THE WOODS OF LIBERIA

October 1959

No. 2159

FOREST PRODUCTS LABORATORY
MADISON 5, WISCONSIN

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
In Cooperation with the University of Wisconsin

THE WOODS OF LIBERIA[1]

By

JEANNETTE M. KRYN, Botanist
and
E. W. FOBES, Forester

Forest Products Laboratory,[2] Forest Service
U. S. Department of Agriculture

- - - -

Introduction

The forests of Liberia represent a valuable resource to that country--especially so because they are renewable. Under good management, these forests will continue to supply mankind with products long after mined resources are exhausted. The vast treeless areas elsewhere in Africa give added emphasis to the economic significance of the forests of Liberia and its neighboring countries in West Africa.

The mature forests of Liberia are composed entirely of broadleaf or hardwood tree species. These forests probably covered more than 90 percent of the country in the past, but only about one-third is now covered with them. Another one-third is covered with young forests or reproduction referred to as low bush.

The mature, or "high," forests are typical of tropical evergreen or rain forests where rainfall exceeds 60 inches per year without prolonged dry periods. Certain species of trees in these forests, such as the cotton tree, are deciduous even when growing in the coastal area of heaviest rainfall, which averages about 190 inches per year. Deciduous species become more prevalent as the rainfall decreases in the interior, where the driest areas average about 70 inches per year.

---

[1]The information here reported was prepared in cooperation with the International Cooperation Administration.

[2]Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

In scattered sections of the Western and Central provinces where shallow soils overlie solid rock, there are forest areas that have the characteristics and species associated with the fringe or savannah forests in other parts of Africa. These fringe-forest conditions are also brought about in some areas by cutting, burning, and shifting agricultural practices. With the exception of small areas, however, Liberia has no true savannah or park forests where trees and grass are interspersed.

Occurrence of tree species is closely associated with rainfall, sunshine, and soil. Both the total. annual amount and distribution of rainfall influence tree species distribution. Amount and intensity of sunshine are much less in the Eastern province than in the Western province and accounts in part for differences in forest composition. Swampy soils and shallow soils that tend to dry out quickly also affect species distribution. All of these conditions exist in Liberia in varying degrees and create favorable ecological conditions for the large number of species that occur.

In order to make the best use of these forests, it is necessary to know the trees. Each family, genus, or species of tree produces wood that has characteristic properties and uses. Some yield timbers large and strong enough for beams in a temple, while others have machining and finishing properties suitable for fine furniture, Scientific investigation is the most efficient way to determine these characteristics.

Scientists from a number of countries have studied the trees of Liberia and West Africa. The results of their work, however, appear in a number of publications and in several languages. This report is a compilation of data from all available sources. It represents considerable research in locating, translating, and, wherever possible, converting data to a common base. All species collected in Liberia are included, together with some, from adjacent areas, which are probably in Liberia but not yet reported.

While this report contains considerable data on a few species, there is definite need for additional data on most species. Forest inventory work will show which are the dominant and common species. Such information, coupled with that in this report, will indicate a logical priority for additional scientific investigations. Resulting programs should lead to the orderly development and use of Liberia's forests.

The species described in this report are taken up in alphabetical order by genus. Where common names exist, they are listed next, followed by the family name.

Shaded area on the map of Liberia shows the extent of the forests.

