and that the price per cubic foot continues to rise up to the age of 120 years.

(3) That the mean annual commercial timber volume and value increments per tree do not culminate up to the age of 120 years.

It may, however, be pointed out that the foregoing study deals entirely with single trees, and provides the necessary information, regarding the very pronounced price increment per cubic foot for Bori teak of larger dimensions and the estimated age corresponding to the size of the tree which fetches the highest net return. It gives no indication whatsoever, of the most profitable *crop rotation* on a monetary basis as distinct from that of single trees."

Notes sur les conifères de l'Indochine. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropical* (Paris) 24: 269, 270 & 271: 7-34; 4 plates (1 map); 1944.

Species of 14 genera are described, collections cited, distributions shown, and uses and vernacular names given. One new genus and species, *Ducampopinus Krempfii* comb. nov. (= *Pinus Krempfii* Lecomte) are described as new.

Softwoods in Australian forestry. By C. J. Rodger. *Empire Forestry Rev.* (London) 25: 2: 180-187; 1946.

"Australia's native softwoods consist of the Cypress Pine of the interior, Hoop, Bunya and Kauri Pines of the north-east coast and the Huon, King William and Celerytop Pines of Tasmania, as well as a few Podocarps and other coniferous genera of no economic importance.

"The Cypress Pines (*Callitris* spp.) occur scattered all over Australia. The largest areas of compact stands are however, to be found in the central districts of New South Wales and southern Queensland, in regions of 20 to 30 inches rainfall where *Callitris glauca* forms almost pure stands with occasional patches of *Callitris calcarata*. . . . The cut of Cypress Pine in New South Wales and Queensland over the last seven years has averaged about 1,800,000 cubic feet sawn, but for 1944-45 was less than 1,500,000 cubic feet. In New South Wales these stands have been cut so much faster than they are growing that in order to maintain supplies to the established mills, trees as small as 8 inches and less in diameter breast high over bark are being utilized."

"Hoop Pine *(Araucaria cunninghamii)* occurs scattered and in small stands throughout the rain forests of south-eastern Queensland and north-eastern New South Wales. Bunya Pine *(Araucaria bidwillii)* occurs over a much smaller area of south-eastern Queensland and owing to the similarity of its timber to that of Hoop Pine, the two are marketed together. They furnish valuable timber, used particularly for the manufacture of plywood and veneers and for joinery and cabinet work generally. . . . It has also been estimated that the original stand of these species was equivalent to 850,000,000 cubic feet sawn, but is now estimated that there remains only the equivalent of about 50,000,000 cubic feet sawn. The log cut for some years has averaged a little over 10,000,000 cubic feet per annum, equal to a sawn output of about 7,000,000 cubic feet, of which Bunya Pine has represented about 10 per cent."

"Fair stands of Kauri Pine *(Agathis robusta)* were once to be found in south Queensland, but they have now nearly

all disappeared as a result of cutting. *Agathis palmerstoni* now supplies practically all the output. It occurs in north Queensland, where there are also small patches of *A. microstachya*. . . . For some years the output of Kauri Pine has been about 7,000,000 cubic feet sawn, but for the last two or three years has been only about 500,000 cubic feet per annum."

"The Tasmanian Pines, King William *(Athrotaxis selaginoides)*, Huon *(Dacrydium franklinii)* and Celerytop *(Phyllocladus rhomboidalis)* grow naturally scattered through the Tasmanian rain forests in generally very difficult country from the point of view of access. King William Pine was the most plentiful and Huon Pine the most intrinsically valuable. The Celerytop Pine was a somewhat smaller tree than the other two. Small quantities of all these Pines are still being obtained, the sawn output being equivalent to about 1,500,000 superficial feet per annum. These Pines all provide a fine-grained timber of the highest quality with remarkably little distortion or shrinkage in seasoning."

Les ormes de France. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* 22: 254, 255 & 256: 429-459; 1942.

To the six species of Europe given by Rehder *(Ulmus hollandica* is probably a hybrid) have been added *U. pyrenaica, U. gallica, U. vulgaris,* and *U. corylacea.* English Elm *(U. procera)* also grows in the parks of north-western France.

The trees, hybrids, woods, and classifications are discussed and a key for identification presented.

Contribution à l'étude des charbons de bois de l'afrique Occidentale Française. By A. Aubréville. *Actes & Comptes Rendus l'Assoc. Colonies-Sciences* (Paris) 16: 183-184-185; 61-65; 1940.

Charcoal from many species has been tested for use as fuel in gasogene motor cars. Many excellent charcoals have been found indicating the feasibility of this means of transport in these regions. Tables are given showing common

names, scientific names, origin, density, and volumetric consumption.

Previous articles were published *ibid.* 16: 177: 25-35; 16: 178-179-180: 37-47; 16: 181-182: 49-59; 1940.

Les forêts coloniales de la France. By Louis Lavauden. *Rev. Bot. App. & d'Agr. Tropicale* 21: 239-240; 285-365, 509-622, 671-752; maps; 1941.

This paper presents an extensive study of the forests and forestry of the French Colonies, particularly African and Madagascar. Considerable discussion is centered upon the destruction of tropical forests through improper cutting practices. It is contended that as the equatorial forest is removed the moist condition is lost and the typically poor soil will henceforth support only a poor forest growth or may revert to brush land. These forests are typically unevenaged and would best be handled as such.

The trees of economic importance, their uses, ranges, and silvicultural characteristics are described in Part IV.

La dénomination officielle des principaux bois coloniaux francaise. By D. Normand. *Rev. Bot. App. & d'Agr. Tropical* 23: 260, 261 & 262: 160-164; 1943.

Official names are given for the more important woods exported from the French Colonies, particularly into European markets. Those listed were normally exported (prior to 1939) in annual quantities exceeding a million tons.

A.—Woods imported from the African colonies

Okoumé = *Aucoumea klaineana* Pierre (Burseracea). Gabon: V: (vernacular names) Angouma.

Aiélé = *Canarium Schweinfurthii* Engl. (Burseraceae). Ivory Coast; Cameroon: V. Abel, Acajou pâle; Gabon: Abeul, M'Bili.

Acajou d'Afrique = *Khaya ivorensis* A. Chev. (Meliaceae). Ivory Coast: Grand Bassam; Cameroon: V. N'Golon; Gabon: Zaminguila, N'Dola.

Acajou blanc = *Khaya anthotheca* C. DC. (Meliaceae). Ivory Coast: V. Ira, Krala, Acajou grand Lahou; Cameroon: Mangona; Gabon: Dilolo.

Tiama = *Entandrophragma angolense* C. DC. (Meliaceae). Ivory Coast. Exists in Cameroon: V. Timbi; Gabon: Abeubègne.

Sapelli = *Entandrophragma cylindricum* Sprague (Meliaceae). Cameroon. Exists in Ivory Coast: V. Aboudikro. The woods exported under these names coming from Mungo (Frontier of Cameroon under English mandate) and from certain timber yards in the Ivory Coast are related to Kosipo.

Sipo = *Entandrophragma utile* Sprague (Meliaceae). Ivory Coast: V. Mébrou, as Acajou de Sassandra often. Exists in Cameroon: V: Assi; Gabon: V. Assié, Cossi-Cossi.

Kosipo = *Entrandrophragma Candollei* Harms (Meliaceae). Ivory Coast. Exists in Cameroon: V. Atom Assié. Mixed with lots of Acajou, it is never exported up to now under its true name.

Bossé = *Guarea cedrata* Pellegr. (Meliaceae). Ivory Coast: Cèdre d'Afrique. Exists in Cameroon: V. Ebangemva. Similar wood furnished by *Guarea Thompsonii* Sprague & Hutch. Gabon, Moyen Congo: Kisoko; Ivory Coast: V. Mutigbanaye. Frequent confusions for the trees with the *Trichillia* species; woods often sold as Acajou pâle or Acajou odorant d'Afrique.

Kotibé = *Cistanthera papaverifera* A. Chev. (Tiliaceae). Ivory Coast. Similar woods exist in Cameroon: V. Ovoué; Gabon: V. Aborbora. In mixture with lots of Acajou from the Ivory Coast and from Gabon.

Oboto = *Mammea africana* Don (Guttiferae). Ivory Coast: V. Djimbo; Cameroon: V. Aborzok; Gabon: V. Eborn'zok, Ibéca. Similar wood furnished by *Mammea klaineana* Pierre. Mixed with lots of Acajou from Gabon.

Niangon = *Tarrietia utilis* Sprague (Sterculiaceae). Ivory Coast. Exists in Gabon: V. Ogoué. That coming from the Ivory Coast is furnished by the variety *laxiflora* Pellegr. of the species *T. utilis*, and that from Gabon by the variety *densiflora* Pellegr.

Makoré = *Mimusops (Dumoria) Heckelii* Hutch. & Dalz. (Sapotaceae). Ivory Coast.

Douka = *Mimusops (Tieghemella) africana* H. Lec. (Sapotaceae). Gabon: V. Okala.

Moabi = *Mimusops (Baillonella) Djave* Engl. (Sapotaceae). Gabon: Adza. Exists in Cameroon: V. N'jabi. Improperly called Poirier d'Afrique.

Iroko = *Chlorophora excelsa* Benth. & Hook. (Moraceae). Ivory Coast: V. Odoum; Cameroon: V. Bang; Gabon: V. Abang, Mandji, Kambala. Improperly called African Teak (Teck d'Afrique) or African Oak (Chêne d'Afrique). Similar wood furnished by *C. regia* A. Chev. in Ivory Coast.

Ayous = *Triplochiton scleroxylon* K. Schum. (Sterculiaceae). Cameroon. Ivory Coast: V. Samba. Another commercial name: Abachi.

Avodiré = *Turraeanthus africana* Pellegr. (Meliaceae). Ivory Coast. Similar woods exist in Cameroon: V. Engan; Gabon.

Limbo = *Terminalia superba* Engl. & Diels (Combretaceae). Central Congo: V. Limba; Ivory Coast: V. Fraké; Cameroun: V. Akom, Fraké. Perfectly white wood (Limbo blanc): improperly called sometimes Oak-Limbo (Chêne-Limbo); perfectly brownish-gray wood, veined with black (Limbo noir): improperly called Noyer (Walnut) of Mayombe.

Azobé = *Lophira procera* A. Chev. (Ochnaceae). Cameroon: V. Bongossi; Ivory Coast: V. Azobé; Gabon: V. Akoura. Sometimes called Bois de fer (ironwood); another commercial name: V. Ekki.

Dibétou = *Lovoa trichilioides* Harms (Meliaceae). Ivory Coast. Cameroon: Bibolo; Gabon: V. Eyan, Dilolo noir. Improperly called Noyer d'Afrique.

Bilinga = *Sarcocephalus Trillesii* Pierre (Rubiaceae). Gabon: V. Aloma; Ivory Coast: V. Badi; Cameroon: V. Akondoc. Other commercial names: Bois d'or Opepe. Similar wood furnished by: *S. Pobequini* Hua (= Sibo).

Bahia = *Mitragyna ciliata* Aubr. & Pellegr. (Rubiaceae). Ivory Coast. Cameroon, Gabon: V. Elelom. Improperly called sometimes Tilleul d'Afrique. Similar wood furnished by *M. stipulosa* O. Kuntze (= Voukou).

Bubinga = *Copaifera Tessmanii* Harms (Caesalpiniaceae-Leguminosae). Cameroon: V. Essingang; Gabon: V. Ovang, Kevazingo. Improperly called sometimes Bois de Rose d'Afrique. Similar woods furnished by *C. Demeusei* Harms and *C. coleosperma* Benth.

Movingui = *Distemonanthus Benthamianus* Baill. (Caesalpiniaceae-Leguminosae). Gabon: V. Oguéminia; Cameroon: V. Eyen. Exists in Ivory Coast: V. Barré. Improperly called sometimes Acacia d'Afrique or Citronnier d'Afrique.

Framiré = *Terminalia ivorensis* A. Chev. (Combretaceae). Ivory Coast.

Padouk = *Pterocarpus Soyauxii* Taub. (Papilionaceae-Leguminosae). Gabon: V. M'Bel; Cameroon: V. M'beu. Other commercial names: Bois corail, Santal rouge.

Olon tendre = Variety of *Fagara macrophylla* Engl. (Rutaceae). Gabon: V. Nungo, N'torwol. Exists in Cameroon: V. Bongo.

Olon dur Olonvogo = *Fagara macrophylla* Engl. (Rutaceae). Ivory Coast: V. Bahé; Gabon: V. Olonvogo; Cameroon.

Doussié = *Afzelia pachyloba* Harms (Caesalpiniaceae-Leguminosae). Cameroon. Exists in Gabon. Similar woods furnished by *A. africana* Smith = V. Lingué and *A. bipindensis* Harms. Sometimes in commerce under the name Edoussié and even Eyène.

Zingana = *Brachystegia* sp. (Caesalpiniaceae-Leguminosae). Gabon: V. Zebrano. Exists in Cameroon: V. Amouk.

Ebéne = *Disopyros crassiflora* Hiern (Ebenaceae). Gabon: V. Evila; Cameroon: V. Mevini.

Tali = *Erythrophloeum ivorense* A. Chev. (Caesalpiniaceae-Leguminosae). Ivory Coast. Similar woods furnished by *E. guineense* G. Don. Cameroon, Gabon: V. Eloun.

B.—Woods imported from Madagascar

Ebéne = *Diospyros Perrieri* Jum. (Ebenaceae). Ebène de Majunga. Similar woods furnished by other species including perhaps *D. microrhombus* Hiern. Other commercial names: Ebène Tamatave, Ebène Fort-Dauphin.

Palissandres = *Dalbergia* sp. (Papilioniaceae-Leguminosae). Palissandre Majunga = *Dalbergia trichocarpa* Bak. Other commercial names: Palissandre Tamatave or Faux Rio and Pal. Faux Rose. The botanical identification of the wood is still uncertain.

Hintzy = *Intsia bijuga* C. Ktze. (Caesalpiniaceae-Leguminosae).

C.—Woods imported from Indochina (Cambodia and Annam)

Dâu = *Dipterocarpus* sp. (Dipterocarpaceae). South-Indochina: V. Chhoeuteal, yang. Improperly called Teck rouge du Cambodge (red Teak of Cambodia). Wood furnished principally by *D. alatus* Roxb., *D. obtusifolius* Teysm., *D. intricatus* Dyer, *D. tuberculatus* Roxb.

Lim = *Erythrophloeum Fordii* Oliv. North-Annam. Improperly called Teck Lim.

Dang Huong = *Pterocarpus pedatus* Pierre (Papilionaceae-Leguminosae). Indochina: V. Thnong, May Douk. Other commercial names: Maidou, Padouk d'Indochine.

Palissandre Trac = *Dalbergia cochinchinensis* Pierre (Papilionaceae-Leguminosae). Indochina: V. Kranhung.

Pin Thong = *Pinus Merkusii* Jungh. (Pinaceae). Indochina: Sral. Other commercial name: Pitchpin d'Indochine.

Bang Lang = *Lagerstroemia* sp. (Lythraceae). Indochina: V. Sralao, Entranel. Wood furnished principally by: *L. angustifolia* Pierre, *L. Flosreginae* Retz.

Sao = *Hopea odorata* Roxb. (Dipterocarpaceae). South-Indochina: V. Koki. Similar wood furnished by *H. dealbata* Hance.

Ven Ven = *Anisoptera cochinchinensis* Pierre (Dipterocarpaceae). South-Indochina. Similar woods furnished by: *A. glabra* Kurz, *A. robusta* Pierre.

Goi = *Aglaia gigantea* Pellegr. (Meliaceae). North-Indochina. Similar woods furnished by different species of the same genus.

Gu = *Sindora cochinchinensis* Pierre (Caesalpiniaceae-Leguminosae). Indochina: V. Krakas.

D.—Woods imported from Guiana

Amarante = *Peltogyne venosa* Benth. (Caesalpiniaceae-Leguminosae). Another commercial name: Bois violet. Similar wood furnished by other species of the same genus.

Angélique = *Dicorynia paraensis* Benth. (Caesalpiniaceae-Leguminosae). Improperly called Teck Guyane (Guiana Teak).

Amourette = *Piratinera guianensis* Aubl. (Moraceae). Wood of speckled letters.

Wacapou = *Vouacapoua americana* Aubl. (Moraceae). Another commercial name: Epi de blé (Head of wheat).

Coeurs dehors = *Vatairea guianensis* Aubl. ? (Papilionaceae-Leguminosae). Botanical identification uncertain, perhaps *Bowdichia guianensis* Ducke. Often mixed in with lots of Wacapou.

Saint-Martin rouge = *Andira coriacea* Pulle (Papilionaceae-Leguminosae).

Satiné = *Piratinera paraensis* Ducke (Moraceae).

Balata rouge = *Mamilkara bidentata* A. Chev. (Sapotaceae). Another commercial name: Abeille.

A propos de la nomenclature de quelques Sapotacées africaines. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* 23: 266, 267 & 268: 282-285; 1943.

The author is not in accord with the genus *Pouteria* as presented by Ch. Baehni: Mémoires sur les Sapotacées, II. Le genre *Pouteria*. *Candollea* 9: 147-476; 1942. (See *Tropical Woods* 89: 62.) The seven African genera, placed by Baehni in *Pouteria*, are reviewed.

Sur quatre genres de Sapotacées de l'Afrique occidentale. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* 23: 266, 267 & 268: 286-294. 1943.

The four genera *Pachystela*, *Synsepalum*, *Afrosersalisia*, and *Rogeonella* are described and the diagnoses given for the West African new species of these genera.

Peut-on créer des forêts de conifères dans les pays tropicaux? By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* 24: 269, 270 & 271: 1-6; 1944.

The author recommends the establishment of Conifers in deforested tropical regions not only for wood supply but also to rebuild impoverished soils for the growing of more complex forests.