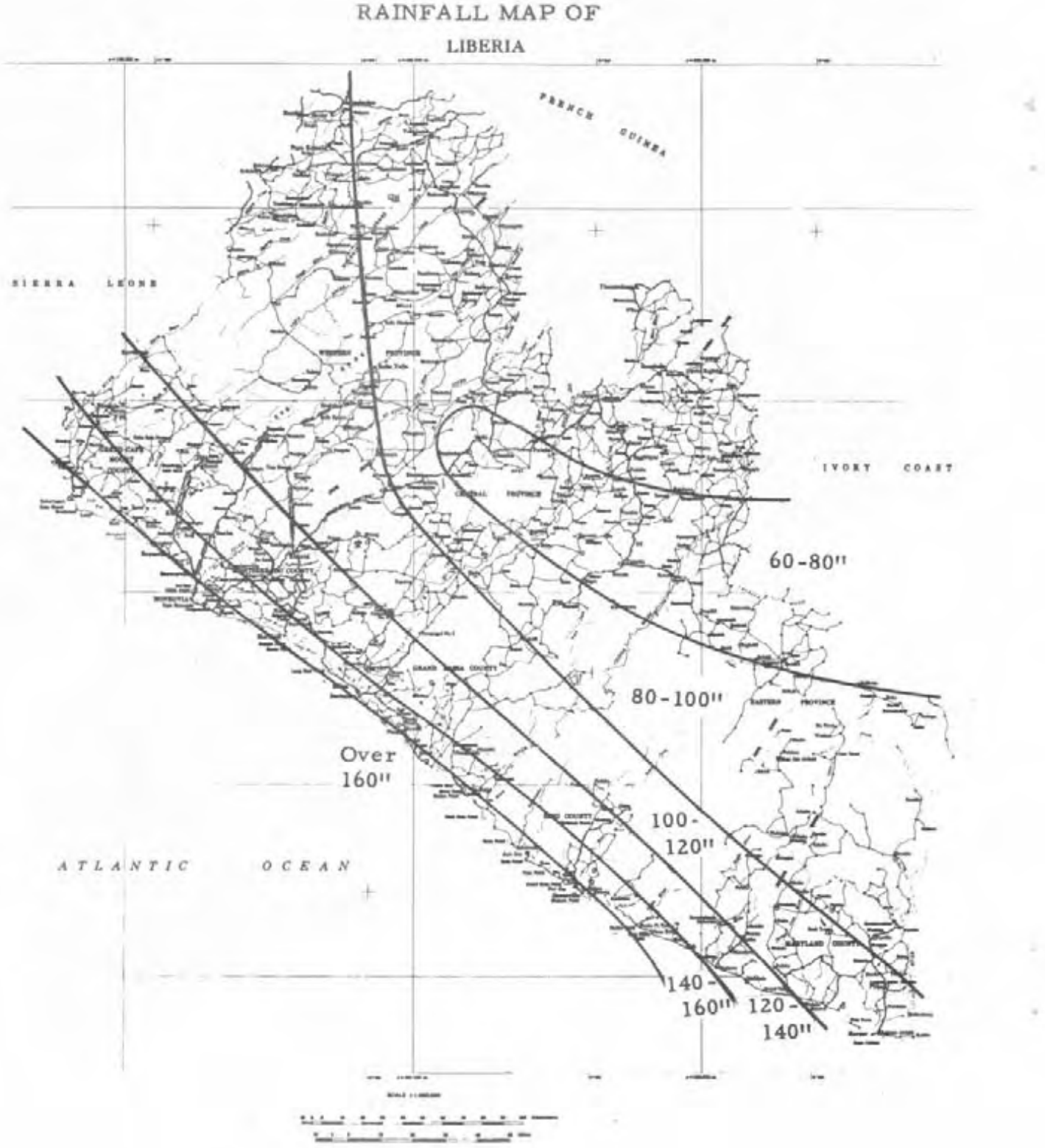
ZM 115 852

Intermixed deciduous and evergreen trees in the rain forests of Liberia.

ZM 115 856

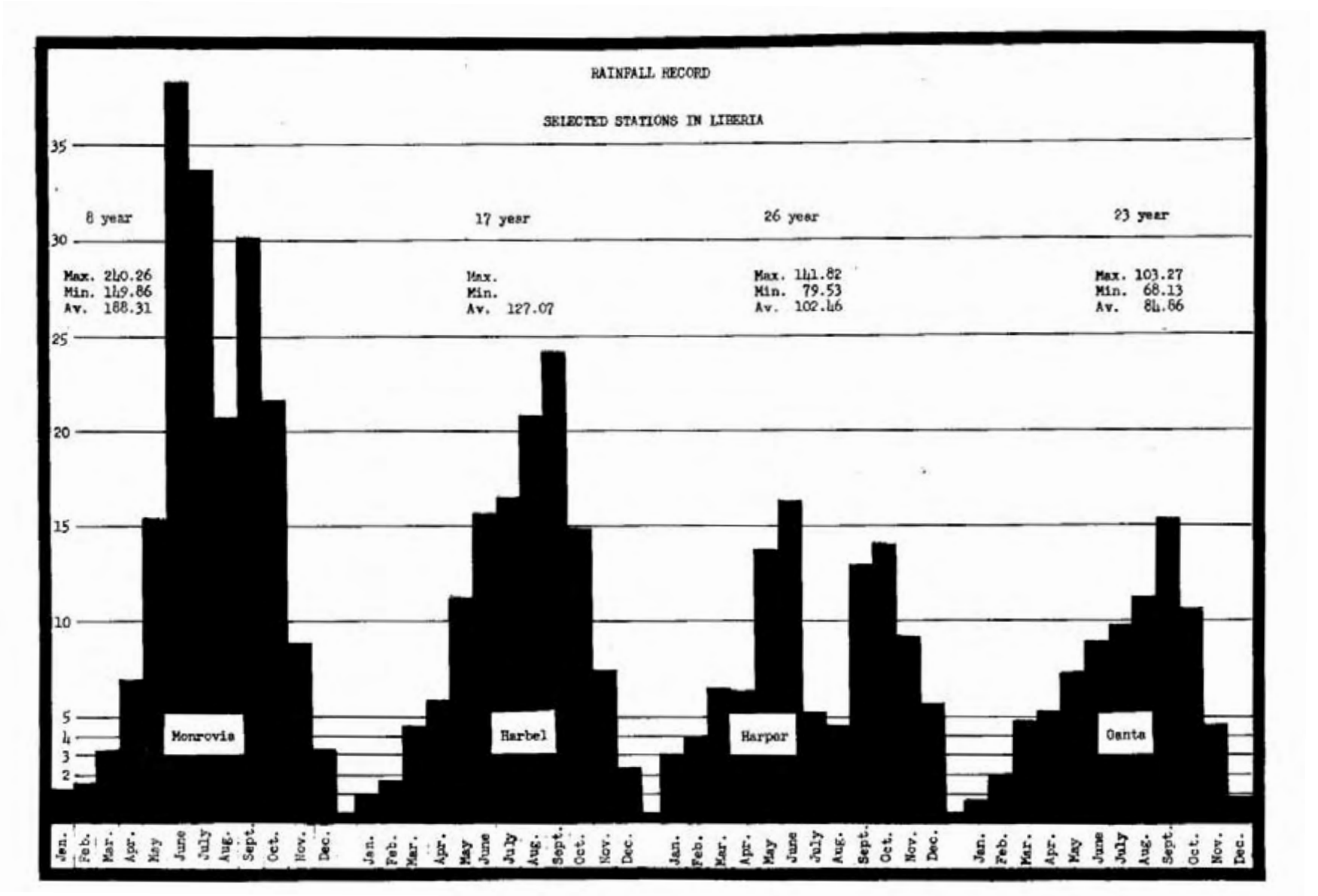
National Forests of Liberia.