Les arbres à ail de l'Afrique équatoriale. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* (Paris) 27: 291 & 292: 22-25; 1947.

Two trees of equatorial Africa, *Scorodophloeus Zenkeri* Harms and *Hua Gabonii* Pierre, have long been noted for their garlic-like odor. The bark and leaves are used in place of garlic bulbs for flavoring.

Two additional trees with a similar odor are now reported: these are *Afrostyrax Kamerunensis* Perkins & Gilg and *A. lepidophyllus* Mildb.

Note sur les bois de Zingana et autres Césalpiniées africaines à trés petites folioles. By D. Normand. *Rev. Bot. App. & d'Agr. Tropicale* 27: 293 & 294: 139-150; 1947.

In the study recently published in this same review, A. Chevalier announced that the characteristics would be given of the woods of the trees of tropical Africa, of which he has made an interesting revision.

The appearance and wood structure of *Dipetalanthus* A. Chev., *Tripetalanthus* A. Chev., and *Talbotiella* Bak. f. are still provisionally unknown. *Scorodophloeus Zenkeri* and *Berlinia polyphylla* are not included although figuring in Chevalier's above-cited work, as they belong to the Caesalpiniaceae of small leaflets of the same morphological type as certain *Afzelia*, *Dialium*, *Copaifera* and other species of the *Cynometra*, *Brachystegia* or *Monopetalanthus*.

The systematic examination of the woods of this series will be the object of a later note.

Included here are: *Microberlinia* A. Chev., *Tamarindus* L., *Tessmannia* Harms, *Brachystegia* Benth., *Cynometra* L., *Hymenostegia* Harms, *Cryptosepalum* Benth., *Monopetalanthus* Harms, and *Zingana* A. Chev.

The exterior appearance of the woods as well as their internal structure is dealt with, in particular detail for *Microberlinia* and *Monopetalanthus*.—M. Record.

La famille des Huacaceae et ses affinities. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* 27: 291 & 292: 26-29; 1 plate; 1947.

The descriptive features of the family and the two genera, *Hua* and *Afrostyrax*, are given.

Four new species of *Memecylon* from east tropical Africa. By J. P. M. Brenan. *Kew Bul.* No. 2: 89-96; 2 figs.; 1946.

One, *M. Greenwayi* Brenan, is a small evergreen tree common only on the rock slopes of Mlinga Peak.

Some ecological observations on a tropical forest type in the Gold Coast. By A. Foggie. *Jour. Ecology* 34: 1: 88-106; 5 figs.; February 1947.

"The . . . description has been confined to the forest type studied in the Bobiri Forest Reserve, but forest of the same physiognomic formation and similar floristic composition covers a very great area of the Gold Coast. It passes gradually, almost imperceptibly, into the "Evergreen Forest,' or 'Rain Forest' of Richards, in the south-west of the colony and into a drier type of forest to the north and east. The structure is indeed very close to that of the Rain Forest proper and it is doubtful if a purely structural difference could be drawn between them. There is a greater difference between it and the drier type which has only two strata. Floristically the type described is exceptionally rich and extremely mixed. Owing to the large numbers of unclassified species the Enumeration Survey cannot be used as an indication of the number of species met with throughout the forest but on the two strips studied in detail, whose area is only 0.1 hectare, no fewer than 75 species occur in the tree and shrub layers alone, and they belong to fifty-three genera in twenty-three families. Of the emergents and dominants only *Triplochiton scleroxylon* K. Schum. and the *Celtis* spp. constitute any appreciable proportion of the whole. In the understory *Cleidion gabonicum* Baill. is here dominant, but as mentioned above this is thought to be a local occurrence."

L'exploitation forestière au Congo Belge. By F. Peche. *Bul. Comptoir Vente Bois Congolais* (Brussels) No. 10: 2-3; May 1947.

Exploitations should be organized through the use of more powerful engines. Many-wheeled motor lorries and powerful Diesel tractors equipped with tow-lines in addition, would lower the cost of transport. This development, rendered necessary by commercial exigencies, should be accompanied by a strengthening of bridges.–M. Record.

Les Toona's ou Cèdres bâtards. Arbes de reboisement. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* (Paris) 24: 272, 273 & 274: 152-165; 1944.

The author is of the opinion (as pointed out by Alphonse de Candolle in his *Geographie botanique raisonnée)* that many species of plant life do not always occupy the area best suited to them. Many times artificial forests may be created of trees that will grow in their man-made habitats much better than in the spots where accident or nature puts them. This can be turned to advantage commercially, and the importation of species often will leave behind their parasites so that the trees will prosper better than in the country of origin. The *Toona's,* called in French: Cèdres bâtards, Faux Ailantes, and Acajous de Chine (in English: Bastard Cedar, False Ailanthus, Mahogany of China) are very remarkable as regards ability to acclimate themselves to different surroundings.–*(Translation.)*

The genus *Toona* and its characteristics are described, a revision of the species presented, the rapidity of growth and plantings discussed, and the properties and uses of the woods are given.–Mary Record.

Les Sapotacees a graines oleagineuses et leu avenir en culture. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* 23: 260, 261 & 262: 97-159; 2 plates, 1 fig.; 1943.

This is the beginning of a study of the Sapotaceae with oily seeds, that may be suitable for commercial plantings. A monograph of *Butyrospermum Parkii* (Karité) is included.

Études botaniques sur le genre *Hevea*. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* 22: 245 & 246: 1-12; 4 plates; 1942.

The author recommends an extensive study of *Hevea* species, hybrids, and forms. All ecological or morphological forms should be studied and the latex analyzed chemically. From the extensive regional studies selected material should be propagated to develop the best kinds for utilization.

Plates representing four species are presented.

Le statut actuel du genre *Coffea* L. By Aug. Chevalier. *Rev. Bot. App. & d'Agr. Tropicale* 22: 247 & 248: 129-150; 3 plates; 1942.

The history of the genus is reviewed and a fixed status proposed. The resultant genus retains some fifty species.

Botanical names of forest trees. By W. H. Guilleband. *Forestry* (Oxford) 20: 78-79; 1946.

The standard Forestry Commission name (botanical) is given for twenty-eight important trees. The present names according to International Rules are also listed.

Fence and barrier plants in warm climates. By F. N. Howes. *Kew. Bul.* No. 2: 51-87; 1946.

"A large number of plants, probably more than 500 species, are used for hedges or fences in the warmer parts of the world. Some of these are now widely distributed in cultivation and are to be found, sometimes naturalised, wherever conditions are suited to them, whereas others appear to be more or less peculiar to certain countries and have not yet become widely adopted as hedge or fence plants."

More than 130 species are discussed.

World timbers, Vol. II. Pub. by Timber Development Assoc., Ltd., (75 Cannon St., London, E. C. 4.). 1947.

Additional single pages have been issued covering the species Pine–Ponderosa, Podo, Pyinkado, Sugar Pine, and Western White Pine.

M.M.CHATTAWAY

Price 25 cents

Yale University School of Forestry

TROPICAL WOODS

NUMBER 92 DECEMBER 1, 1947

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Yale University School of Forestry

TROPICAL WOODS

NUMBER 92 December 1, 1947

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.*

Subscription price One Dollar for four consecutive numbers. Remittances should be made payable to TROPICAL WOODS.

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

THE DECAY RESISTANCE OF CERTAIN CENTRAL AMERICAN AND ECUADORIAN WOODS

By THEODORE C. SCHEFFER and CATHERINE G. DUNCAN

Pathologists, Division of Forest Pathology,[1] Bureau of Plant Industry, Soils and Agricultural Engineering, Agricultural Research Administration, United States Department of Agriculture

As a part of the war effort, information and data were gathered by the Forest Service relative to the suitability for various purposes of a number of Central American and Ecuadorian woods.[2] Samples of the species investigated were

[1]In cooperation with the Forest Products Laboratory, maintained by the Forest Service, United States Department of Agriculture, at Madison, Wis., in cooperation with the University of Wisconsin.

[2]Latin American Forest Resources Project, financed by the Coordinator of Inter-American Affairs.

collected and sent to the Forest Products Laboratory for determinations of physical characteristics and properties. Material representing 41 of the species was also tested for decay resistance, and the findings of this phase of the work are the subject of this report. A few of the species were tested in Central America, but most of them were tested in Wisconsin and Mississippi.[3]

Material and Test Procedures

Tests in Central America

These tests were made in soil, using small stakes in order to accelerate results. They were established at two places, Barro Colorado Island, Canal Zone and Turrialba, Costa Rica. Seven species collected in Costa Rica and Panama, and three United States species included for comparison were tested at both places. The latter consisted of Douglas-fir, from virgin trees grown in western Oregon, several strains of black locust, grown in the Northeastern United States, and white oak, from large trees grown in North Carolina. Five of the locust trees represented were of so-called yellow strains, the wood of which is generally regarded as having more than average durability for the species. Wood from the six other trees appeared for the most part to be fully as decay resistant in these tests. It is not known how typical the Douglas-fir and white oak wood was in this respect.

Material for the tests was sawed into small stakes, 6 inches long, 1 inch wide, and ⅜ to ⅝ inch thick. Thickness variation in stakes of some of the tropical woods was unavoidable because of the hardness of the wood and the limitations of local sawing equipment. The stakes were taken insofar as possible from three different radial positions in the heartwood of each tree, namely, the outer third of the heartwood

[3]The collection numbers of trees sampled for testing in the United States may be obtained from the Division of Forest Pathology, at Madison. These numbers were assigned by members of the field party for the Latin American Forest Resources Project.

radius, the intermediate third, and the inner third. Stakes for the Central American tests also were taken from the sapwood of a few species, but not enough were included to warrant consideration of the results.

The testing was done by setting the stakes in soil to a depth of 3 inches. The stakes at Barro Colorado were randomly distributed in seven different plots, two of which were screened against termite attack. Those at Turrialba were randomly distributed in five plots, none of which were screened, but which fortunately escaped much termite attack.

The decay and termite damage was rated visually and by using a knife to aid in determining the extent of softening.[4] At the completion of the test, some of the Barro Colorado stakes were sawed to uniform dimensions and estimates made of the losses in specific gravity of the dry wood. These estimates were based on the difference in specific gravity between the wood below ground and the essentially sound wood two to three inches above the ground line.

Tests in the United States

Tests in Soil

Two stake tests in soil were made in the United States, at Saucier, Mississippi, and at Madison, Wisconsin. These contained 35 woods from Ecuador, three from Central America, and the same three United States species already mentioned. The stakes were 1 by ¼ by 6 inches. They were taken where obtainable from the four radial positions, including the sapwood, mentioned in connection with the Central

[4]The writers are indebted to the following persons for carrying out the tests in Central America:

John A. Scholten, Forest Products Laboratory, for preparing and labeling all the test stakes and for establishing the test at Turrialba.

Theodore J. Grant, Bureau of Plant Industry, Soils, and Agricultural Engineering, for ascertaining and reporting the results of the Turrialba test, and

James Zetek, Bureau of Entomology and Plant Quarantine, for establishing and reporting on the test at Barro Colorado.

American tests. In a little more than 60 percent of the species there was no visible differentiation with respect to heartwood and sapwood. In these instances the outermost inch of wood was tested as sapwood. With some additional allowance for sapwood, the remaining wood was tested as nominal heartwood. The radial depths arbitrarily allowed for sapwood are listed in the tabulation of results; these varied somewhat according to the diameter of the trunk section. Wood from each radial position was tested in duplicate at each site.

The test at Saucier was made in a rather sandy soil, of relatively low fertility, on a screened plot. The one at Madison was made indoors, in large covered bins containing loam soil. Distilled water was added to the Madison soil as needed to make it cohere without being sticky when balled in the hand. The purpose of the indoor exposure was to insure decay throughout the winter months. The stakes in both tests were randomly distributed and set in the soil to a depth of 5 inches.

The amounts of decay were measured by the percentage loss in dry weight of the stakes. Weighings for this purpose were made before and after testing, with the wood dried to equilibrium weight in a special conditioning room maintained at 30 percent relative humidity and 80° F.

Pure-culture Tests

Samples from the pieces of wood that furnished the stakes were also tested against pure cultures of wood-rotting fungi. An additional species from Central America *(Quercus copeyensis)* was also included in these tests. The test specimens were 1 by 1 by ¼-inch blocks, the shortest dimension being in the direction of the grain. Each test was made in triplicate. As with the stakes, the amounts of decay were measured by the percentage loss in the dry weight of the wood.

The decay was carried out in 6-ounce, screw-topped bottles of the French square type, each containing 20 ml. of nutrient medium consisting of 2.5 percent of Trommer's

diastasic malt extract and 1.5 percent of Bacto-agar in distilled water. The substrate was hardened with the bottles on their sides, and inoculated shortly thereafter. The air-dry test blocks were partially sterilized by autoclaving for 20 minutes at 212° F. They were then cooled and placed, one to a test bottle, on a V-shaped, 4 mm. glass rod resting on the mat of fungus mycelium that had been allowed to cover the substrate. Following this, the bottles and contents were stored for 4 months in a room having a temperature of 80° F. and a relative humidity of about 65 percent.

Eight fungi were used: *Lenzites trabea* (Madison 617), *Poria monticola* (Mad. 698),[5] *P. incrassata* (Mad. 563), *P. species*, (two strains, Mad. 43415 and Wash. 142), *Stereum frustulosum* (Wash. 56461-R), *Polyporus versicolor* (Wash. 72074), and *P. gilvus* (Mad. 43320). The last three produce what is known as "white rot," because of the lighter color usually imparted to the wood, and the others produce "brown rot." In general, the white-rot fungi destroy both cellulose and lignin, whereas the brown-rot fungi use little or no lignin. Inasmuch as *S. frustulosum* is not a typical white-rot fungus, however, and because it behaved more like a brown rotter it is considered with the brown-rot fungi in this report. The brown rotters and *S. frustulosum* were used on all of the wood prepared for testing. The two *Polyporus* white rotters were not used until later, after it became apparent from supplementary tests that these could vigorously attack many of the woods that were markedly resistant to the brown rotters, and therefore might be expected to give results more indicative of the relative decay resistance of the species. Sufficient material remained at this time for testing only the outer heartwood and some of the sapwood.

[5] This fungus was formerly named *Poria microspora*, and was received originally from R. W. Davidson, Division of Forest Pathology, Plant Industry Station, Beltsville, Md.

Results of Tests in Central America

The relative resistance to decay and termites exhibited by heartwood stakes of the different woods tested in soil at Barro Colorado and at Turrialba is shown in Table 1. The average rating in each case is weighted according to the relative area of wood on the trunk cross section represented by the three heartwood zones samples (see page 2). Thus the weights where all three zones are represented were 5, 3, and 1, for the outer, intermediate, and center heartwood, respectively. These weighted averages approach what might be expected had the entire cross sectional area of heartwood been tested.

The order of decay resistance indicated for the different species was not altogether consistent. In view of this it seemed best to consider the overall evidence simply by averaging the four to five decay results listed for each species.

Table 1–Results of Field Tests of Decay and Termite Resistance at Turrialba, Costa Rica, and at Barro Colorado Island, Canal Zone

Species (heartwood only)	No. of trees	Place collected	Decay results Turrialba: Unscreened plots: No. of stakes	Decay results Turrialba: Unscreened plots: Average decay rating[1]: 13 months	Decay results Turrialba: Unscreened plots: Average decay rating[1]: 21 months	Decay results Barro Colorado: Unscreened plots: No. of stakes	Decay results Barro Colorado: Unscreened plots: Average decay rating[1]: 22 months	Decay results Barro Colorado: Screened plots: No. of stakes	Decay results Barro Colorado: Screened plots: Average decay rating[1]: 18-20 months	Decay results Barro Colorado: All plots: No. of stakes	Decay results Barro Colorado: All plots: Specific gravity loss[2]	Average decay rating for all tests[3]	Termite results Barro Colorado: Unscreened plots: Average termite rating[4]	Termite results Barro Colorado: Unscreened plots: Stakes with C or D termite attack
											Percent			*Percent*
Cordia alliodora ("Laurel")	2	Costa Rica	14	B-C	C	20	B	7	A	21	17	B	A	0
Chaetoptelea mexicana ("Cenizo")	3	Panama	23	C	D	30	A-B	10	A-B	11	27	C	A-B	20
Nectandra whitei ("Bambito Colorado")	3	Panama	30	B	C	30	A-B	10	A-B	17	17	B	A-B	30
Perica rigens ("Pizarrá")	3	Panama	26	B	C	30	B	11	A	22	14	B	A-B	23
Quercus copeyensis ("Roble, encino")	4	Costa Rica	9	B	C-D	23	A-B	—	—	8	18	B-C	B	39
Quercus alba ("White oak")	5	United States	44	B	C	36	A-B	36	A-B	26	14	B	A-B	25
Hieronyma alchorneoides ("Zaparero")	1	Costa Rica	3	C	D	6	A	—	—	4	13	B-C	A-B	17
Pseudotsuga taxifolia ("Douglas-fir")	10	United States	70	A	B	30	A-B	61	A-B	64	24	B	B-C	46
Swetia panamensis ("Guayacán")	1	Costa Rica	5	A	B	6	A	—	—	2	11	A-B	A-B	0
Robinia pseudoacacia ("Black locust")	12	United States	47	B	C	60	A	24	A	25	8	A-B	A	3

[1] Weighted average, for entire heartwood (see page 5). For averaging, numerals were used in place of the letters.
A = Suspected but not certain decay.
B = Decay in at least some parts of test stake indicated by wood perceptibly soft to a knife point.
C = Generally infected, or badly decayed in places.
D = Wood disintegrated to a state of unserviceability.

[2] Specific gravity determinations were made on stakes that were essentially free of termite damage, irrespective of whether they came from the screened or unscreened plots. See page 3 for method of determination.

[3] See page 6 for method of averaging.