ZM 115 853



Approximate rainfall zones as determined from limited records.

ZM 115 851



M 109 247

Rainfall distribution at selected stations, Ganta (Ghanpa) in the interior, and Monrovia, Harbel, and Harper along the coast.

Recently abandoned farmland in the foreground with low bush and high forest respectively in the background.

ZM 115 857

Acioa barteri (Hook f. ex Oliv) Engl.
Acioa scabrifolia Hua.
Monkey-fruit
Family: Rosaceae

Both species of monkey-fruit are of common occurrence. The trees are 40 to 60 feet tall and usually of small diameter, 6 to 10 inches. They grow in the high forest areas of Gamu-St. John in Liberia as well as in the Ivory Coast (14, 25, 29).[3]

The heartwood is various shades of light to reddish brown. The rather wide sapwood is light colored and not sharply distinct from the heartwood, which sometimes has narrow, dark streaks. The wood is medium fine to coarse in texture, and hard.

Identifying Features

Growth rings are absent or indistinct. The tangential diameter of the largest pores is less than 200 microns. The average number of pores per square millimeter is often more than 5. Parenchyma forms fine, irregular, concentric bands 1 to 3 cells wide. The rays are numerous, very fine, and sometimes aggregated to form broad, high, oak-like rays. The aggregate rays, however, apparently are not a truly distinctive character of the genus.

Adansonia digitata L.
Baobab
Monkey-bread
Family: Bombacaceae

The baobab tree is common all over West Africa, in the savannah forest and open country. Trees grow rapidly and have huge trunks, often with a peculiar basal swelling.

The wood weighs 18 to 24 pounds per cubic foot, averaging 20 pounds, when air-dried to 10 percent moisture content. Green timber averages 60 pounds per cubic foot (33).

---

[3]Underlined numbers in parentheses refer to Literature Cited at the end of the text.

The wood is much too soft for structural timber of any kind. It was investigated as a source of paper pulp about 40 years ago and seemed satisfactory, but it was expensive to remove from the forest, and later its use for that purpose was stopped because of too rapid destruction of the trees (1).

Afzelia africana Smith
A. bella Harms var. gracilior Keay
Doussié
Afzelia

Family: Leguminosae - Caesalpiniaceae

Afzelia africana is a transition species found between the savannah forest of dry areas and the dense forests of humid regions in West Africa. In densely forested areas with a more or less pronounced dry season, A. bella is present (29).

A. africana attains its greatest size in the moist, deciduous forest in Liberia. It has a height of 40 to 60 feet and a diameter of 3 feet. The crown is wide with numerous branches, and the bole is relatively short and rarely straight (6).

A. bella var. gracilior is a taller tree, usually 70 to 80 feet high and sometimes up to 125 feet high. It is 2 to 3 feet in diameter. This species also has a heavy crown of many gnarled branches. Buttresses may be absent or heavy and up to 4 feet high (14).

Both species of Afzelia have wood of very similar appearance. The freshly cut heartwood is light brown, but it becomes reddish brown to dark reddish brown after exposure. The sapwood is 1 to 2 inches wide, straw colored, and distinct from the heartwood. It is often gray because of fungus stain. The luster of the wood is low, the grain is straight to moderately interlocked, and the texture is coarse, but even.

The specific gravity of A. africana ranges from 0.52 to 0.71, based on the ovendry weight and the volume of the green wood. The wood is hard and moderately heavy, weighing 40 to 55 pounds per cubic foot when air dried to 12 percent moisture content (13, 32). Results of tests of mechanical properties conducted at the French Centre Technique Forestier Tropical are included in table 1. Some samples of Afzelia are rated moderately good for bending purposes, but others are rated poor.

The volumetric shrinkage of A. africana from the green to the oven-dry condition averages 8.5 percent of the green volume (32). The wood has good dimensional stability (6).

The British Forest Products Research Laboratory reports that Afzelia species, including A. africana, can be kiln-dried satisfactorily, but slowly, from the green condition. Degrade probably will not he severe, but extension of existing shakes and fine checking may occur. Kiln schedule E of that Laboratory (table 6) has been recommended (6).

The heartwood of A. africana is rated very decay resistant and is reported to be resistant to termites. The sapwood is subject to stain by fungi and is low in decay resistance. The heartwood of several species of Afzelia proved very resistant to preservative treatment; the sapwood was moderately resistant (6, 13).

A. africana is rather difficult to work because of its toughness and a tendency of the wood to pick up in planing. Machining produces an irritating dust. The yellow or white deposits present in some groups of pores may make it difficult to obtain a uniform stain (6, 13).

Afzelia africana is a durable general-utility timber used locally for indoor and outdoor construction, railway ties, and cabinetmaking. The wood is suitable for solid doors, stair treads, parquet flooring, and general joinery (13). The presence of the yellow dye deposit in some of the pores of the wood rules out its use for drain boards, laundry equipment, or any articles likely to come into contact with wet fabrics (6).

Identifying Features

The growth rings usually are visible without a lens because of the presence of concentric bands of marginal parenchyma. The wood is diffuse-porous with moderate to large pores distinct without a lens. They are uniformly distributed, singly or in radial groups of two or three pores. Yellow or white solid deposits sometimes are abundant in the pores. Marginal parenchyma occurs in narrow bands, and large diamond-shaped patches of parenchyma surround the pores. The fine rays are visible with a lens on the cross section. They form short, light-colored lines on the tangential surface. The rays are not storied but may sometimes be in echelon.

Albizzia adianthifolia (Schum.) F. W. Wight
(Syn. A. gummifera (J. F. Gmel.) C. A. Sm. and A. sassa Macbride)
A. ferruginea (Guill and Perr.) Benth.
A. zygia (DC) Macbride
A. lebbek (L.) Benth. (cultivated)
Mepepe
Sifou-sifou
Okuro
Lebbek
Family: Leguminosae - Mimosaceae

The genus Albizzia includes at least 30 species in Africa, but many of these are small trees of the savannah forest. The species of commercial importance in Liberia are: A. adianthifolia, A. ferruginea, and A. zygia. They are chiefly trees of the high forest and occur in Africa from Sierra Leone through central Africa to East Africa and south to Southern Rhodesia. A species native to India, A. lebbek, is cultivated in the drier regions of tropical Africa and is grown in Liberia (6, 29).

The largest tree of the three chief native species is A. ferruginea. It grows to 120 feet in height and 3 feet in diameter, with a clear bole of 30 to 40 feet. A. adianthifolia is common in the secondary forest and is a smaller tree. The bole is indented and twisted. A. zygia is a tree of medium size to 90 feet in height and 3 feet in diameter. It is usually heavily buttressed, but the bole form is good. A. lebbek varies greatly in height in its native India and may be 60 to 100 feet high with diameters between 2 and 3-1/2 feet. Clear boles may be 20 to 30 feet long (6).

The wood of each species of Albizzia is more or less distinct on the basis of weight and color, but there is sufficient overlapping to make identification to species difficult when the wood samples are small. In A. ferruginea the heartwood varies from medium brown to dark chocolate brown. It is distinct from the yellowish white sapwood, which may be 2 inches wide. The grain is decidedly interlocked and often irregular. The texture is coarse. A. adianthifolia has similar sapwood of about the same width, but the heartwood is light gold or light brown, sometimes with a greenish tinge. The grain may be straight or interlocked, and the texture is moderately coarse. In A. zygia the sapwood is white, yellowish white, or gray, and distinct from the pale brown heartwood, which sometimes has a pinkish tinge. The grain may be straight or interlocked. The texture is coarse.

The heartwood of A. lebbek is dark walnut brown, often with irregular darker markings. The sapwood is white to yellowish white, wide, and distinct from the heartwood. The grain is often interlocked. The texture is medium to coarse.

The timber of all the species is moderately hard, but variable in weight. The average specific gravity of A. ferruginea is 0.45, based on its ovendry weight and its volume when green. The average specific gravity of A. adianthifolia ranges from 0.49 to 0.52, with an average of 0.50, based on its ovendry weight and volume when green. The average specific gravity of A. zygia similar to that of A. adianthifolia. A. lebbek cultivated in the French Sudan has a specific gravity of 0.58, based on its ovendry weight and volume when green. Values obtained for certain mechanical properties of species of Albizzia are presented in table 1. Tests carried out on the bending properties of a limited amount of A. ferruginea indicated considerable variation in properties (6).

Tests of a very limited amount of partly air-dried material show that the wood of A. ferruginea seasons with little degrade, but very slowly in thick boards. It has good dimensional stability. The British Forest Products Research Laboratory recommends kiln schedule F in table 7 for drying this wood (6). Shrinkage data for several species of Albizzia are given in table 2.

The heartwood of A. ferruginea is rated very decay resistant, that of the other three species moderately decay resistant. Logs of A. ferruginea are attacked occasionally by ambrosia beetles. The sapwood of converted timber is susceptible to attack by powderpost beetles in Nigeria and possibly in other countries where the timber is used. Tests made in Nigeria indicate that the wood is resistant to termites. The heartwood of A. ferruginea is extremely resistant to preservative treatment, but the sapwood is permeable (6).