[4] Weighted averages, for entire heartwood (see page 5). For averaging, numerals were used in place of letters.
A = Nibbles only.
B = General but limited attack.
C = General and substantial attack.
D = Wood attacked to a state of unserviceability.

This averaging was done by using numerals (1 to 4) in place of the letter ratings (A to D) based on the visual estimates of decay and by assigning the same numerals in accordance with the specific gravity losses as follows:

1– 0 to 8 percent loss
2– 9 to 14 percent loss
3–15 to 24 percent loss
4– over 25 percent loss

These average values, represented by corresponding letters, A to D, are given in Table 1. An A rating is regarded as evidence of very resistant wood, B as resistant wood, C as moderately resistant, and D, as relatively non-resistant.

Appraised on this basis, *Sweetia* was the only Central American species with an average rating as good as A-B (very resistant to resistant) and *Chaetoptelea* was the only one with an average as poor as C (moderately resistant).

Quercus copeyensis and *Hieronyma* were indicated to be moderately resistant to resistant and the remaining three species were indicated to be resistant.

By local reputations, *Sweetia panamensis* is a very durable wood, *Cordia alliodora* ranges from moderately durable to very durable, *Quercus copeyensis* is durable, and the other Central American species with the possible exception of *Chaetoptelea mexicana* have only moderate durability. The reputation for *Chaetoptelea* was not ascertained. Resistance to termites, as well as to decay, of course, enters into the local reputations for durability. This could account for the evidence of durable wood (B rating) in some of the species having a reputation for just moderate durability.

Reputations for the three domestic species are: *Robinia pseudoacacia*, very durable, *Quercus alba*, durable, and *Pseudotsuga taxifolia*, moderately durable to durable.

All of these species with the exception of *Hieronyma* and *Sweetia* also were included in the tests at Madison and Saucier. These later tests provide a better basis for any additional comparisons of decay resistance because of their more quantitative character. It is apparent that visual estimates of decay in small stakes are not suitable for bringing out moderate to small differences.

Outstanding termite resistance was evidenced by *Cordia*, *Sweetia*, and *Robinia*, corroborating reputations in this respect for these species. Measured by the proportion of stakes severely attacked, the poorest resistance to termite attack was shown by *Pseudotsuga*. The other six species appeared to have only moderate resistance, with some indication that *Q. copeyensis* might be less resistant than the other five.

Results of Tests in the United States

Decay Resistance in the Heartwood of the Different Species

The data provided by the heartwood stakes tested in soil at Saucier, Miss. and at Madison, Wis. were considered first by plotting the weighted-average weight loss produced in each of the 41 species, as shown in Figure 1. In this way

the extent of agreement in results obtained in the two different soils could be readily observed. It is evident that in the most resistant species the decay in the Saucier soil was, in general, no more than half that in the Madison soil, which was considerably the richer in humus and more continuously warm. The difference was less in the species of intermediate resistance and not apparent in the least resistant species. Of chief importance to the present comparisons, however, are the *relative* differences in decay among the species in the respective soils. In this respect it may be observed that

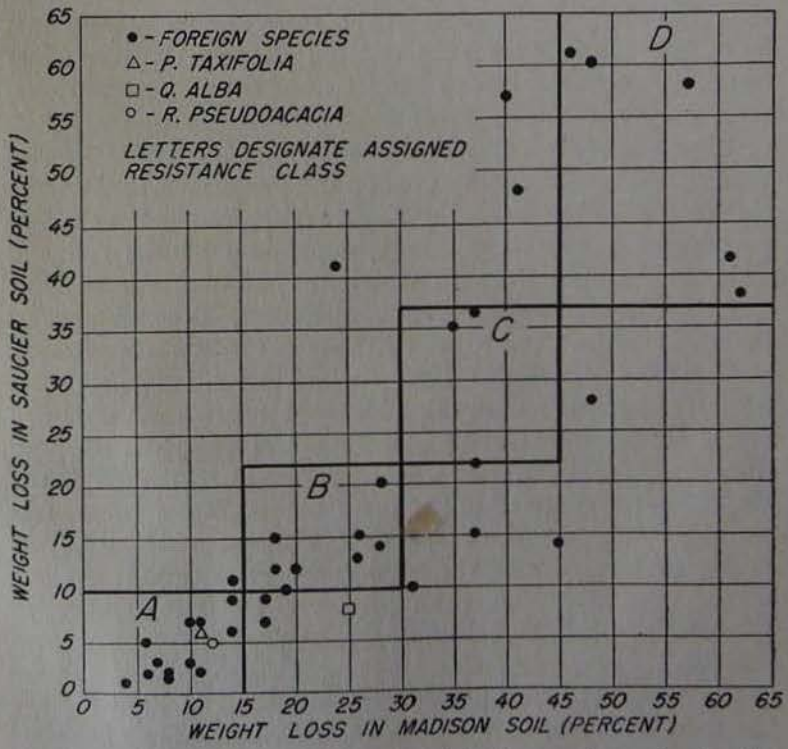

Figure 1—Corresponding average weight losses of species in the Madison and Saucier soils, and assigned limits of four decay-resistant classes. Averages were weighted according to relative amounts of wood represented by stakes from the three heartwood zones sampled (see page 6).

although the ranking (according to weight loss) of the species was much the same in the two tests, it was less close among the less resistant than among the more resistant species. Some of the disagreement is attributable purely to experimental variation, which rather typically is larger as the weight loss is larger. The disagreement in certain of the more pronounced cases was too large to be explained entirely in this way, however, and is regarded as evidence that the relative resistance of the species concerned was not the same in the two soils.

In view of this, the weight losses obtained in the two tests were not averaged. Instead, four sets of weight-loss limits were applied to the plotted data, as illustrated in figure 1, and the species falling within the respective limits were considered to be in the same general class with respect to their probable relative durability in soil. Those species with weight losses falling outside the prescribed limits were regarded as being not in any single resistance class but rather perhaps in one of two classes, depending on the soil and associated fungus flora to which the wood is exposed. In spite of its rather subjective character, this scheme of evaluation is believed to be adequate for practical purposes; moreover, it provides a basis for selection that is in large measure consistent with the additional information obtained about the species. In this connection, it may be remarked that the class limits were chosen partly on the basis of the weight losses incurred in the three United States woods and the reputation of these woods for decay resistance, and partly on the basis of the total range of weight losses obtained, assuming that among such a sizeable number of species all classes of decay resistance probably were represented.

The species as thus classified on the basis of Figure 1 are listed in Table 2, in descending order of indicated decay resistance.[6] Also listed are the average weight losses pro-

[6] *Chaetoptelea mexicana*, *Nectandra whitei*, and *Persia rigens* were collected in Panama; *Quercus copeyensis* was collected in Costa Rica; the other species listed in this table were collected in Ecuador.

duced in the outer heartwood by pure cultures of the two white-rot fungi. To further make the table as informative as possible, the general amounts of decay produced by the brown-rot fungi are indicated, and the local reputations of the species for durability insofar as they could be ascertained. The brown-rot results are not emphasized for reasons given on page 5; they are significant, however, in that they give an indication of differences in the variety of fungi to which the species are susceptible.

The classes of decay resistance indicated by the different tests were notably consistent and in rather good agreement with the reputations of the woods for durability; consequently they are regarded as representative for the most part. The durability of some of the woods was somewhat lower by reputation than indicated by these tests. This might readily be attributed to the fact that the reputations do not rest on resistance to decay alone. The reputation of the Costa Rican and Panamanian species, for example, relates at least partially to the ability of the wood to resist attack by termites. Similarly, the reputation of a large number of the Ecuadorian species stems from their resistance to shipworms and other marine wood borers.

Stakes of the first five and the eighth species listed in Table 2 were replaced in the Madison soil test for an additional year, to ascertain whether with continued exposure more differentiation among these highly resistant woods might be obtained. The final weight losses were, on the average, nearly double those occurring in the first year, hence no significant change in the order of decay resistance was indicated.

Further comment on Table 2 is probably unnecessary other than to add a word of caution about its use. Only a few trees, at most, of each species were tested. Consequently, comparisons among the species should be made with due allowance for this limited sampling. Had more trees been brought into the study a different resistance class might have been indicated for some of the woods, particularly

TABLE 2—GROUPING OF THE DIFFERENT SPECIES BY HEARTWOOD DECAY-RESISTANCE CLASSES ACCORDING TO WEIGHT LOSSES PRODUCED IN SOIL (FIG. 1) AND BY THE TWO WHITE-ROT FUNGI IN THE PURE-CULTURE TEST

Wood species	Average sapwood thickness	No. of trees
	Inches	
Erythroxylon glaucum ("Coquito")	1.0	1
Tabebuia chrysantha ("Guayacán")	[4]1.5	1
Libidibia corymbosa ("Cascol")	2.0	1
Minquartia guianensis ("Guayacán pechiche"; "Pechiche")	1.9	2
Platymiscium pinnatum ("Caoba")	[4]1.2	1
Myroxylon balsamum ("Bálsamo"; "Sándalo")	1.0	1
Vitex gigantea ("Pechiche")	[4]2.5	2
Chlorophora tinctoria ("Moral fino")	1.5	3
Persea (?) sp. ("Guadaripo")	[4]2.5	1
Pseudotsuga taxifolia ("Douglas-fir")	.....	7
Cryptocarya sp. ("Amarillo tainde"; "Alcanfor")	2.2	3
Robinia pseudoacacia ("Black locust")	.....	11
Cordia alliodora ("Laurel negro"; "Laurel"; "Laurel prieto"; "Laurel macho")	1.7	3
Clarisia racemosa ("Moral comido del mono"; "Moral bobo"; "Sota")	2.8	3
Cedrela fissilis ("Cedro"; "Cedro de Castilla")	[4]1.5	1
Rhizophora mangle ("Mangle"; "Mangle injerto")	[4]3.2	4
Tabebuia sp. ("Guayacán")	[4]2.2	2
Quercus copeyensis ("Roble"; "Encino")	1.5	5
Quercus alba ("White oak")	1.0	5
Persea rigens ("Pizarrá")	1.5	3
Beilschmiedia sp. ("Caoba")	[4]2.7	1
Terminalia amazonia ("Roble")	[4]2.7	3
Nectandra pisi ("Caoba")	[4]3.5	1
Sickingia sp. ("Manglillo Colorado")	[4]1.5	1
Nectandra whitei ("Bambito Colorado")	1.1	3
Pouteria (?) sp. ("Colorado")	[4]1.0	1
Pseudolmedia eggersii ("Guión")	[4]3.5	2

TABLE 2—GROUPING OF THE DIFFERENT SPECIES BY HEARTWOOD DECAY-RESISTANCE CLASSES ACCORDING TO WEIGHT LOSSES PRODUCED IN SOIL (FIG. 1) AND BY THE TWO WHITE-ROT FUNGI IN THE PURE-CULTURE TEST *(Continued)*

Soil tests			Pure-culture tests		
Average weight loss[1]		Indicated resistance class[2]	Average weight loss (Outer heartwood)	Indicated resistance class[2]	Reputation for durability[2]
Madison	Saucier				
Percent	*Percent*		*Percent*		
4	1	A	0	A	A[3]
6	2	A	11	B	A[3], A[5]
6	5	A	5	A	
7	3	A	4	A	A[5]
8	2	A	1	A	
8	2	A	1	A	B[3]
10	3	A	2	A	A[5]
10	7	A	1	A	A[5], A[5]
11	2	A	1	A	
11	6	A	18	B[8]	B-C[8]
11	7	A	31	C[7]	C[7]
12	5	A	2	A	A[6]
14	6	A	3	A	A-C[3], A[5]
14	9	A	0	A	B-C[3]
14	11	A-B	14	B	A-B[3], A[6]
17	9	A-B	18	B[8]	B-C[8], C[8]
17	7	A-B	2	A	A[3]
.....	.....	.....	19	B[7]	B[8]
25	8	A-B	34	C[8]	B[8]
18	12	B	14	B	C[8]
18	15	B	50	D[8]	C[8]
19	10	B	17	B	C[8], B-C[8]
20	12	B	53	D[7]	
26	13	B	12	B	
26	15	B	24	B[8]	C[8]
28	14	B	16	B[7]	C[8]
28	20	B	14	B[7]	

TABLE 2—GROUPING OF THE DIFFERENT SPECIES BY HEARTWOOD DECAY-RESISTANCE CLASSES ACCORDING TO WEIGHT LOSSES PRODUCED IN SOIL (FIG. 1) AND BY THE TWO WHITE-ROT FUNGI IN THE PURE-CULTURE TEST *(Continued)*

Wood species	Average sapwood thickness	No. of trees
	Inches	
Pourouma chocoana ("Uva")	[4]2.5	1
Humiria sp. ("Chanul")	[4]2.2	3
Mora megistosperma ("Nato")	[4]3.0	1
Chaetoptelea mexicana ("Cenizo")	1.7	3
Triplaris sp. ("Fernán sánchez"; "Muchín")	[4]1.5	1
Apeiba aspera ("Piene de mono")	[4]3.0	1
Carapa guianensis ("Tangare"; "Figueroa")	2.2	3
Vismia sp. ("Sangre de gallina")	[4]1.0	1
Anacardium excelsum ("Marañón")	[4]2.1	2
Protium sp. ("Anime")	[4]3.5	1
Dialyanthera gordoniaefolia ("Cuángare")	[4]1.5	1
Huberodendron sp. ("Carrá")	[4]2.0	1
Brosimum utile ("Sande"; Cow-tree)	[4]2.2	3
Belotia sp. ("Chillarde")	[4]4.7	1
Virola sp. ("Chalviande")	[4]3.2	1

[1]Weighted average for entire heartwood (see page 6).

[2]

Decay resistance class	Delimiting range of weight loss		
	In soil at—		In the pure-culture test
	Madison	Saucier	
	Percent	*Percent*	*Percent*
A–Very resistant	0 to 14	0 to 9	0 to 10
B–Resistant	15 to 29	10 to 21	11 to 24
C–Moderately resistant	30 to 44	22 to 36	25 to 44
D–Nonresistant	45–	37–	45–
A-B, B-C, C-D: Resistance variable between indicated classes			

[3]Reputation according to information furnished by L. V. Teesdale, Forest Products Laboratory, largely on the basis of reported experience with the species in Ecuador for use in boats; also according to information in: The Forest Resources of Western Ecuador, by E. F. Horn; Agriculture of the Americas 7 (3): 46-49, illus. 1947. Durability information relative to additional Ecuadorian species is given in: Timber of Ecuador Best Suited for Wooden Ships, by L. V. Teesdale; Interim Report (part of General Report), Forest Resources of Ecuador, 1944.

TABLE 2—GROUPING OF THE DIFFERENT SPECIES BY HEARTWOOD DECAY-RESISTANCE CLASSES ACCORDING TO WEIGHT LOSSES PRODUCED IN SOIL (FIG. 1) AND BY THE TWO WHITE-ROT FUNGI IN THE PURE-CULTURE TEST *(Continued)*

Soil tests			Pure-culture tests		
Average weight loss[1]		Indicated resistance class[2]	Average weight loss (Outer heartwood)	Indicated resistance class[2]	Reputation for durability[3]
Madison	Saucier				
Percent	*Percent*		*Percent*		
24	41	B-C	36	C[6]	
31	10	B-C	33	C[6]	
37	15	B-C	17	B[7]	B[5]
45	14	B-C	32	C	
35	35	C	38	C	D[5]
37	36	C	44	C	
38	22	C	41	C[6]	C[5]
40	57	C-D	44	C[7]	
41	48	C-D	36	C[7]	D[5]
48	28	C-D	51	D[8]	
46	61	D	35	C[6]	
48	60	D	47	D	
57	58	D	50	D[8]	D[5]
61	42	D	44	C	
62	38	D	58	D[8]	

[4]No visible differentiation between sapwood and heartwood. In these cases the indicated thickness was the depth arbitrarily allowed for sapwood.

[5]Reputation according to information in: The Forests of Costa Rica; mimeographed report, illus. 48 pages, Nov. 1943. U. S. Forest Service in cooperation with the Office of Coordinator of Interamerican Affairs.

[6]Based on U. S. experience, as reported in: Wood Handbook, 325 pages, illus. 1935, Forest Products Laboratory, U. S. Forest Service.

[7]Decay of outer heartwood by brown-rot fungi: 5 to 10 percent.

[8]Decay of outer heartwood by brown-rot fungi: 11 to 25 percent.

[9]Decay of outer heartwood by brown-rot fungi: over 25 percent.

Values with no reference in this column indicate less than 5 precent loss.

those in which the weight losses were near the limits set up for the class in which they are now placed.

Decay Resistance Indicated by the Wood Extractives

As a supplement to the present tests, determinations were made of the amount and toxicity of hot-water-soluble extractives in the outer heartwood of eleven of the tropical species. This work was done at the New Haven Branch of the Division of Forest Pathology, and has been reported.[7] The primary purpose was to ascertain whether the relative decay resistance of the different woods might be indexed more rapidly by such determinations than by actual decay tests. The toxicity of the extractives was measured by growing *Lenzites trabea* and *Poria monticola (P. microspora)* on malt-agar medium containing the extractives in amounts proportional to their concentration in the wood; the reduction in linear growth rate caused by the extractives was taken as the index of toxicity.

Although differences among the species in both extractive content and extractive toxicity were considerable, they did not furnish reliable evidence of the decay resistance as judged by reputations for the species. The inadequacy of the extractives for such a purpose is further brought out in Table 3, in which the extractive contents and toxicities are compared with corresponding weight losses produced by decay in the present tests. Although the woods with an extractive content of 6 percent or more and a toxicity index of 21 or more tended to be more resistant than those with lower extractive values, the relation in general was not close.

In an earlier study,[8] made on black locust, the amount of hot-water-soluble extractives and their toxicity were found

[7]Waterman, Alma M. The effect of water-soluble extractives from the heartwood of Tropical American woods on the growth of two wood-decay fungi. *Tropical Woods* 88: 1-11. 1946.

[8]Scheffer, T. C., Lachmund, H. G., and Hopp, H. Relation between hot-water extractives and decay resistance of black locust wood. *Jour. Agr. Research* 68(11); 415-426, illus. 1944.

to account for much of the variation in decay resistance within individual trees but not among trees or strains of the species. The evidence suggests, therefore, that these water extractives are not the only fungus inhibiting materials of consequence or that the method of obtaining and testing them did not bring out fully their typical inhibiting capacities.

TABLE 3—HOT-WATER-SOLUBLE EXTRACTIVE CONTENT OF THE OUTER HEARTWOOD OF ELEVEN TROPICAL WOODS, THE RELATIVE TOXICITY OF THE EXTRACTIVES TO *Lenzites trabea* AND *Poria monticola*, AND CORRESPONDING WEIGHT LOSSES IN DECAY TESTS MADE ON THE WOODS

Wood Species	Average extractive content	Average reduction in growth rate of decay fungi (toxicity index)	Average weight loss in Madison and Saucier soil tests	Average weight loss in pure-culture tests[1]
	Percent	*Percent*	*Percent*	*Percent*
Clarisia racemosa	13.3	100	11	1
Quercus copeyensis	10.5	59	—	3
Persea rigens[2]	8.1	27	17	1
Chaetoptelea mexicana	7.3	81	22	0
Terminalia amazonia	7.0	37	10	3
Cryptocarya sp.[3]	6.0	21	11	2
Rhizophora mangle	5.9	0	14	15
Nectandra whitei[4]	4.2	13	16	21
Brosimum utile	4.2	12	58	58
Carapa guianensis	4.1	0	33	38
Humiria sp.	2.8	1	20	18

[1]Decay by *L. trabea* and *P. monticola*.

[2]Given as *Persea pallida* in report cited in footnote 7.

[3]Given as *Nectandra rectinervia* in report cited in footnote 7.

[4]Given as *Ocotea tonduzii* in report cited in footnote 7.

Radial Variability of Decay Resistance in the Heartwood of Individual Trees

Rather pronounced radial differences in weight loss, usually in the form of fairly well defined trends, were found in the trunks of a number of species. The most prominent differences of this kind indicated in the soil tests are shown graphically in Figure 2. Two general trends may be noted. With eight of the species, represented by 16 trees, the average resistance of the outer heartwood was greater in both tests than that of the center heartwood. In six of these species, four of which were the only ones of Figure 2 that had visibly differentiated heartwood and sapwood, the resistance of the intermediate heartwood was intermediate between that of the outer and central heartwood. Values for the intermediate heartwood in the other two species were not obtained. Radial trends of this type have been found in a number of other species, conifers as well as hardwoods, and are probably rather general in woods having well defined heartwoods.[9,10,11,12,13]

With respect to the resistance of at least the outer and center heartwood, a reverse trend appears in five of the species, and in the remaining three species, the trends exhibited in the two soils are in opposite directions. The relative resistance of the intermediate heartwood in these cases was variable. Although the factors associated with the

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[9]Cartwright, K. St. G. The variability in resistance to decay of the heartwood of home-grown western redcedar (*Thuja plicata* D. Don.) and its relation to position in the log. *Forestry* 15: 65-75, illus. 1941.

[10]_____ The variability in resistance to decay of the heartwood of home-grown European larch, *Larix decidua* Mill. (*Larix Europea*), and its relation to position in the log. *Forestry* 16: 50-51, illus. 1942.

[11]Scheffer, T. C., and Hopp, H. The decay resistance of black locust heartwood. U. S. Dept. of Agriculture Tech. Bull. (In preparation.)

[12]Scheffer, T. C. The decay resistance of oak wood. *Mining Congress Journal* 30(1):45-47, illus. 1944.

[13]Sherrard, E. C., and Kurth, E. F. Distribution of extractives in redwood: its relation to durability. *Indus. and Eng. Chem.* 25(3):300-302, illus. 1933.

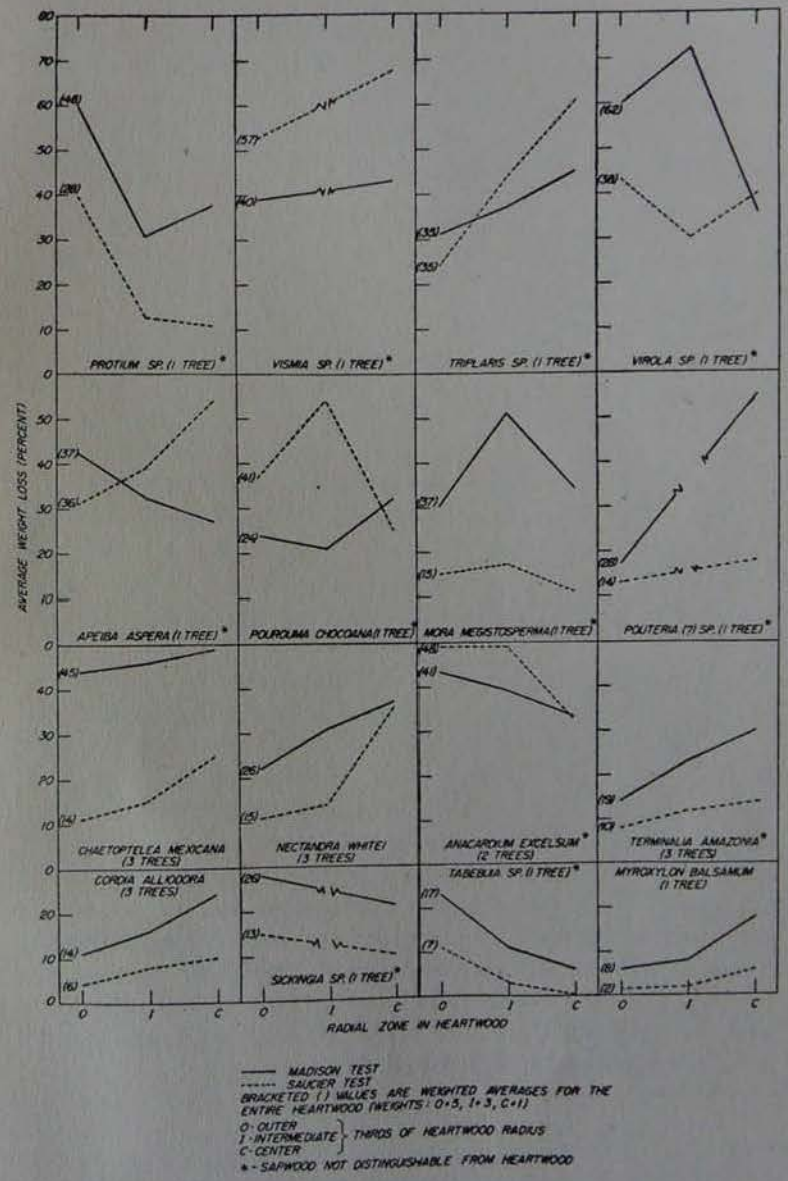

FIGURE 2—Average radial variability in the heartwood decay resistance of species in which such variability was most prominently indicated. (Data from the tests in soil.)

observed differences in radial variability of decay resistance are indefinite, it may be significant in part that with all eight of the species in which the outer heartwood was not consistently more resistant than the center heartwood there was no visible evidence of heartwood and sapwood differentiation.

The differences in resistance between outer and center heartwood indicated by the soil tests for *Anacardium*, *Myroxylon*, *Nectandra*, *Pouteria*, *Protium*, *Sickingia*, *Terminalia*, *Virola*, and *Vismia*, also were indicated by the pure-culture tests against the brown-rot fungi. The differences were mostly less pronounced in pure cultures, however, and were not apparent in *Chaetoptelea*, *Cordia*, *Tabebuia*, and *Triplaris*, which were among the species most resistant to brown rot. *Persea rigens* was the only species in which substantial radial differences in resistance were indicated by the pure-culture tests with brown-rot fungi but not by the soil tests. With this species, like the others having definite heartwood, the highest resistance occurred in the outer heartwood.

It is pertinent to recall at this point that in determining the species differences in average heartwood decay resistance, radial differences in resistance were taken into account according to the relative area of heartwood on a cross section represented by each of the three heartwood zones samples (page 6). Thus the results obtained for the outer heartwood received five-ninths of the total weight used in averaging. This was deemed appropriate not only because the outer heartwood as sampled represented approximately five-ninths of the heartwood volume but also because the outer heartwood contributes most to the strength of round timbers and bears the chief burden of resisting fungus attack after the sapwood is destroyed.

Sapwood Decay Resistance

The decay resistance of the sapwood or nominal sapwood[14] was tested in order to observe whether this portion of the wood might have some durability of practical significance in certain of the species and also because of uncertainty in many cases of where the boundary of the heartwood, if present, might lie. The results showed that the sapwood of a considerable number of the species was highly resistant to the brown-rot fungi but comparatively susceptible to attack by the white rotters and by fungi (presumably white rotters) that were most active in the soil tests. The latter result is typical of the low sapwood resistance generally found in all or nearly all United States species of commercial importance.

Species in which the sapwood exhibited sufficient resistance to warrant a class B rating, as used in Table 2, were *Humiria* sp., *Sickingia* sp., *Persea* sp., *Beilschmiedia* sp., *Tabebuia chrysantha*, *Vitex gigantea*, *Minquartia guianensis*, *Libidibia corymbosa*, and *Cryptocarya* sp. Only the last two of these had visibly distinguishable sapwood, hence for the most part these cannot be regarded as truly sapwood results. In any case, the practical advantage of this level of resistance in the outermost wood is obvious, particularly inasmuch as the "heartwood" of all but *Humiria* and *Sickingia* was among the most resistant of the tested woods.

To consider a more fundamental implication of the sapwood results, it may be noted (Table 4) that of the species in which there was no visible distinction between sapwood and heartwood (group A) nearly half (largely those with the most resistant "outer heartwood") decayed sufficiently more in the "sapwood" to suggest the presence of differential amounts of at least the fungus-retarding constituents commonly associated with visible heartwood and sapwood. It may be of further significance in this respect that the

[14] In this section and elsewhere, the term sapwood relates to the outermost wood whether or not it was truly sapwood as ordinarily considered (see page 3).

coefficients of correlation between weight losses in the "outer heartwood" and "sapwood" was 0.90 for the less resistant species of group A, 0.77 for the more resistant species of group A noted above, and 0.41 for the species with color

TABLE 4—CORRESPONDING WEIGHT LOSSES PRODUCED BY DECAY IN BLOCKS FROM THE OUTER HEARTWOOD AND THE SAPWOOD[1]

Species in which sapwood and heartwood were not usually distinguishable (Group A)	No. of tests[2]	Average weight loss: Nominal outer heartwood	Average weight loss: Nominal sapwood
		Percent	*Percent*
Virola sp.	1	60	44
Brosimum utile	2	58	46
Belotia sp.	2	52	49
Huberodendron sp.	3	51	43
Protium sp.	3	50	54
Dialyanthera gordoniaefolia	3	47	35
Vismia sp.	3	45	45
Anacardium excelsum	3	43	49
Pourouma chocoana	3	32	28
Triplaris sp.	3	31	33
Mora megistosperma	3	21	31[3]
Pseudolmedia eggersii	3	20	26
Humiria sp.	2	20	18
Sickingia sp.	3	18	15
Nectandra pisi	2	17	46[3]
Pouteria (?) sp.	1	16	34[3]
Beilschmiedia sp.	2	15	18
Cedrela fissilis	3	14	37[3]
Rhizophora mangle	2	14	37[3]
Tabebuia sp.	3	12	26[3]
Terminalia amazonia	2	11	17[3]
Tabebuia chrysantha	2	10	22[3]
Vitex gigantea	2	6	14[3]
Minquartia guianensis	3	5	20[3]
Persea (?) sp.	3	4	18[3]

differences denoting heartwood and sapwood (group B). It seems reasonable to believe that the decay resistance of "heartwood" and "sapwood" might be most comparable (i.e. correlated) in species in which these two types of wood are least differentiated in general.

Species having definite heartwood and sapwood, as evidenced by color differences (Group B)	No. of tests[2]	Average weight loss: Outer heartwood	Average weight loss: Sapwood
Carapa guianensis	2	33	34
Chaetoptelea mexicana	3	29	49
Persea rigens	2	17	27
Nectandra whitei	2	16	42
Cryptocarya sp.	2	11	15
Chlorophora tinctoria	3	6	44
Cordia alliodora	3	6	25
Libidibia corymbosa	2	6	17
Myroxylon balsamum	1	2	38
Erythroxylon glaucum	1	0	22
Quercus copeyensis	1[4]	6	22
Clarisia racemosa	1[4]	1	39

[1]Heartwood and sapwood nominal (see page 3) in the species whose heartwood and sapwood components, if present, were not visually distinguishable.

[2]Tests on which the average weight losses are based were: the soil exposure at Madison, the soil exposure at Saucier, and the exposure to pure cultures of the two white-rot fungi. Results of one or more of these three tests were used, depending on which ones included both the sapwood and the heartwood.

[3]Decay in the "sapwood" sufficiently greater to suggest a real difference with respect to sapwood and heartwood.

[4]Tests against pure cultures of the brown-rot fungi. The sapwood was not otherwise tested in these species.

SUMMARY

Tests were made of the decay resistance of 41 species of wood from Costa Rica, Panama, and Ecuador. To aid in interpreting the results, wood of three domestic species

generally regarded as moderately durable to very durable was included. The tests were made in soil, using small stakes, and in the laboratory, using small blocks and pure cultures of wood-rotting fungi. Also, limited data on the termite resistance of the Central American species were obtained incidentally.

With respect to the heartwood, or inner wood in cases in which there was no visible distinction between heartwood and sapwood, about a fourth to a third of the foreign species appeared to warrant classification as very durable and about an equal number as durable. The remainder was classified as relatively nondurable to moderately durable. Local reputations for durability were in generally good agreement with the test evidence.

Radial variability in decay resistance within individual trees was rather pronounced in sixteen species. A trend from higher resistance in the outer heartwood to lower resistance in the center heartwood was present in half of these species. An opposite and commonly less uniform trend was found in other species but there was no visible distinction between the heartwood and sapwood in these cases. These radial variations were taken into account in evaluating the species for relative decay resistance.

The sapwood, or outermost wood, of nine of the species was sufficiently high in decay resistance to be classified as durable. In a number of species having no visible distinction between heartwood and sapwood, differences in decay resistance indicative of at least partial characteristics of these two types of wood were exhibited.

STUDIES OF THE TREES OF BRITISH GUIANA
II. GREENHEART *(OCOTEA RODIAEI* [SCHOMB.] MEZ.)

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

VERNACULAR NAMES

Greenheart (trade); Bibiru (Arawak); Sipiri (Arekuna); Rora-yek (Akawaio); Sipu (Carib).

BOTANY AND ECOLOGY

The Tree.—Evergreen, canopy tree to 40 inches in diameter and 130 feet in height, usually 16 to 24 inches in diameter and 100 feet high; bole 50 to 75 feet, basally swollen or with low buttresses; bole form good, cylindrical, straight, with moderate taper (1 inch of diameter per 15 feet of length), occasionally crenately wavy (bull-forehead Greenheart); branches erect-spreading, crown conical or oval, sometimes irregularly open, small, heavy, dark glossy green; bark creamy, flaky; slash creamy yellow, hard, thin and brittle.

Leaves.—Sub-opposite, stiff, leathery, oblong or eliptical, 12 to 15 x 5 to 7 cm., base acute, apex acuminate, smooth, shiny; midrib prominent beneath, primary nerves, 10 per side, arcuate, obsolete above, prominulous beneath, petiole 8 mm. long.

Flowers.—In few-flowered axillary densely rusty-tomentellous panicles to 5 cm. long on 6 mm. pedicels; flowers creamy, jasmine-scented, 5-10 mm. diam., with conspicuous 2 mm. tube, tomentellous; perianth segments thick, spreading, papillose inside, triangular, 4 mm. long; stamens in 3 rows, fertile, oblong, papillose, 2 mm. long, outer row extrorse or introrse, second row introrse, inner row extrorse; ovary ellipsoid, sericeous.

Fruit.—Oblong-globose, slightly laterally compressed berry, 7 x 5 x 4 cm., with 1 to 2 mm. thick woody exocarp,

brittle, pale brown with white specks; cupule shallow, with entire margin, woody, 2 cm. in diameter.

Habitat.—Dominant and moderately gregarious over small areas of rain and evergreen seasonal forest on light sandy loam soils, occasional to locally frequent in other types of forest on any kind of soil. Prefers a mesophytic habitat but will grow under conditions of physiological drought as in Mora and even in Wallaba forest.

Stocking.—Conservative figures of sound merchantable timber 16 inches in diameter and upwards, averaged over all types of forest for the various districts, are as follows:

District	Cubic feet per acre
Barama-Waini	2
Cuyuni-Essequibo-Supenaam	200
Cuyuni-Mazaruni	170
Mazaruni-Essequibo	270
Essequibo-Demerara-upper	225
Essequibo-Demerara-lower	16
Mahaicony	present
Berbice-Corentyne-upper	110

On the Ikuribisi River, the presumed center of distribution, the average is 430 cu. ft. per acre and the best 70 square miles averaged 630 cu. ft. per acre.

Individual reefs run to as much as 1,000 or 1,200 cu. ft. per acre. Country which has more than 200 cu. ft. per acre is considered economically workable.