The heavier material of A. ferruginea can be worked rather easily with both hand and machine tools and has relatively little effect on cutting edges. Irregular interlocked grain causes tearing in planing. When the correct filler is used, the wood takes stain and polish well. The lighter wood has rather good nailing properties, but the heavier timber tends to split. The fine dust formed in sawing is irritating to the nose (6).

The Liberian species of Albizzia should be useful for joinery and general carpentry.

Identifying Features

The growth rings may vary from indistinct to distinct because of differences in fiber density and color. The pores are solitary or in groups of two or three. They are large and seen distinctly without a lens, but they are not abundant. The parenchyma is moderately abundant. It surrounds the pores and often has confluent winglike extensions at either side. There are also narrow concentric bands of parenchyma at the margins of the growth rings. These rays are not conspicuous and are rather low. They are from one to four or six cells wide. The fibers are rather short.

Allanblackia floribunda Oliv.
(Syn. A. parviflora A. Chev.)
Family: Guttiferae

There are about a half-dozen species of Allanblackia in tropical Africa. A. floribunda is an evergreen tree of the coastal forest area. It may be 75 to 100 feet high and 2-1/2 feet in diamater (14, 19, 30).

The wood is pinkish beige and has little luster. The grain is fairly straight, and the texture is medium to coarse.

The timber is moderately soft and of medium weight. Values obtained for mechanical properties of the wood are presented in table 1. It is easy to work and takes a smooth finish. It will probably hold its place well when manufactured. It does not seem to be resistant to decay (14). No information is available about its seasoning characteristics. Shrinkage data are included in table 2.

Identifying Features

The growth rings are not distinct. The pores are large and appear singly or in radial rows of two or three pores. They are scattered and fewer than 10 per square millimeter. The parenchyma occurs in coarse, concentric bands that form a network with the rays. The rays are in groups of 5 to 10, seriate, and are high. The ray cells are large.

Alstonia congensis Engl.
Emien
Alstonia
Family: Apocynaceae

There are about 30 species of Alstonia in India, Malaya, tropical Australia, and Polynesia. A. congensis is the only important species in Africa. It is abundant in parts of West Africa and is found in Central and East Africa (6, 16). It occurs in the humid forests along the coast from Senegal to the Cameroons, where it is most abundant, and eastward through the Belgian Congo to Uganda.

The tree may reach a height of 130 feet and a diameter of up to 4 feet, but the average diameter is 2 to 2-1/2 feet. Buttresses form early and extend for 20 feet or more up the stem. The bole may be free of branches for 80 feet and is usually cylindrical (6, 16).

Alstonia is uniformly pale yellow or pale buff, with no distinction between sapwood and heartwood. It is sometimes discolored by staining fungi. The texture is fine to medium, and the grain usually is straight. The tangential surface of the wood often has slitlike or lenticular openings, the latex traces, which may be large enough or so abundant that they mar the appearance of the wood. They vary in size, but they are usually about 1/2 inch high and occur fairly regularly at intervals of 1 to 3 feet along the axis.

The wood is light and soft. It weighs about 25 pounds per cubic foot when air-dry, and 36 pounds per cubic foot at 88 percent moisture content. The timber does not seem suitable for steam bending (6, 16). Values obtained for the mechanical properties of the wood are presented in table 1.

Alstonia is easy to season and dries rapidly. Splitting and checking are very slight. A small amount of distortion may occur because the initial moisture content is very high. Shrinkage data for Alstonia are given in table 2. The British Forest Products Research Laboratory recommends its kiln schedule H (table 8). The latex traces contract in drying and may become slitlike open passages through the boards when their contents shrink and solidify (6).

The wood decays readily when attached by fungi under moist conditions. Logs are attacked by ambrosia beetles, and the sapwoodis susceptible to attack by powderpost beetles. The wood has been reported as not

resistant to termites. It should not be used in contact with the ground and should be treated for use where permanence is required in joinery. It readily absorbs preservative (6, 16).

Alstonia can be worked easily with both hand and machine tools. It finishes to a smooth surface, but when interlocked grain is present, quarter-sawn material has a tendency to tear. Tools must be sharp to prevent crumbling when the end grain is worked, for the wood is rather soft. It has good gluing characteristics and takes stains and polishes well. The latex traces, however, mar the appearance of the wood.

Alstonia can be used for rough carpentry work, moldings. core stock for veneers, wooden utensils, matches. and boxmaking. At the present time it is used primarily locally.