Distribution.—Greenheart is widely distributed in 20,000 square miles of the near interior from the Corentyne River to the Waini River with isolated patches further west (St. Bedes, Barama River; Maboni creek, Aruka River). Southward it extends up the Mazaruni River as far as Kamakusa, the Cuyuni River as far as Aranka, the Essequibo to about King William IV Falls, on the Simuni creek, Rupununi River and on the Corentyne River to Lanaballi creek. The center of distribution is along the Ikuribisi River, the right bank of the Mazaruni River and (the best remaining stands)

in the Bartica Triangle, the Kartabo triangle, the Cuyuni-Supenaam-Pomeroon area and the upper Demerara River. Greenheart occurs in Surinam only on the upper Maratakka River and in Venezuela only on the upper Cuyuni River.

Silviculture

Phenology.—Flowering and fruiting take place annually at approximately the same time, as the fruit matures in 12 months. Records are vague, because the flowers do not fall until flowering is finished. January to June with a peak in April or May seems to be usual. Very occasionally the odd tree will flower and fruit in August or September. Individuals remain in flower for six to eight weeks.

New leaves are produced on the ultimate twigs during the mid-year rainy season, the older leaves shed over the course of two to three years.

Seed dispersal.—Direct dispersal is mostly within the crown zone of influence, aided by gravity on sloping ground. The seeds are not buoyant. A small percentage of seed is dispersed by animals carrying it off for food and discarding it.

Survival.—Seed loses its viability very quickly once it dries out. Moist seeds will retain viability for one or two years. Seedlings will survive for 20 to 50 years under heavy shade and yet respond to opening of the canopy.

Germination.—Hypogeal. Seed germinates in the forest in 4 to 6 months, in the nursery in 6 to 8 months and continues to germinate over a 2 to 3 month period. Germination in the forest is probably 90 percent, with dibbled seed in the nursery 60 percent, with broadcast seed which tends to dry out as low as 20 percent.

Seedlings.—(a) Nursery. Height growth is moderately fast, 12 to 15 inches in the first three weeks and 2 feet in the first year. Subsequent growth depends on suitable light conditions and amount of root competition. Root growth is in proportion; for the tap root 8 to 10 inches in the first three weeks, up to 12 inches in six months before dying back to about 6 inches; the branch roots increase from 5 to 10

inches in the same period. The first leaves are similar to mature leaves and harden up in 3 to 5 weeks.

(b) Natural. Seedlings attain a height of 2 to 3 feet in the first year. They thrive best with moderate shade. Seeds will germinate in the open, if they remain moist but subsequent growth is almost nil and the seedlings remain sclerotic and stunted. Partial or side shade on loose, well drained sands produces the same effect.

Nursery practice.—Dibbling seed under shelterwood seems to be the most effective method, as the seed must be kept moist.

Plantation practice.—No attempt has been made to form plantations. Two methods of supplementing the natural supply of seed and regeneration in the forest have been successfully tried—(a) broadcasting seed, (b) transplanting natural seedlings. With abundant natural regeneration, however, it is simpler, cheaper and just as effective to manipulate the canopy to obtain the extra regeneration.

Silvicultural characteristics.—Greenheart is a strong shade bearer, from the seedling to the mature tree but requires direct overhead light for its best development. Greenheart forest is fairly light with an illumination near the ground of approximately 1/120 of full sunlight. It coppices freely except from over-mature trees or trees growing outside the normal habitat. Root suckers do not occur. It is shallow-rooted with poor wind resistance. It has a high natural resistance to pests, diseases and fire.

Sociability.—Greenheart is moderately gregarious, occurring in reefs on the upper slopes of valleys on light sandy loams. The extent of individual reefs, which are never very large, depends on the site factors. The concentration of Greenheart in a reef, i.e., the average number of trees per acre is approximately 24, distributed by size classes as follows:

Diameter classes, inches	<4	4-8	8-12	12-16	16-20	20-24	>24
Number of trees per acre	4	½	1½	3	6	4½	5

Rate of growth.—Greenheart is a fairly slow growing species. Shoot growth in the seedling and young sapling stage varies from 2 to 4 inches per annum in natural forest to 8 to 18 inches per annum after timber stand improvements. Mean diameter growth for trees of all sizes from 4 to 24 inches dbh. is approximately 0.12 inches per annum, which means that a tree will reach 16 inches breast height in 136 years. With treatment it is reckoned that Greenheart will reach exploitable size (16 inches dbh.) in 120 years.

Regeneration.—Natural regeneration in Greenheart forest is ample to abundant, in other types of forest containing mature Greenheart, locally occasional to frequent. Under normal conditions the amount of natural regeneration depends on the number of seedbearers, as regeneration is more or less restricted to the crown influence zone. Where seedbearers are sufficiently numerous, the patches of regeneration coalesce to form a whole, otherwise, isolated patches of regeneration occur around the parent trees. On unfavorable sites regeneration is sparse to absent and often stunted or sclerotic or both.

Response to treatment.—Natural regeneration responds well to canopy manipulation. It has been found that the best method of manipulation is as follows:—In Greenheart forest or forest with a reasonable proportion of Greenheart regeneration, gaps are made in the canopy and understory by poison-girdling a sufficient number of the trees directly over the most promising members of a group of regeneration so that the canopy will not close up again before the young Greenheart are well on the way to fill the gaps themselves. Once it receives the sunlight, the regeneration shoots ahead. Annual height growth rises from a mean of 2 inches to a mean of 10 to 12 inches. Little diameter growth is put on until the sapling reaches canopy height.

Pests.—Logs lying in the forest are attacked by various species of shot hole borer (*Platypus mulsanti* and *P. alternans* have been identified). The damage often necessitates resquaring of the logs. Large rodents like acourie and labba

will feed on the seed, when other more palatable seeds are scarce.

Properties and Utilization

The Log.—Greenheart is obtainable in hewn squares up to 70 to 85 feet long and 24 to 30 inches square. Specifications usually call for 11 to 18 inches square and 30 to 50 feet long. Round piles can be obtained 80 feet long but more usually 40 to 60 feet with a 12 to 18-inch butt diameter and a 6 to 12-inch tip diameter.

The taper of a hewn log does not exceed 2 inches in a 60-foot or 1 inch in a 40-foot hewn log. Logs squared to maximum dimensions seldom vary more than 1 or 1½ inches on adjacent faces.

Figured logs (bull-forehead Greenheart) are not uncommon, but difficulty is experienced in squaring them. The figure is usually limited to the outer part of the log, occasionally through and through.

On the average 15-20% of standing trees are unsound at least at the butt. The percentage of unsoundness rises on rocky sites and falls on optimum sites.

The Wood.—(a) Macroscopic features. Sapwood pale yellow or greenish, 3 inches thick in small, 1 to 2 inches thick in large trees, ill-defined from the heartwood, non-durable, attacked by insects; heartwood varies from yellow green, greenish yellow or light olive through golden yellow, dark olive or yellow brown to very dark brown or blackish. Figured (bull-forehead) lumber has a curly grain with golden or black bands across the width of the board.

Growth rings usually absent, pores evenly distributed, about 8 per sq. mm., parenchyma vasicentric, rays about 6 to 8 per mm. Ripple marks and gum ducts absent.

(b) Microscopic features. Average diameter of pores 0.13 mm. Rays mostly biseriate, few to 30 (to 40) cells high, mostly homogenous. Wood fibers small, arranged in radial rows, walls very thick and cavities minute.

Physical Properties.—Specific gravity 1.06 (air dry), to 1.23 (green), 65 (60-70) lb. per cu. ft. air dry, 75-85 lb. per cu. ft. green (50% moisture content); odorless and tasteless when dry, freshly cut wood strongly aromatic; texture medium fine, grain uniform, straight to roey; remarkably free from knots, lustrous, cold to touch.

Very hard, heavy, strong and dense, flexible in narrow lengths, with a high coefficient of friction, hence has a non-slip tractive property even when wet or coated with a film of oil or grease; practically unaffected by variations in exposure and with a very low acid content (0.48% calculated as acetic acid on the air-dry weight of the wood), hence minimum corrosive effect on nails and spikes.

Rated A1 at Lloyds, second to Teak, and approved by American Bureau of Shipping. Highly resistant to fire (very slow burning), almost immune to wood destroying fungi, the dry wood termite *(Cryptotermes)*, pin-hole borers and insects in general, resists abrasion, highly resistant to marine organisms in temperate salt or brackish waters (chiefly *Limnoria*) and in tropical salt waters (chiefly *Teredo*) but not in tropical fresh or brackish waters (chiefly *Neoteredo* and *Neobankia)*. Very durable, both exposed and in contact with the ground. Its high powers of resistance and durability are ascribed to its alkaloid content and the presence of tyloses in the vessels.

Working Properties.—Moderately hard to work by hand or machine tools; has considerable dulling effect on tool edges, but finishes well to a fine, smooth, lustrous surface. Care is necessary in working cross- and end-grain material, as the wood has a tendency to split and "flake off" (chips and slivers break out) when planing, moulding or recessing. It turns easily and takes a high polish with oil, wax or French Polish, no filler being needed. It rends easily and straight, bends moderately well but does not take nails well. The wood should be prebored with a metal drill for nails and screws.

Gluing gives fairly good results. For rip sawing, band saws with 4 teeth per inch or circular saws with the following specifications are recommended: 26 inch diameter with rim speed of 10,000 feet per minute, pitch 0.048 x diam., 15°

hook for green, 10° hook for seasoned material, depth of gullet 0.4 x pitch, width of tooth 0.3 x pitch. For cross-cutting a peg type tooth is recommended.

Mechanical Properties.—Its strength properties are exceptionally high, even for its weight. It is 40-50% heavier than Oak, 100% harder, 140% stronger in bending and compression along the grain, and 120% stiffer in bending under gradually applied loads. It is 25% stiffer than *Robinia*, the strongest and stiffest North American hardwood. In resistance to shock it is twice as strong as Oak, but considerably below Hickory. Its cleavage is low, it has the same resistance as Oak to splitting radially and 70% more than Oak tangentially. It is one of the best timbers for resisting tensile and compressive strains. According to Molesworth the tensile strength per square inch is 8,960 lb. and the crushing strain per square inch 14,200 lb. The properties outlined combine great hardness with relatively low cleavage strength. There are no reliable data to prove that the strength properties are affected by color variations.

It is a moderately good bending wood which requires very efficient support on the outer face even for large radii of curvature. Where S = wood thickness and R = minimum safe radius the ratio S/R (supported) = 1/12 and S/R (unsupported) = 1/56.

Tests by the Public Works Department, Georgetown, in 1912 showed that, at 68 lb. per cu. ft. the Modulus of Rupture is 22,680 lb. per sq. inch and Modulus of Elasticity is 3,840,000 lb. per sq. inch.

Tests by Duke University, School of Forestry on its screw holding capacity prove that it is a little better than Locust *(Hymenaea)* and almost as good as Purpleheart *(Peltogyne)*. The force, in pounds, necessary to extract No. 6 and No. 10 screws embedded to the limit of the thread from the side and end grain is as follows:

	Side	End
No. 6	870	660
No. 10	1000	690

More complete mechanical tests by Forest Products Research Laboratory at Princes Risborough and the Forest

Products Laboratory at Madison will be found in the table below.

		F.P.R.L.	F.P.L.
Static bending			
F.S. at L.P.	lb./sq. in	11730	—
Eq: F.S. at M.L.	lb./sq. in	19670	18240
M. of E.	1000 lb./sq. in.	3009	2792
Work to L.P.	inch lb./cu. in.	2.58	—
Work to M.L.	inch lb./cu. in.	12.9	—
Total work	inch lb./cu. in.	35.8	—
Impact bending (50 lb. hammer)			
F.S. at L.P.	lb./sq. in.	23230	—
M. of E.	1000 lb./sq. in.	3997	—
Work to L.P.	inch lb./cu. in.	7.69	—
Maximum drop	inches	46	—
Compression parallel to grain			
F.S. at L.P.	lb./sq. in.	8500	—
F.S. at M.L.	lb./sq. in.	10500	9910
M. of E.	1000 lb./sq. in.	3280	—
Compression perpendicular to grain			
F.S. at L.P.	lb./sq. in.	1977	1633
Hardness			
Radial surface	lb.	2124	—
Tangential surface	lb.	2021	—
End surface	lb.	2118	—
Shear parallel to grain			
Radial Plane	lb./sq. in.	1291	1922
Tangential Plane	lb./sq. in.	1490	1922
Cleavage			
Radial Plane	lb./in. width	425	—
Tangential Plane	lb./in. width	583	—
Specific gravity	O. D. weight / Volume at test	0.817	—
Moisture Content	percent	41.4	45
Weight per cubic foot at 50% moisture content		76.4	—

Abbreviations:
Eq:–Equivalent
F.S.–Fiber stress
L.P.–Limit of proportionality
M.L.–Maximum load
M. of E.–Modulus of elasticity
O.D.–Oven-dry
F.P.R.L.–Forest Products Research Laboratory, Princes Risborough
F.P.L.–Forest Products Laboratory, Madison

Seasoning Properties.–Under mild air drying conditions, in a covered shed in England, the lumber seasons very slowly with a tendency to checking and to some end splitting. Shakes are unusual. Warping is not excessive. The total degrade is negligible. The difference between radial and tangential shrinkage is very low due to the uniform structure and gelatinous thick-walled fibers. Under cover in British Guiana lumber seasons reasonably fast with little tendency to check or split.

Results of air seasoning:

England–1 inch boards season to 18% m.c. in 1 year
2 inch boards season to 18% m.c. in 2 years

British Guiana,–Mazaruni Station (equilibrium 17% m.c.)
1 inch boards season to 17% m.c. in 3 months
1 inch boards season to 15% m.c. in 5 months

British Guiana,–Georgetown (equilibrium 15% m.c.)
1 inch boards season to 15% m.c. in 3 months

Kiln seasoning is very slow with considerable degrade, especially with timber over 1 inch thick (the latter should be partly air seasoned). Distortion is not serious but checking and splitting are severe. The shrinkage in kiln drying from green to 12% moisture content is as follows:

Tangential ¾ to 7/16 inch per ft. or 6.2 to 3.7% } F.P.R.L.
Radial 7/16 to ⅜ inch per ft. or 3.6 to 3.1% } England

Tangential 4.2% } Duke Univ. School of Forestry
Radial 3.4% } Duke Univ. School of Forestry

The following kiln drying schedule is recommended:

Moisture content (%) of the wettest timber on the air inlet side at which changes are to be made	Temperature (dry bulb) °F	°C	Temperature (wet bulb) °F	°C	Relative humidity %
Green	105	40.5	101	38.0	85
60	105	40.5	99	37.2	80
40	110	43.3	102	38.7	75
35	110	43.3	100	37.9	70
30	115	46.1	103	39.5	65
25	120	48.8	105	40.8	60
20	125	51.7	107	42.0	55
18	130	54.4	109	43.0	50
16	135	57.2	111	43.8	45
15	140	60.0	115	46.2	45

Preservative Treatment.–Unnecessary and unsatisfactory. The wood although not impermeable is very resistant to pressure treatment. The preservative only penetrates to a small depth longitudinally.

Uses.–Building construction: Foundations, sills, joists, framing, weather boarding, flooring, veranda posts, steps, stair-treads, panelling, mouldings, parquet flooring, fence posts, rails, gates, vat bottoms, rustic building.

Boat building: Keel, stem, stern posts, planking, decking, fenders, gangways, sheathing whaling ships.

Marine construction: Piles, sheet piling, fenders, braces, decking, groins, revetment, land ties in slipways, sluice gates, lock gates, keelblocks, underpiling, rubbing pieces on dock gates and caissons, dock gates, landing stages.

Land communications: Cross arms, bridge runners, trestles, decking, bridge rails, paving blocks, boardwalks, box culverts, wooden rails, axles, wheel spokes, carriage shafts.

Furniture and Ornamental Work: Heavy furniture, turnery, inlay.

Agricultural and Industrial: Mining timber, sawmill foundations, engine bearers, electric switch blocks, work-

shop floors, saw-benches, wood working planes, lift runners, "pickers" in textile industry, chemical vats.

Miscellaneous: Fishing rods, walking sticks, billiard cue butts, tobacco plugs, fretsaw bows, belaying pins, mortars.

Pulp: A fairly good yield of rather poor quality pulp can be produced by the soda process.

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

British Guiana

(1) Slipway of dockyard of Sprostons Ltd., Georgetown, sound after 29 years and the piles after 45 years.

(2) Piles at Garnett and Co.'s Wharf, Georgetown, sound after 55 years' service.

(3) Veranda pillars of Eve Leary Mess, Georgetown, fully exposed to weather, renewed after being in place 100 years.

U. S. A.

(4) Piles at the Battery Landing, New York, sound after 7 years although subjected to unusual wear and tear.

(5) Decking at Pier 11, East River, New York, has stood up to heavy traffic, for 7 years, and shows little wear.

England

(6) Manchester Ship Canal, has 54 pairs of Greenheart gates. The cost of maintenance from 1894-1902 was $15 per pair of gates per year.

(7) The gates of the Canada Lock, Liverpool, built in 1856 were still sound in 1896, when they were taken up and reconstructed in the course of deepening the lock. The new gates containing the horizontal ribs of the original gates were still sound in 1936.

(8) Gates of the Alfred Lock, Birkenhead, built in 1866 were in excellent condition, free from "worm" attack after 48 years.

(9) Jetties at Canada Basin, Liverpool, built between 1879 and 1885 were practically as sound in 1932 after 50 years' service as when constructed.

(10) Four pairs of gates in the Albert Edward Dock, Newcastle, built in 1884, were still in good condition after 33 years of constant use.

(11) Piers used in the Tyne River harbor works, were not attacked by "sea worms" after 20 years' service.

(12) Keel, mitre and sill timbers of lock gates at the LNER Tyne River dock still sound after 57 years' service and used again as fenders.

(13) Piles, etc., at the LNER, Hartlepool docks still in good repair after 60 years' use.

(14) Piles at Cattlewater, were still sound after 30 years.

(15) Piles at six points on the coast averaged 20 (4-36) years' life, after attacks by *Teredo*, *Limnoria*, and *Chelura*.

Scotland

(16) Piles at Glasgow and Leith, sound after 60-80 years.

(17) Specimen of Greenheart in the Kelvingrove Museum, Glasgow, from a wreck submerged for 18 years on the west coast, is merely slightly pitted on the surface, the body of the wood being sound.

(18) Piles at nine places on the coast have an average life of 17 (3-30) years against *Limnoria*.

Ireland

(19) Piles at No. 1 Lighthouse, Belfast, suffered little or no deterioration after 30 years.

France

(20) Lock gates of the Guillain dock at Dunkerque, constructed about 1880, were in perfect condition 43 years later, when removed for repairing iron work.

Belgium

(21) Jetty at Ostend, installed 1889-90 still in good condition in 1923.

(22) Piling in harbors at four places show on the average 13½ years' resistance against shipworm, and still in good condition.

Holland

(23) Piles at ten places on the coast of Holland showed after 12 years no "shipworm" attack deeper than ¾ inch in sapwood, heartwood sound.

Mediterranean

(24) Test piles in the Arsenal basin of the Suez Canal at Port Said were sound after 2 years, although Pine and Oak piles alongside were almost entirely destroyed.

(25) Piling in harbor works gives 20 years' service.

South Africa

(26) Piling in harbor works has an average life of 12 years.

India

(27) Dock gates have an average life of 14 (10-20) years.

Malay States

(28) A half tide fender (faced with ballow, the best local hardwood) was still sound after 9 years in Singapore harbor.

New Zealand

(29) Test piles at Auckland, driven in 1917 were still sound in 1931.

(30) Nansen's polar exploration ship "Fram" was strengthened throughout with Greenheart framing.

Trade Substitutes.—Relatively few timbers can be passed off for Greenheart, even in the rough. The Groenheart of Surinam *(Tabebuia serratifolia)* bears little resemblance except in name. Manniballi *(Moronobea coccinea)* and Wabaima Silverballi *(Licaria cayennensis)* bear a superficial resemblance to Greenheart, but compulsory Government inspection renders substitution impossible.

Minor Uses.—All parts, especially the seeds, contain various bitter alkaloids (bibirine, sipirine, etc.) which have been used as febrifuges and cures for dysentery and diarrhoea. Dr. Rodie, a naval surgeon settled in British Guiana, in honor of whom the tree is named, first isolated bibirine in 1833 and used it as a febrifuge in intermittent fever. Dr. Maclagen of Edinburgh University in 1845 prepared bibirine

sulphate and was much impressed with its febriuge properties. It appeared in the British Pharmacopoeia from 1864-98. Bibirine has been used in place of quinine as an antiperiodical but without marked success. It has also been used in various uterine diseases, affections of kidney and bladder, periodical neuralgia and externally against inflammation of the eyes, again without marked success.

The seeds contain 54% starch, which is sometimes used in bread. The starch must be repeatedly washed to remove the bitterness. The seeds make excellent charcoal. Local superstition blames Greenheart splinters for causing festering wounds liable to lead to tetanus; there is no truth in the superstition.

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DOES MAHOGANY *(SWIETENIA)* OCCUR IN ECUADOR?

By Elbert L. Little, Jr.
Forest Service, United States Department of Agriculture

Although Mahogany *(Swietenia)* is reported in various published lists of trees and woods of Ecuador, no authentic record that this valuable cabinet wood is native there has been found. Furthermore, Ecuador is outside the known geographic distribution of this genus.

Some current errors in scientific names of Ecuadorian plants can be traced to the classic work of Theodor Wolf (Geografía y Geología del Ecuador. 671 p., illus. 1892). In his chapter on the vegetation of Ecuador, he mentioned true Brazilian Mahogany, "el Mahagoni legítimo del Brasil *(Swietenia mahagoni)*," from the Napo region east of the Andes (p. 440). P. Luis Mille (Nociones de Geografía Botánica Aplicadas al Ecuador. Ed. 2, 72 p., illus. 1922) had *Swietenia mahagoni* L., common name Caoba, in his list of plant names (p. 63). Zon and Sparhawk (Forest Resources of the World. 2 v., illus. 1923) in their compiled list of the principal woods of Ecuador stated (v. 2, p. 772): "Caoba *(Swietenia* sp.?) resembles Mahogany and is used for similar purposes." In an article on "The Forests of Ecuador" *(Tropical Woods* 31: 1-9. 1932), August Rimbach mentioned Caoba *(Swietenia* sp.) as a component of the lower slopes of the Western Cordillera and adjacent lowland (p. 4, 8).

Perhaps the most detailed accounts are those by M. Acosta Solís in a series of articles published in *Maderil.* His article on the principal woods of Ecuador placed Caoba *(Swietenia mahagoni* and other species) first on the list of high-class woods known in international trade. It was recorded as abundant in the western or coastal region, especially in the virgin forests, in the provinces of Esmeraldas, Guayas, and Manabí, and was mentioned as a potential wealth for Ecuador *(Maderil* 12 [133]: 7. 1939). Various lists in his articles on the forests and woods of the province of Esmeraldas mentioned Caoba or Caobano *(Swietenia* sp. or *Swie-*

tenia mahagoni) (Maderil 14 [164]: 27; [167]: 14, 16; 14 [168]: 11, 15. 1942). These writings were republished in his book, "Nuevas Contribuciones al Conocimiento de la Provincia de Esmeraldas" (vol. 1, 606 p., illus., Quito-Ecuador. [1944]).

A brief review in *Tropical Woods* (60: 52. 1939) of Acosta's first article gave emphasis to his report of the abundance of Caoba *(Swietenia)* in the virgin forests of the three provinces noted above. Next, Record and Hess (Timbers of the New World. 640 p., illus. 1943) citing this review credited to Acosta the statement that *Swietenia* is a component of the virgin forests in northwestern Ecuador (p. 372). Accordingly, their map (map 7) on the range of Mahogany in South America, shows an extension into northern Ecuador. They mentioned *Swietenia* also from "southern Ecuador" in the Amazon basin but did not indicate this range on their map.

More recently, Julian W. Shinol (Forest Resources, Lumber Industries, and Trade in Ecuador. U. S. Off. Internatl. Trade, Indus. Ref. Serv. Pt. 6, Forest Prod., v. 4, No. 51, 14 p., illus. 1946) repeated the reports that Caoba *(Swietenia macrophylla)* was believed to occur in significant quantities in the virgin forests of northwestern Ecuador. In his latest article, Acosta Solís (Commercial Possibilities of the Forests of Ecuador—mainly Esmeraldas Province. *Tropical Woods* 89: 1-47, illus. 1947) did not even mention *Swietenia.*

W. D. Brush (Mahogany [*Swietenia* species]. 20 p., illus. Forest Service, U. S. Dept. Agr. 1941) clearly showed on his distribution map that northwestern Ecuador is far outside the known range of Mahogany. This map, published before the boundary settlement of 1942, does not indicate the present eastern limits of Ecuador, which do not extend east to the known areas of Mahogany on tributaries of the Amazon in northeastern Peru. Eastern areas formerly claimed by Ecuador are now a part of Peru.

No botanical specimens of *Swietenia* from Ecuador were found in a check of several large herbaria of the United States. There is no evidence that wood of *Swietenia* is logged, sawed, or sold in Ecuador. The Forest Service field party in Ecuador in 1943 did not find *Swietenia* there, either in the forests or in the form of lumber. That group, of which I was a member, did not locate Mahogany in a month of field work in the province of Esmeraldas in northwestern Ecuador or in travels in other western provinces.

Actually, northwestern Ecuador is far removed from the nearest known areas of *Swietenia* in northern Colombia. The upper valley of the Magdalena River in Columbia, mentioned by Record and Hess (p. 372) as one of the areas of Mahogany, I know from personal observation, is semi-arid and does not contain this species. The flora of western Ecuador though poorly known has been studied enough that *Swietenia* should have been collected if common there. This region is sufficiently populated that the inhabitants should have discovered this valuable wood and its uses, if it occurred in commercial quantities in accessible localities. It is possible, though, that *Swietenia* may later be found in the poorly explored and almost uninhabited Oriente region of the Amazon drainage in eastern Ecuador, as Wolf stated. If so, the wood would be exported down the Amazon River across Brazil.

The Forest Service survey did discover the probable explanation for the erroneous reports of *Swietenia* in Ecuador. One of the native tree species of the province of Esmeraldas, *Platymiscium pinnatum* (Jacq.) Dugand (family Leguminosae), is known by the common name "Caoba," the usual Spanish equivalent of Mahogany. The reddish brown wood of this species resembles Mahogany, is fairly hard and durable, and has a specific gravity (oven-dry) of 0.76. It is used in Ecuador for furniture, cabinet work, and to a limited extent in small ships. This species is widely distributed from Central America to Venezuela and Ecuador. An experienced native guide in Esmeraldas used the name "Caoba" for trees of two species of Lauraceae, *Nectandra pisi* Miq., known also as "Jigua", and *Beilschmiedia* sp.

MARINE BORER RESISTANCE OF *SYNCARPIA LAURIFOLIA*

By C. H. Edmondson
Bishop Museum, Honolulu

Scattered plantings of the Australian Turpentine tree, *Syncarpia laurifolia* Ten., were made in Hawaii nearly forty years ago, even before the identity of the species was recognized locally. Some fairly good stands of this timber have become established in the islands as it is among the numerous introduced species that have gained favor as watershed cover for upland areas. Should the Turpentine tree in Hawaii acquire the reputation for durability that it has received in Australia, especially in contact with sea water, it may develop into a commercially valuable timber in the future. A good supply of a hard, strong wood, highly resistant to marine borers, would doubtless prove to be an asset in the island economy.

With such possible future utility in view investigations of the reaction of this Hawaiian grown myrtle to marine wood borers were conducted. The experimental station selected is in Honolulu Harbor, about one-half mile from the entrance, in quiet water, salinity ranging slightly above or below 33.8, depth about 30 feet at ebb tide. Tests involved blocks of green and well seasoned wood; of sapwood and heartwood; of sections with and without bark, and sections of bark stripped from trees and treated as separate units. Juvenile specimens were examined as well as wood from trees 6, 8, 12 and 15 inches in diameter. Local foresters estimate that the Turpentine tree in Hawaii, under favorable conditions, may attain a diameter of 12 inches in 20 years, and that trees 15 inches in diameter are about 35 years old.

Through the courtesy of the Maritime Services Board of New South Wales seasoned blocks (heartwood) of *Syncarpia laurifolia* were received from Australia for comparative tests with the Hawaiian grown timber. Information regarding the age of the trees from which the Australian samples came is not available, but there is reason to believe they were much older than any now growing in Hawaii.

Summary of Tests

Hawaiian grown timber.

1. Sapwood. Seasoned sapwood was usually badly damaged by teredos and *Limnoria* within six months and riddled within one year, whether juvenile sections or those cut from the oldest trees. Green blocks had slight advantage over seasoned ones.

2. Heartwood. Blocks from trees 6, 8, 12 and 15 inches in diameter showed parallel reactions. They were consistently and moderately attacked by teredos and *Limnoria* during periods ranging from nine months to one year. Destruction of heartwood compared with that of sapwood was in the ratio of about 1 : 2. Maximum penetration by teredos of sapwood from a green tree 6 inches in diameter was 75 mm. in one year; of heartwood, from the same source and during the same period, 45 mm. Seasoned heartwood from a tree 15 inches in diameter, however, showed a maximum penetration by teredos of 75 mm. within nine months. (See Fig. 1.)

3. Bark. Trees 10 to 12 inches in diameter have bark 12 mm. to 15 mm. thick, the outer surface of which is very shaggy and irregular. In juvenile sections the comparatively smooth bark, 5 mm. thick, was readily penetrated by teredos within six months. In sections of trees 12 inches in diameter, with bark intact, there was no complete penetration of the bark during periods of 15 months. Teredos, however, passed from the sapwood and deeply furrowed the inner surface of the bark, while the outer layers were reduced by *Limnoria*.

Bark stripped from older trees and submerged as test blocks responds as it does when in contact with sapwood. Teredos burrowed through the inner portion of the bark and *Limnoria* attacked the outer, shaggy layers but there was no complete penetration during periods exceeding one year. (See Fig. 3.)

Australian grown timber.

Heartwood blocks of Australian grown timber were tested in Honolulu Harbor parallel with sections cut from the hearts of the largest and oldest Hawaiian trees available. Submerged time for the Australian timber was two years. At no time did test blocks show more than very light infestation by teredos, and damage by *Limnoria* was almost negligible. Maximum penetration by teredos was 15 mm. during an interval of two years. (See Fig. 2.)

Physical Contrasts (Heartwood)

The Australian specimen at hand is of homogeneous dark reddish brown color, very hard and dense; weight 63.7 lbs. per cu. ft. Observations by School of Forestry,[1] Yale University, indicate vessels contain gum deposits which were absent from Hawaiian grown specimens examined.

Hawaiian samples from largest trees available, light reddish brown, with alternate streaks of darker and lighter shades. Density less than Australian timber; weight 56.6 lbs. per cu. ft.

Conclusions

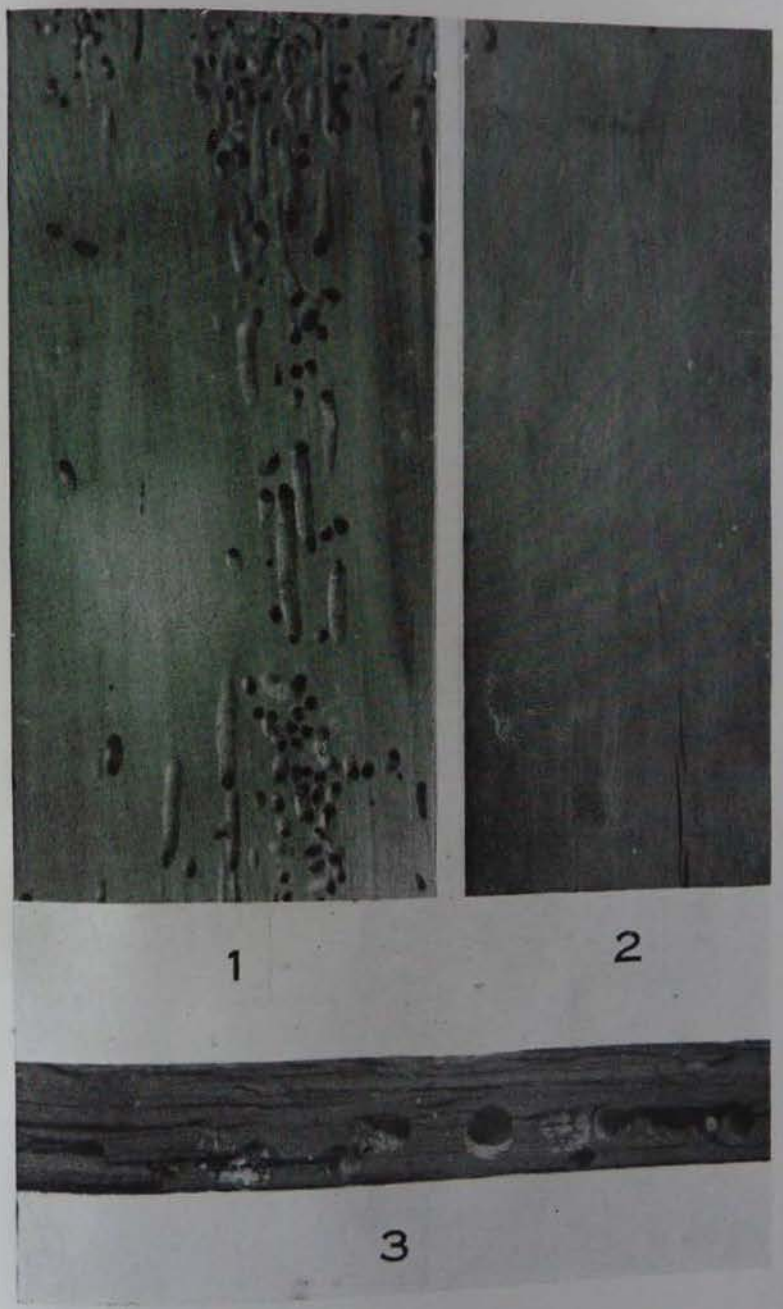
Even the older Turpentine trees growing in Hawaii lack resistant properties that give durability in sea water. Marine wood borers readily attack both sapwood and heartwood.

Heartwood from the older Hawaiian timbers reacts to marine borers much as does immature or juvenile wood. Lack of age and rapidity of growth may account for this apparent immaturity and low resistance, as compared with specimens of Australian timber examined.

The presence of gum deposits in vessels of the Australian timber and their absence from Hawaiian specimens is doubtless a specific factor influencing the reaction of the woods.

While bark in older Hawaiian timbers would be a temporary protection against marine borers, the action of

[1]Personal communication.



Limnoria would probably soon reduce it to a condition permitting the invasion of teredos.

Although many Turpentine trees in Hawaii have now reached a suitable size for piles, there are indications that such timbers would fail in the shoal waters within a few years.

Explanation of Figures

Fig. 1. Hawaiian grown *Syncarpia laurifolia*. Heartwood from tree 15 inches in diameter, about 35 years old. Moderate attack by marine wood borers after 9 months in Honolulu Harbor. Maximum penetration by teredos, 75 mm.; slight superficial damage by *Limnoria*. Test block 1½ x 4½ x 9 inches, sawed through the middle

Fig. 2. Australian grown *Syncarpia laurifolia*. Heartwood lightly attacked by marine wood borers after 2 years in Honolulu Harbor. Maximum penetration by teredos, 15 mm.; slight damage by *Limnoria*. Test block 1½ x 2¾ x 8 inches, sawed through the middle.