Identifying Features

The growth rings are inconspicuous on the end surface. The pores are just within the limit of vision without a lens, sometimes solitary but mostly in radial rows of three to five or more. They are fairly numerous but are evenly distributed. The parenchyma tissue occurs in numerous fine, usually wavy concentric lines not related to the pores, are not uniformly spaced, and are distinct without a lens on a moist end surface. The rays are fine and not distinct without a lens on the end surface; they appear as low flecks, slightly darker than the background, on the radial surface. The latex traces appear on the tangential surface as lenticular or slotlike openings in horizontal rows at intervals of 1 to 3 feet up the stem. The traces are cross sections of radial passages extending from the pith, they are about 4 inches apart in each row and may be from 1/8 to 4 inches high. In dry wood the traces are filled only with shrivelled remains of their original contents. If the tip of the tree has been damaged in growth, the latex traces may be irregularly spaced and very numerous.

Amanoa bracteosa Planch.
Family: Euphorbiaceae

Amanoa bracteosa may reach a height of 65 feet and a diameter of about 16 inches. The heartwood is marbled, rather than regularly veined, with a dark brown color (30).

The pores are not very numerous and are uniformly distributed, mostly in radial rows of two to four. The parenchyma forms a fine network with the rays and is difficult to see clearly. There are long crystalliferous parenchyma strands present. The rays are difficult to see even with magnification. They are uniseriate or biseriate.

A. bracteosa is not now of commercial importance, though the possibilities for its utilization are favorable. (25).

Amphimas pterocarpoides Harms
Family: Leguminosae - Caesalpiniaceae

Amphimas pterocarpoides is a rather frequent tree in the dense, shady forests on the Ivory Coast, and in the transition zone to the forests where there are seasonal changes. It is probably less abundant in Liberia. The tree is nonevergreen, up to 70 feet tall, and has a diameter of 18 to 24 inches. The buttresses are low, and the bole is long and clear (14, 29).

The heartwood is light yellowish brown; the white sapwood is not sharply demarcated from the heartwood. The texture is very coarse, and the grain may be straight or interlocked. The wood has a low luster.

Amphimas is moderately hard and heavy, with a specific gravity of 0.67, based on its ovendry weight and volume when green (32). Values obtained for the mechanical properties of the wood are presented in table 1.

The wood has a fairly high volumetric shrinkage (table 2). There is no information about its seasoning characteristics.

The wood is reported to be low in decay resistance.

Amphimas is not easy to work, but it finishes smoothly (14).

This wood has no established timber value at present, but it is considered promising for future general commercial use, either foreign or domestic (25).

Identifying Features

The growth rings are not distinct, The pores are large, fewer than four per square millimeter, scattered, and solitary or in short radial groups. They are readily distinct without magnification. The parenchyma is conspicuous, even without a lens, in numerous broad, wavy concentric bands of fibers. The pores are partially or entirely included within the parenchyma bands. The rays are distinct with magnification on the cross section. They are low and inconspicuous on the radial surface and are distinctly storied. All the cellular elements are in seriation in the wide parenchyma areas, but they sometimes appear only in echelon in the intervening areas under the microscope.

Anopyxis klaineana (Pierre) Engl.
(Syn. A. ealaensis (DeWild.) Sprague)
Bodioa
"White oak" (local English)
Family: Rhizophoraceae

Anopyxis klaineana is a large forest tree up to 150 feet high and 4 feet in diameter. It has tall, narrow buttresses and a clean, straight bole 60 to 70 feet long (14, 19).

The wood is uniformly light yellow-brown, sometimes stained blue by a fungus. It has a rather low luster. The texture is coarse with a harsh feel, and the grain is rather irregular,

Anopyxis is hard and heavy, with an average specific gravity range of 0.75 to 0.81, based on its ovendry weight and volume when green (32). The specific gravity was 0.88 based upon the weight and volume of five ovendry samples from Liberia (15). Values obtained for the mechanical properties of the wood are presented in table 1.

The wood has a fairly high shrinkage rate. Shrinkage data are given in table 2. There is no information about its seasoning characteristics.

Anopyxis is apparently not resistant to decay (14).

Machining tests at the U. S. Forest Products Laboratory showed that only 40 percent of the planed samples were free of planing defects, 80 percent were good to excellent in shaping, and 100 percent were good to excellent in turning (15).

It is used locally for planks and general building purposes (14). It has no present commercial value in world markets, but gives promise for future general commercial use, foreign or domestic (25).

Identifying Features

The growth rings are absent. The pores are visible without a lens. They are solitary, uniformly distributed, and numerous but not crowded. The rays, which are visible without a lens on the cross section, are one pore width or less apart. They are distinct only with a lens on the tangential section and are inconspicuous on the radial section. The parenchyma forms short, narrow wings on either side of the pores. The wings are rarely confluent.

Anthocleisia nobilis G. Don
Family: Loganiaceae

Anthocleista nobilis is a tree 50 to 60 feet tall and from 12 to 18 inches in diameter. The buttresses, when present, are low. The tree grows in wet areas or on river banks (14).

The wood is brownish white, frequently discolored by blue stain in the sapwood. The luster is moderately high. The texture is medium, and the grain usually is straight.

The wood is moderately light and soft, but firm. It is very easy to work and finishes smoothly. It probably will hold its place well when manufactured.

It is apparently nonresistant to decay (14).

The timber is suitable for general carpentry, boxboards, plywood, and other uses requiring ease of working rather than attractiveness or durability though it has no present commercial value (14, 25).

Antiaris africana Engl.
Antiaris welwitschii Engl.
Kirundu
Antiaris
Family: Moraceae

The two species of Antiaris differ in botanical characteristics and habitats, but their woods are very similar. A. welwitschii is dominant in the dense, humid forest area, while A. africana predominates in the North. The trees are fairly common in the high forest zone of West, Central, and East Africa (6, 29).

Antiaris trees may reach a height of 120 to 150 feet with a diameter of 2 to 5 feet. Clear boles up to 70 feet long are available. There are usually no buttresses (6).

The wood is light yellow-brawn or nearly white in color. The sapwood may be up to 6 inches thick but not clearly distinct from the heartwood. The texture is medium to rather coarse, and the grain usually is interlocked.

Antiaris is moderately soft and light. The average specific gravity ranges from 0.43 to 0.49, based on the weight of the ovendry wood, and volume when green (6, 32). The air-dry wood varies from 23 to 33 pounds per per cubic foot with an average of about 27 pounds (6). Values obtained for the mechanical properties of the wood are presented in table 1, Limited tests show that it is a poor timber for steam bending (6).

The wood seasons rather rapidly, but it has a decided tendency to distort, particularly to twist. Thick boards often split near the end. Shrinkage data for antiaris are given in table 2. The British Forest Products Research Laboratory recommends its kiln schedule A (table 3) for this wood (6).

The timber is not durable. The lags frequently are damaged by ambrosia beetles in Africa, and those imported often have been attacked in both the heartwood and sapwood. Longhorn beetles sometimes attack logs also. The lumber is subject to attack by powderpost beetles. Antiaris is not resistant to termites. Felled logs are readily subject to sap stain. It is a permeable wood, however, and takes preservative treatment (6).

The wood is worked fairly easily with both hand and machine tools. Transverse cuts sometimes cause crumbling, however, and some tearing occurs in planing under standard conditions. The wood has goad nailing, gluing, and staining characteristics (6).

Antiaris is not suitable for all-veneer plywood because it is too soft and coarse. It appears suitable for lightweight lumber core stock for plywood. The veneer is very brittle (6).

This timber would be suitable for interior millwork and joinery if care were taken in grading the logs and preventing attack by insects and wood-staining fungi. It might be used locally for crates and boxmaking. Although Mayer (25) lists A. africana as being of commercial importance and A. welwitschii as promising for the future, the wood is at present of little value even in England.

Antrocaryon micraster A. Chev. and Guillaum
Akoua
Family: Anacardiaceae

This species is found from French Guinea to the Gold Coast. It is relatively rare in the dense, shaded forest areas and somewhat localized in the northern parts of the forests with seasonal changes. In Liberia it is found in the central section of the eastern high forest area (25, 30).

Antrocaryon is virtually the only African member of the Anacardiaceae that produces large trees, which may be 3 feet or more in diameter.

The heartwood is not sharply distinct from the sapwood. It is pinkish white with a pearly luster, The texture is rather fine, and the grain usually is straight.

The wood is moderately hard. The specific gravity is 0.46, based on the weight of the ovendry wood and its volume when green (32). Values obtained for the mechanical properties of the wood are presented in table 1.

There is no information about the seasoning properties of this wood.

The timber is subject to attack by fungi, and sap stain is common.

Antrocaryon at present has no commercial timber value, but it is considered promising for future specialized foreign or domestic use (25).

Aubrevillea kerstingii (Harms) Pellegr.
Aubrevillea platycarpa Pellegr.
Family: Leguminosae- Mimosaceae

These two species of Aubrevillea are similar to Piptadenia africana. A. kerstingii is a large tree of the dense forest. It does not extend as far into the humid forest as A. platycarpa (29).

The heartwood is brownish yellow or grayish brown with a violet tinge. The wood is relatively hard.

The timber is not of commercial importance at the present time, but it may prove a useful wood in the future for general commercial use (25).

Baphia nitida Lodd.
Baphia pubescens Hook. f.
Camwood
Family: Leguminosae- Papilionaceae

Baphia nitida occurs most frequently on river banks and in forests that are periodically flooded. It is rather abundant in the understory of the dense forest of the Ivory Coast. It is found in the littoral bush regions from Sierra Leone to Gaboon (29).

Under certain biological conditions and in fallen logs the heartwood may be entirely red. At the time of felling it is usually yellowish white and uniquely colored at the areas of injury or necrosis. A natural oxidation process causes the red wood, which has been exposed for a long time after planing, to become a blackish brown, similar to the color certain African padouks (Pterocarpus species) assume after long exposure to light. Often the red color is absent in the heartwood, which then is not distinct from the sapwood (29).

The wood is fine textured, hard, anti very heavy. In a test made on a single specimen at the Forest Products Laboratory the specific gravity was 1.02, based on the volume and weight of ovendry wood.

The red heartwood has long been a source of dye in Africa as well as in other countries. In England it has been mostly replaced by certain Brazilian leguminous woods but at least one company in the United States is still using it. The species is listed as one of the trees of Liberia attaining a diameter of at least 2 feet. It is considered of commercial value (25).