Fig. 3. Bark of Syncarpia laurifolia, 10 mm. thick, stripped from tree and submerged in Honolulu Harbor 14½ months. Inner portion (below in figure) badly damaged by teredos; outer portion (above in figure) deeply furrowed by *Limnoria*, but no complete penetration of the bark.

THE WOOD COLLECTORS SOCIETY

The organization of a society for those interested in collecting wood specimens as a hobby has been announced. Excerpts from the constitution indicate the purpose of the society to be:

1. To collect and disseminate all information considered pertinent and instructive to those interested in collecting specimens of woody plants.
2. To encourage others to become collectors.
3. To assist in accurate naming and classification of specimens.
4. To encourage exchange of wood specimens upon an organized basis by members or others in all parts of the world.
5. To encourage the adoption of standard methods for wood collections. This shall include specimen sizes, numbering systems, authenticity ratings and other details relating to standardization and improvement of individual collections.
6. To emphasize the importance of a uniform specimen size of ½ x 3 x 6" when finished.
7. To cooperate with institutions, universities and schools in the augmenting of their scientific collections of herbarium specimens and woods and to receive aid in the proper naming of specimens.

The newly elected officers are: W. F. Opdyke, President. Henry Dentzman, Vice-president. C. D. Gilbert, Secretary-Treasurer.

Applications for membership may be made to the Secretary-Treasurer (Mr. C. D. Gilbert, 2412 South Boulevard, Houston, Texas). Applications should be accompanied by a remittance of $3.00 as application fee and $3.00 annual dues.

CURRENT LITERATURE

Mahogany of Santo Domingo. By Rollo P. Stovall. *Agric. Americas* (Washington) 7: 8 & 9: 107-108; 3 figs.; August-September 1947.

In excess of 500,000 board feet of mahogany (*Swietenia mahagoni* Jacq.) has been cut annually in Santo Domingo. In Ciudad Trujillo the lumber is worth from $180 to $250 per thousand board feet. The resistance of the wood to the ravages of the drywood termite promotes its local use for doors, sills, interior woodwork, and furniture.

"The oldest known article made of mahogany is believed to be an old cross in the Cathedral of Santo Domingo. According to the inscription on the cross it was placed on the site of the cathedral in 1514 at the time construction was started."

A forest lover in the Caribee Islands. By J. S. Beard. *Jour. N. Y. Bot. Gard.* 48: 572: 181-188; 6 figs.; August 1947.

This is the last of a series of seven articles and deals with the Limestone Caribbees, Antigua and Barbuda. The vegetation of the islands is described in interesting and authoritative style.

Preceding articles under the same general title and the dates of the Journal in which they are found are: I. Tobago, May 1944. II. Grenada, June 1944. III. St. Vincent, August 1944. IV. Dominica, October 1945. V. St. Lucia, October 1946. VI. Saba to Montserrat, April 1947.

Two new flowering plants from St. Lucia. By A. C. Smith and H. A. Gleason. *Jour. Arnold Arb.* (Jamaica Plain, Mass.) 28: 3: 333-336; July 1947.

Two species of small trees are described as new—*Licania oligantha* A. C. Smith and *Miconia luciana* Gleason.

Le "magnolia", *Talauma dodecapetala*, des Petites Antilles; Monographie sylvo-botanique. By H. Stehlé and E. Marie. *Caribbean Forester* (Rio Piedras, P. R.) 8: 3: 183-190 (French), 190-195 (English); July 1947.

The names, botanical desription, habits and habitat, the tree, and wood of the Magnolia as it occurs in the Lesser Antilles are described in some detail. The heartwood is highly valued for marquetry, gunstocks, furniture, and boat construction.

Some observations on conservation of natural resources in El Salvador. By Thomas W. McKinley. *Jour. Forestry* (Washington, D. C.) 45: 10: 755-761; 6 figs.; October 1947.

A brief, general account of the forests, their exploitation, and re-establishment.

Chinchona — the quinine tree. By Lyall E. Peterson. *Jour. Forestry* 45: 7: 500-502; 2 figs.; July 1947.

This is an account of the American Cinchona Plantations in Costa Rica. Present plans call for the planting of 400 or more of the 3100 acres in the plantation.

Noticias botanicas Colombinas, VIII. By Armando Dugand. *Caldasia* (Bogotá) 4: 19: 305-309; May 1947.

Colombian representatives of the families Achatocarpaceae, Polygalaceae, and Bignoniaceae are discussed. One new species, *Anemopaegma chrysantha* Dugand, is described. Two new species names are proposed for the genus *Securidaca*.

Arawak Indian plant names. By D. B. Fanshawe. *Caribbean Forester* 8: 3: 165-180; July 1947.

The "list of Arawak plant names with their botanical equivalents has been compiled partly from the records of the Forest Department in British Guiana, partly from Dr. Stahel's notes in his article on Arawak plant names in the New York Botanical Garden's Journal for December 1944, but mostly from the Arawak Indians themselves in British Guiana."

"The Arawak vernaculars apply to plants, excluding cultivated species which are known personally to them in an area perhaps 50 miles wide, stretching from the North West District of British Guiana to the Berbice R."

Ensaio para o glossário determinologia florestal. By D. Guilherme de Almeida. Reprints from *Bol. Soc. Bras. Agronomia* 9: 2: 105-122, 9: 4: 249-262; 1946.

The first part of this paper lists 384 terms (Portuguese) useful in forestry with their definitions. The second part lists the equivalent terminology in English, French, and Italian.

Como herborizar material arbóreo. By M. Kuhlmann. Pub. by Instituto de Botanico (São Paulo, Brazil), 1947. Pp. 39; 10 figs.

Ingenious devices for collecting herbarium materials from standing trees are described in detail and well illustrated. Included are two types of saws manipulated from the ground by lines, and equipment for attaching and ascending lines.

The forests of Western and Central Ecuador. By L. R. Holdridge, L. V. Teesdale, J. E. Myer, E. L. Little, Jr., E. F. Horn, and José Marrero. Pub. by U. S. Forest Service (Washington, D. C.), June 1947. Pp. 134; 78 figs.; 1 map.

The various forest areas and the major forest types are described. Production and utilization of products, exports, forest and land use management, and other phases of forestry are discussed. The important timber trees and their woods are described and the common names listed. A key for the identification of the more important commercial woods is presented. A bibliography and a discussion and map of routes traveled are included.

Chinchonas del Ecuador. By M. Acosta-Solis. Pub. by the author, Quito, 1946. Pp. 276; 41 plates.

The twelve chapters are devoted to the history of cinchona, historic and recent botanical explorations, habitat and distribution of cinchona, botanical descriptions and nomenclature, the chemical and pharmacological aspects of the barks, and the cultivation of the species.

The plant resources of Peru. By W. H. Hodge. *Economic Botany* (Lancaster, Pa.) 1: 2: 119-136; 13 figs.; April-June 1947.

"More than 51% of Peruvian territory is forest land, called 'montaña,' and lies east of the principal Andean axis." In addition to the commercially important mahogany and Spanish cedar other locally used woods include "tornillo *(Cedrelinga catenaeformis* Ducke) of the Upper Huallaga; and castaña *(Bertholletia excelsa* H.B.K.), estoraque *(Myroxylon Balsamum* (L.) Harms), huacapu *(Lindackeria maynensis* Poepp. & Endl.), mashonaste *(Anonocarpus amazonicus* Ducke), palo vibora *(Phyllanthus* sp.), quillobordon *(Aspidosperma subincanum* Mart.), and tahuari *(Tahebuia* sp.)—all of the Peruvian Madre de Dios."

Flora Riograndensis. By K. Emirich and B. Rambo. *Lilloa* (Tucuman, Arg.) 12: 87-109; 5 figs.; 1946.

New or little known species of the Rio Grande flora conserved in the Herbario Anchieta, Porto Alegre (Brazil) are enumerated. Included are 51 species of 44 genera, 28 families.

Contributions to the flora of extra-tropical South America. IX. By Harold N. Moldenke. *Lilloa* 12: 111-176; 1946.

Listed are 295 species of 101 genera, 19 families.

El territorio del Chaco y su riqueza forestal. *M.A.N.* (Ministerio de Agricultura de la Nacion, Buenos Aires, Argentina) 84: Pp. 8; 14 figs.; March 1947.

A brief description of the forests and their exploitation include enumeration of the most important species and their uses. These are: Quebracho colorado, Urunday, Guayacán, Itín, Quebracho blanco, Algarrobos, Guayaibí, Viraró, Lapacho, Guaraniná, Mora and Tatané.

Reply to comments on "A forester's observations in Mindoro". By W. H. Lambert. *Jour. Forestry* (Washington, D. C.) 45: 7: 516-517; July 1947.

"Cruises made near Sablayan Municipality showed the stand averaged 34.92 M^3 per hectare. This was made up of 21.87 M^3 second group species, including akleng-parang *(Albizzia procera)*, anubing *(Artocarpus* sp.), banaba *(Lagerstroemia speciosa)*, guijo *(Shorea guiso)* and Makasim *(Eugenia* sp.), and 13.05 M^3 of third group, comprising amugis *(Koordersiodendron pinnatum)*, dalinsa *(Terminalia comintana)*, nato *(Palaquim* sp.), and toog *(Petersianthus quadrialata)*. The stand table for an area near San Jose Municipality shows an average volume of 89.34 M^3 per hectare. This was broken down into 12.28 M^3 of ipil *(Itsia* sp.), a first group species, 9.60 M^3 of akleng-parang of the second group, 17.30 M^3 of the third group represented by dao *(Dracontomelum dao)* and amugis, and 50.16 M^3 of fourth group represented by antipolo, pahutan, kuping, and various lauans."

A contribution to the knowledge of the Melastomataceae occurring in the Malay Archipelago especially in the Netherlands East Indies. By R. C. Bakhuizen Van Den Brink, Jr. *Mededelingen* (Utrecht) 91: 1-391; map; 1943.

The work represents a monograph of the Melastomaceae insofar as the material available, primarily in the Leyden and Utrecht Herbaria, permitted. The species are described in detail, with citations; keys, references, and indices are given.

Species novae Fagacearum Sinicarum. By Woon-Young Chun and Ying Tsiang. *Jour. Arnold Arb.* (Jamaica Plain, Mass.) 28: 3: 320-327; July 1947.

Three new species are described in the genus *Lithocarpus* and five in *Quercus*.

Notes on Chinese Sterculiaceae. By Woon-Young Chun and Hsiang-Hao Hsue. *Jour. Arnold Arb.* 28: 3: 328-330; July 1947.

Included are descriptions of two new species in *Sterculia* and two in *Reevesia*.

***Kajewskiella*, a new rubiaceous genus from the Solomon Islands.** By E. D. Merrill and L. M. Perry. *Jour. Arnold Arb.* 28: 3: 331-332; 1 plate; July 1947.

The new genus is represented by plants reaching five meters in height.

On the anatomy of *Cynometroxylon indicum* gen. et sp. nov., a fossil dicotyledonous wood from Nailalung, Assam. By K. A. Chowdhury and S. S. Ghosh. Reprint from *Proc. Nat. Inst. Sci. India* 12: 8: 435-447; 15 figs.; 1946.

The anatomy of the fossil specimen is described in detail. Using the wood parenchyma pattern as a basis 40 genera of 16 families of living Dicotyledons are selected for comparison. All were eliminated through detailed comparisons except *Cynometra* (in part). Described fossil woods were also eliminated on the same basis.

Note: The authors report identification of wood artifacts and fruit shells from Arikamedu excavations in *Ancient India* No. 2, 102-108.

Regional keys for the identification of important timbers used in military areas of inspection. Parts I, II, III. By K. Ahmad Chowdhury. *Indian Forest Records* n.s. (Forest Research Inst., Dehra Dun) 3: 7: 1-67; 57 plates; 1945. Price Rs 5/12/—.

A brief discussion of wood structure and the methods for identification of timbers is followed by hand lens keys for the identification of woods from various districts. Short descriptions of the timbers are followed by photomicrographs of cross-sections.

The afforestation of dry and arid areas. By R. L. Badhwar, A. C. Dey and A. L. Griffith. Indian Forest (Dehra Dun) Bul. No. 133; 1946. Pp. 55; 2 maps.

There are listed 250 species of trees, shrubs, herbs and grasses with recommendations for planting, and description of their habitat, distribution and uses.

A decade of silvicultural research in Ceylon, 1937-1946. By C. H. Holmes. Pub. by Ceylon Gov. Press, Colombo, 1947. Pp. 7.

A brief summary of accomplishments and status prepared for the British Empire Forestry Conference (1947).

Badania nad drewnem brazylijskiego (*Araucaria Brasiliana Lamb.*) i peroby rózowej (*Aspidosperma polyneuron* Muell. Arg.) . . . By Julian Rafalski and Stanislaw Stryla. Reprint from *Odbitka z Roczników Nauk Rolniczych i Lesnych.* 65: 229-264; 8 figs.; 1939.

This contribution from the Institute of Forest Engineering, University of Poznan, Poland, is an account of the timbers of Paraná Pine and Peroba Rosa. Results of the extensive mechanical tests are detailed. (In Polish.)

Pewne wlasnosci fizyczne i mechaniczne drewa niektórych gatunków peruwianskich. By JULIAN RAFALSKI. Reprint from *Odbitka z Rocznikow Nauk Rolniczych i Lesnych* 46: 219-228; 1939.

"Certain physical and mechanical properties of some Peruvian woods" is a contribution of the Institute of Forest Engineering, University of Poznan, Poland. Results of tests on 20 woods, mostly identified by common names, include specific gravity, compressive strength parallel to grain, and Brinell hardness.—N. V. POLETIKA.

Nomenclature of commercial timbers. British Standards Inst. (28 Victoria St., London, S.W. 1) B. S. 881: Hardwoods & B.S. 589 Softwoods; 1946. Pp. 102. Price 7/6.

For each of 254 hardwood timbers and 70 softwood timbers are listed the standard name, botanical species, sources of supply, remarks, and other commercial or botanical names. A list of authors of botanical names and their abbreviations and an index are included.

An introduction to the forests of central and southern Ethiopia. By W. E. M. LOGAN. Imperial Forestry Inst. (Oxford) Paper No. 24; 1946. Pp. 68; 1 map. Price 4 s. 0 d.

In the first part the environment is discussed with respect to topography, climate, geology, soils, and mankind. Following this are descriptions of the forests arranged according to types and associations. Included is a discussion of the utilization and products. The third part discusses the forestry problem. Tables give details of climate, the principal species, and a list of sawmills. A map shows the existing forests and vegetation types.

"The principal species at present exploited consist of Cedar *(Juniperus procera)*, Podo *(Podocarpus* spp.), Sombo *(Ekebergia rueppelliana)*, Olive *(Olea* spp.), Chellalaka *(Apodytes acutifolia)*, Tukur Incet *(Pygeum africanum)*, Amalaka *(Celtis kraussiana)* and Badessa *(Syzygium guineense)*; of these Cedar and Podo are by far the most widely used."

Report for the years 1939-1945. Department of Forests, Palestine (Jerusalem) No. 4; 1947. Pp. 32; folded map.

Included in the report is a "list of protected trees under forest ordinance":

NAMES OF PROTECTED TREES	ENGLISH AND COMMON NAMES	ARABIC NAME	HEBREW NAME
Olive (Olea europea)	Olive	Zaytun	Zayith eropi
Carob (Ceratonia siliqua)	St. Johns bread	Kharrub	Haruv
All spp. oak (Quercus)	Oak	Ballut, Sindian, Abbas	Alon
All spp. pistachia (Pistachia)	Pistachia	Saris, Mastic, Butm	Ela
All spp. pine (Pinus)	Aleppo Pine	Hab-kraish, Snobar	Oren
All spp. tamarisk (Tamarix)	Tamarisk	Athl, Tarfa	Eshel
All spp. arbutus (Arbutus)	Strawberry tree	Kaikab	Katlab
All spp. sage (Salvia)	Sage	Miriamyah	Marva
All spp. rock-rose (Cistus)	Rock-Rose	Ghubrah	Lotem
Judas tree (Cercis siliquastrum)	Judas tree, Red-bud	Zemsarik	Klil Hahoresh
Storax (Styrax officinalis)	Storax	Abhar, Libna	Livna Refui
Phillyrea (Phillyrea media)	Lance-leaved tree	Barza	Bar-zayith
All spp. zizyphus (Zizyphus)	Christ-thorn	Sidr	Sheizaf
All spp. poplar (Populus)	Poplar	Hor	Tzaftzefa
All sp. willow (Salix)	Willow	Sufsaf	Arava
All spp. acacia (Acacia)	Wattle	Anbar, Sayal, Haras	Shita
All spp. eucalyptus (Eucalyptus)	Gum tree	Kina	Eucalyptus
All spp. casuarina (Casuarina)	Australian oak	Kasvarina	Casuarina
Silky-Oak (Grevillea robusta)	Silky Oak	Grevillea	Grevillea Hasuna
Prosopis stephaniana	Prickly shrubby	Yanbut, Akal	Kalis sadeh
Poterium spinosum	Syrian Christ thorn	Billan, Natsh	Sira korzanit
Zizyphus spina Christi	Lotus	Sidr	Sheizaf matzui
Zizyphus lotus	White broom	Dom	Sheizaf Hasiah
Retama roetam	Cypress	Ratam	Rotem Hamidbar
All spp. cypress (Cupressus)	Bay-tree, Laurel	Seru	Brosh
All spp. laurel (Laurus)		Ghar	Ar

West African timbers. By GILBERT R. KEEN. *Wood* (London) 12: 6: 172-176; 4 figs.; June 1947.

Four kinds of Sapele *(Entandrophragma)* are described on the basis of their foliage, timber, and wood structure as visible with the aid of a hand lens. Photomicrographs of the cross-sections and line drawings of the leaves and seed pods are presented.

Le Limba dans la fabrication des hélices d'avion. By G. H. STARK. *Bul. Comptoir Vente Bois Congolaise* (Brussels) 13: 3-4; 1 fig.; August 1947.

During the war Limba *(Terminalia superba)* was used for many purposes, one of them being for airplane propellers. The South African Air Force sought a substitute for the Honduras Mahogany previously used and after many trials selected Limba. Several thousand propellers have been made and proven satisfactory.—M. RECORD.

L'aménagement des forêts du Mayumbe. By NOEL HART. *Bul. Comptoir Vente Bois Congolaise* (Brussels) 12: 2-4; July 1947.

Mayumbe has become so important from a forestry point of view in the past 15 years that a special chapter must be devoted to it. Mayumbe furnished 80% of the Congo forest exportation before the war and 75% of the total production consisted of Limba. This development is due not only to its privileged geographic position but especially to its stands of Limba and their density.

Included is a review of an article by P. Humblet *(Bul. Agr. du Congo Belge* 37: 1; 1946) entitled "L'aménagement des forêts climatiques tropicales au Mayumbe."—M. RECORD.

Notes on East African timbers. Timber Development Assoc. (London) Ref. No. 28. 1947. Pp. 7.

A brief description of the wood and its uses is given for each of 37 East African timbers. "East Africa" includes Kenya, Rhodesia, Tanganyika, Uganda, Nyasaland, and Mozambique.

Annual report of the Forest Department. Pub. by Uganda Protectorate (Entebbe), 1947. Pp. 25; 1 folded map.

"Timber supplies have been greatly reduced by wartime exploitation. Muvule *(Chlorophora)* is a dwindling asset even under the most careful rationing. Mahogany is reduced to a level which prohibits its use for all but the finest work and timber for general purposes is by no means abundant. Exploitation outside the *Chlorophora* savannas is confined to some 500 sq. miles in the regions of Lake Victoria and Lake Albert. The forests of the western perimeter are too distant to make working, except for local demands, an economic proposition at present. Without these, and anticipating the exhaustion of privately-owned forests. Uganda cannot reckon on more than 700,000 cubic feet of timber a year, which is slightly more than the average output of the five pre-war years but little enough at the present rate of industrial development and African progress."

L'exploitation forestiére au Congo Belge. By FERDINAND JASSOGNE. J. & A. Janssens, Bruxelles, 1945. Pp. 192; illus.; 7 folded maps.

In this presentation on the forests and timbers of the Belgian Congo particular emphasis is placed upon methods of exploitation including organization, transportation, methods of cutting, laws and civil controls, as well as the properties and values of the timbers. A tabular comparison of properties and general descriptions of the important species are included. Seven folded maps show the forest areas of each province.

Timber exploitation in the Gold Coast. By W. E. M. LOGAN. *Empire Forestry Rev.* 26: 1: 30-53; 10 figs.; 1947.

"Gold Coast timber exploitation is concentrated in the evergreen, moist and dry deciduous types of forest which together comprise the rain forest. Of the many species occurring therein only about twenty are currently exploited to any extent. The stocking of these latter is very variable,

but for practical purposes may be taken as averaging about 80-200 cubic feet of mature merchantable timber per acre in the evergreen and dry deciduous types and from 200-400 cubic feet per acre in the moist deciduous forest. In terms of sustained outturn, these stockings correspond to 4-10 cubic feet per acre per annum in the first two types and from 10-20 cubic feet per acre per annum in the moist deciduous forest.

"Demands for timber amount to about 5,250,000 cubic feet annually, of which just over half is exported. Exports are 95 per cent Mahogany, mostly in the log. The United States and the United Kingdom together absorb over 90 per cent of Gold Coast timber exports."—*From summary*.

Informal notes on forestry in Nigeria. By F. S. COLLIER. *Farm and Forest* (Ibadan, Nigeria) 7: 2: 128-133; 1946.

The writer of this article states that the "encroachment of the Sahara" is a phenomenon which has been greatly overworked by many foresters. The southern limit of the desert has fluctuated tremendously in geological time but "the changes . . . are imperceptible to any one civilization and can hardly be altered by man." In fact there is evidence to indicate that the desert once extended south of its present limits. A broad belt of savannah vegetation lies between the true desert and most of Nigeria. The seasonal fluctuation of the northern limit of the southeasterly trade-winds causes an impressive variation in the condition of the vegetation of this belt.

"Man's destruction of vegetation alters the appearance of a locality but does not necessarily destroy its potentiality, which is decided in general by the main climatic factors." The population of the Sahara has decreased because of the abandonment of old caravan routes in favor of transportation by sea.

Establishment of satisfactory forestry policies will be greatly advanced by the introduction of more efficient and settled agricultural practises which require less area for necessary food production. Diameter limit cutting in the rain forests is not consistent with adequate silviculture. Provision must also be made for the reduction of useless middle story vegetation to allow the healthy development of the abundant natural regeneration of good species.—D. M. SMITH.

Classification des Apocynacées, III, genre *Ochrosia*. By M. PICHON. *Bul. Mus. Hist. Nat.* (Paris) 19: 2: 205-212; March 1947.

To correct the present disorder in the systematic arrangement of the genus *Ochrosia* this author recognizes three sections: *Lactaria* F. Muell. and *Echinocaryon* F. Muell each with at least 16 species separated into three series, and *Phragmochrosia* **nov.** with one species. *Ochrosia confusa* (Sect. *Echinocaryon)* is described as new.—M. RECORD.

Classification des Apocynacées II, genre "Rauvolfia". By MARCEL PICHON. *Bul. Soc. Bot. France* (Paris) 94: 1 & 2: 31-39; 1947.

A complete classification of the genus *Rauwolfia* is presented. Fourteen sections are described and a key for their separation given. Three new species are described.—M. RECORD.

A conspectus of the genus *Cunuria*. By J. T. BALDWIN, JR. and RICHARD EVANS SCHULTES. *Bot. Mus. Leaflets* (Harvard, Cambridge) 12: 10: 325-351; 6 plates, 1 fig.; July 1947.

"As now known and interpreted, Cunuria comprises four species and one variety. Two species are established in the present paper, and one concept, recently described as a species, is here reduced to varietal rank."

Studies in the genus *Hevea* I. By RICHARD EVANS SCHULTES. *Bot. Mus. Leaflets* 13: 1: 1-15; September 1947.

Two studies are presented: "I. The differentiation of *Hevea microphylla* and *H. minor*." "II. New interpretation of *Hevea nitida* and its variety."

Notes on new and noteworthy plants. II. By HAROLD N. MOLDENKE. *Phytologia* (N. Y. Bot. Gard.) 2: 8: 306-324; June 1947.

Among the news species and varieties described is the tree *Aegiphila farinosa* Moldenke sp. nov.

The water conducting capacity and growth habits of *Juniperus horizontalis* Moench and *Juniperus virginiana* L. By CAL G. BIFOSS. *Ecology* 28: 3: 281-289; 5 figs.; July 1947.

The series of tests on the water conductivity and measurements of the tracheids of *Juniperus horizontalis* and *J. virginiana* showed no significant difference between the specific conductivities when taken from similar habitats. Specific water conductivity was low for both species. Mean tracheid lengths were 0.77 mm. and 0.75 mm. respectively.

The systematic anatomy of the vegetative organs of the Angiosperms. By C. R. METCALFE. Reprint from *Biol. Rev.* (Great Britain) 21: 159-172; 1 fig.; 1946.

"The practical value of systematic anatomy cannot be fully assessed until much more descriptive work has been done. It is known that the method is of definite value in the interpretation of genera, and that it often affords evidence concerning the interrelationships of families. It is of less value in the interpretation of species and taxonomic units of still lower rank. Systematic anatomy is of economic importance, since it enable timbers, fibers, crude drugs and similar botanical material to be identified even when floral characters are lacking. The approximate affinities of sterile herbarium specimens may also be established by this method. A more complete knowledge of the systematic anatomy of present-day plants would be of assistance to paleobotanists.

"Recent studies have shown how graded series of anatomical features in the secondary xylem of the dicotyledons and in the metaxylem of the vascular bundles of the monocotyledons can be used to indicate probable phylogenetic sequences. There are difficulties in comparing woody plants and herbs from this point of view owing to the small amount of secondary xylem in the latter. This fact sets a limit to the value of phylogenetic studies which are based on wood structure alone.

"The basis of taxonomy is being broadened at the present time, and there seem to be reasonable prospects that, in the future, the facts of systematic anatomy, together with those of cytology, embryology, genetics and other branches of botany, will play an important part by helping to give a deeper significance to systems of classifications than they have done in the past."—*From author's summary.*

Wood anatomy of New Zealand *Dacrydium* species. By H. R. ORMAN and J. S. REID. *New Zealand Journ. For.* (Palmerston, North, N. Z.) 5: 3: 215-219; 6 figs.; 1946.

The anatomy of the six species is discussed and two keys, one in detail and one in outline form, are presented.

A comparative study of the structure and chemical composition of tension wood and normal wood in beech (*Fagus sylvatica* L.). By K. Y. CHOW. *Forestry* 20: 62-77; 2 plates; 1946.

"1. The anatomical structure and chemical composition of tension wood and normal wood in beech (*Fagus sylvatica* L.) are compared.

"2. The staining reactions of the two types of wood are described. Chlor-zinc-iodine is a useful reagent for distinguishing tension wood from normal wood under the microscope. It can also be used to detect tension wood by applying it to a clean-cut end-surface, tension wood being stained purplish or reddish-brown and normal wood yellow.

"3. Tension wood has a more compact anatomical structure than normal wood, as shown by the larger proportion of fibers, the greater thickness of the fiber walls, the smaller size and smaller number of vessels per unit area, and the smaller proportion of vessels.

"4. Tension-wood fibers are characterized by short, discontinuous spiral markings in the walls, which are here described for the first time. They are considered to be *incipient tension failures*, resulting from mechanical forces acting on the wood of the standing tree.

"5. The findings of previous investigations, that tension wood has a higher specific gravity and a greater longitudinal shrinkage than normal wood, are confirmed.

"6. Tension wood has a higher ash content, a higher solubility in water, and a lower solubility in 1 per cent sodium hydroxide than normal wood.

"7. It is confirmed by chemical analysis that tension wood is highly lignified and has a higher cellulose content and lower pentosan content than normal wood. It is further indicated that the cellulose in tension wood is of longer average molecular chain length than the cellulose in normal wood.

"8. Evidence is given to support the view that the cellulose chain molecules in untreated tension-wood fibers, as opposed to untreated normal wood fibers, are relatively more highly orientated in the direction of the long axis of the fibers and therefore of the long axis of the tree itself. On this account tension wood should be inherently stronger in tension than normal wood. That no marked difference in tensile strength is in fact observed is explained by the incipent tension failures in tension wood as revealed by the characteristic markings on the fiber walls.

"9. The abnormal longitudinal shrinkage exhibited by tension wood on drying below the fiber saturation point is not, as hitherto supposed, associated with the angle of inclination of the cellulose fibrils in the wood cell-walls. It is most probably associated with the marking in the walls of tension-wood fibers. These markings are regarded as minute, transverse cracks indicative of a stretched condition in green tension wood. The closing of innumerable cracks of this type and disposition during drying of tension wood accounts, in large measure, for the well-known abnormal longitudinal shrinkage."—*Author's summary.*

The structure of wood. By H. E. Desch. *Wood* (London) 12: 4: 110-114; 12 figs.; April 1947.

This is the second article of this well-illustrated series and deals with the anatomy of hardwoods.

The structure of wood. By H. E. Desch. *Wood* (London) 12: 5: 140-143; 14 figs.; May 1947.

This is part three of a series and deals with parenchyma, rays, ripple marks and gum ducts in hardwoods. The brief semi-technical discussions are illustrated with photomicrographs.

A propos de liquides mucilagineux intracellulaires. By E. de Wildeman. Reprint from *Bul. Classe des Sciences*, Académie Royale de Belgique (Brussels). Series 5: 32: 100-116; 1947.

The author discusses the properties of these liquids and gives genera known or believed to contain them. These are found in the following families: Amaryllidaceae, Araceae, Commelinaceae, Dioscoreaceae, Iridaceae, Liliaceae, Orchidaceae, and Zingiberaceae.

Aluminium in trees. By E. M. Chenery. *Empire Forestry Rev.* (London) 25: 2: 255-256; 1946.

The determination of the presence of aluminum in the wood of various species (particularly *Mouriria marshalli* Burtt-Davy and Sandwith) is discussed.

"Since the original literature on this subject is rather obscure it might be of interest to mention here all the woody genera that have been recorded as aluminium accumulators. These are: *Orites, Kibara, Camellia, Eurya, Schima, Stewartia, Melastoma, Platycentrum, Leandra, Meriania, Clonostegia, Heterotrichum, Mecranium, Henriettea, Necrameum, Memecylon, Aporosa, Baccaurea, Hicoria, Cornus, Symplocos, Diclidanthera, Coussarea, Rudgea, Chasalia, Saprosma* and *Palicourea* . . . *Erisma, Vochysia* and *Qualea* . . . *Tococa, Maieta, Adelobotrys, Osbeckia* and *Craterispermum.*"

What is mahogany. By Geo. N. Lamb. *Veneers and Plywood* (Indianapolis) 41: 5: 30, 32, 33; May 1947.

The use of the name Mahogany for woods other than *Swietenia* and *Khaya* is discussed. Some of the difficulties arising from this practice are outlined.

Produits des Chênes. By Aimée Camus. *Rev. Bot. App. & d'Agr. Tropicale* 25: 275 & 276: 24-37; 1945.

This is a brief discussion of the Oaks *(Quercus* and *Lithocarpus)* and their products, including tanning materials, fruits, cork, therapeutics, alcohol, truffle-grounds, and silk worm food.

A propos des branches d'*Araucaria brasiliana* et des nœuds: leur utilisation. By M. Guinier. *Rev. Bot. App. & d'Agr. Tropicale* 20: 225-226-227; 343-345; 1940.

This is a discussion of the "red wood" in conifers with particular reference to branches. In the State of Parana the wood from the "crowns" (knot whorls) of *Araucaria* is used to make novelties whose attractiveness is enhanced by the translucent red wood of the knots.

Plybamboo. By C. F. Yee, C. H. Lo, and C. B. Hwang. Bureau Aeronautical Research (China) Tech. Rep. No. 26, September 1945. Pp. 52; illustrated. In Chinese.

Plybamboo is made from thin veneers of woven bamboo strips. The strips are cut from the outer 30 per cent of the stem and are usually about 4 mm. wide and 0.5 mm. thick. Two-ply plybamboo with half the strips at right angles to the applied force was found to have one-half the tensile strength of solid bamboo. The inclusion of nodes was found to reduce the tensile strength about 19 per cent from the average mean value of 67,500 lb. per sq. in.

Complete mechanical test data are presented and the results of many grain directions and types of weaving given.—Ying-Pe Chang.

Properties of szuchu (*Sinocalamus affinis* MacClure) grown in Szechuan. By C. F. Yee and L. G. Shen. Bureau Aeronautical Research (China) Tech. Rep. No. 27, January 1946. In Chinese.

Specific gravity, moisture content, tensile strength, and modulus of elasticity were determined for the species in relation to vertical and radial position in the stem. The influence of the concentration of vascular bundles upon strength was also determined.

Specific gravity is proportional to the height and also to the distance outward from the axis to the epidermis; average specific gravity of internode, 1.04. The greatest strength was in the outer 10 per cent of the stem; strength in the internode portion is greater than the node; minimum variation in strength is found in the region 2 to 6 meters above the ground. The strength was greater in specimens assembled from glued layers cut in a tangential plane than specimens made from radially cut specimens.

The average tensile strength of the internode (based upon tangentially cut material) was 2730 kg/cm^2; modulus of elasticity, 2.6 x 10^5 kg./cm^2. The tensile strength of the outer 10 per cent of the internode was 4520 kg./cm^2.—Ying-Pe Chang.

Le gemmage des pins en Indochine. By P. Maurand. *Rev. Internat. Bois* (Paris) No. 118: 75-82; April 1947 and No.s 120 & 121: 123-133; June-July 1947.

The naval stores industry and products as applied to *Pinus Merkusii* in Indochina are discussed in detail. The physical and mechanical properties of the two-leaved pines are listed.

L'utilisation de bois tropicaux dans l'industrie des pâtes a papier. *Rev. Internat. Bois* No.s 120 & 121: 135-138; June-July 1947.

Twenty species of wood are tested and listed according to their relative suitability for package paper and printing paper. A table of fiber dimensions is included.

Das kolonialforstliche Wirtschaftsziel. By MAX SCHLUTER. *Mitt. Forstwirt Forstwiss.* (Hannover, Ger.) 12: 1: 1-24; 10 figs.; 1941.

A discussion of the various methods of management and exploitation practiced in tropical forests and the relative advantages and disadvantages of each.

World rubber production and trade. By C. A. GEHLSEN. International Inst. Agri. (Rome) Report No. 7; 1940. Pp. 191; 6 maps.

The economical and the technical aspects of both rubber business and rubber production are treated in detail in this monograph.

The tung oil trees (*Aleurites*) and the tung oil industry throughout the world. International Inst. Agri.; 1938. Pp. 237; 3 maps.

Species, cultivation, technical phases of processing, and the tung oil business are discussed in considerable detail. An extensive bibliography is included.

The waiting forest resources of the American tropics. By ARTHUR KOEHLER. *Jour. N. Y. Bot. Gard.* 48: 567: 67-70; March 1947.

To solve the problem of effective utilization of the large numbers of tropical timbers the author recommends research to determine the technical properties of the woods and methods of overcoming objectionable features that any may have. Concomitant with this a detailed survey of the availbale resources is advised.

Exploitation of tropical forests and the problem of secondary species. By ALEX. RULE. *Empire Forestry Rev.* (London) 26: 1: 83-86; 1947.

The problems of tropical forest exploitation are discussed and some of the bad practices noted. Recommendations for improved methods and summaries of probable developments are given.