Berlinia confusa Hoyle
(Syn. B. acuminata Soland.)
Berlinia grandiflora (Vahl) Hutch. and Dalz.
Berlinia occidentalis Keay
B. bracteosa Benth.
"Red oak"
Ebiara
Family: Leguminosae- Caesalpiniaceae

Species of Berlinia grow throughout West Africa in various types of forests. The most important timber species occur in the high forest belt of Sierra Leone, Liberia, the Ivory Coast, the Gold Coast, Nigeria, and the Cameroons. In some areas trees over 2 feet in diameter are very numerous, with from 100 to 700 per square mile.

The trees are from 80 to 140 feet high and may be up to 4 feet in diameter, with an average of 2-1/2 feet at maturity. The trunk is usually without buttresses, but it may be fluted at the base. The bole is reasonably straight, clear, and cylindrical (6, 14).

The sapwood varies from light red to dark red-brown, with dark purple or brown irregular streaks. Freshly cut sapwood is pink, but it turns white or gray, often with a pink tint, after exposure. It is relatively thick. Traumatic vertical gum ducts are frequently present, appearing on the cross section in arcs of varying lengths. The texture of the wood is coarse, and the grain is usually interlocked and sometimes very irregular. Brittleheart may occur in large logs.

The timber is moderately hard and moderately heavy. A rather wide range in weight was observed in the various samples of the wood tested (6, 14). The average specific gravity ranges from 0.63 to 0.73, based on the weight of the ovendry wood and it5 volume when green (32).

The wood seasons slowly and for a few isolated cases, without distortion. Any existing shakes tend to extend in drying. Discoloration from mold growths that tend to develop during seasoning is a frequent problem. Shrinkage data for Berlinia are given in table 2. The British Forest Products Research Laboratory recommends its kiln schedule E, given in table 6 (6).

Berlinia is moderately decay resistant. The logs are subject to attack by ambrosia beetles, and the sapwood is attacked by powderpost beetles.

A Berlinia tree in the Gio National Forest,

ZM 115 855

The wood is reported to be moderately resistant to termite attack. The sapwood is permeable and takes preservative treatment, but the heartwood is resistant (6).

Since logs of this wood usually have a wide band of sapwood, lumber with a large proportion of sapwood must be considered with the heartwood in the determination of its working characteristics. Sapwood that has relatively straight grain and the less dense of the heartwood can be worked fairly easily with machine and hand tools and have a moderate blunting effect on the cutting edges. The tearing that occurs in planing and molding can be eliminated by reducing the cutting angle to 20°, unless the wood has irregular wavy grain, when no amount of reduction of the angle will help.. When the denser heartwood is cut, there is a tendency for the ripsaw teeth to vibrate in the cut. Most other operations are satisfactory with this wood. Sapwood with highly irregular grain is difficult to stain and polish, but other material stains well. The timber can be glued satisfactorily and nails fairly well, but care must be taken to avoid splitting when nailing near the edges. Tests of the steam bending properties of this wood indicate that some exudation of resin might occur during steaming and that, when pin knots are present, the timber cannot be bent.

The various species of Berlinia are used for carpentry and general cabinetmaking. The timber is suitable for the same uses as oak except where bending is required. It is considered unsuitable for the manufacture of plywood (6, 14).

Bersama abyssinica (Fres.)
Ssp. paullinioides (Planch)
Var. paullinioides Verdcourt
(Syn. B. paullinioides (Planch) Bak,)
Family: Melianthaceae

The Bersama are small trees of the forest understory. Although many species have been named and the trees are widely distributed in both East and West tropical Africa, it is thought that most of them are merely forms of B. abyssinica. They occur at the edges of the dense forest and in the savannah areas (30).

The wood is grayish white and is subject to a brownish discoloration as a result of fungus attack. It has a fine texture and is rather homogeneous in appearance on the tangential face but has ray flecks on the radial face. The timber is rather hard.

The trees attain a diameter of 1 foot or more, but they have no present commercial timber value (25).

Blighia welwitschii (Hiern) Radlk.
(Syn. Phialodiscus bancoensis Aubrev. and Pellegr.)
Family: Sapindaceae

This species is widely distributed in the Ivory Coast from the coastal rain forests to the dry forests. It is found in Liberia along the Cavalla river in the southeastern part of the country. The tree grows also in Ghana and the Belgian Congo (25, 30).

A tree was observed in the Congo to be 94 feet tall, with a diameter of 1.7 feet at breast height. The bole was 52 feet long. Another tree, with a 52 foot bole, was 2.2 feet in diameter (18).

The sapwood is 3 to 4 inches wide. It is pinkish yellow and passes gradually into the somewhat reddish brown heartwood. The grain is interlocked, and quarter-grain material shows a ribbon stripe or moire pattern of narrow vertical bands as the wood is turned in the light. The numerous pith flecks are very fine, rather long, and brownish. The wood is moderately fine textured and has a moderately high luster.

The wood is hard and heavy. The average specific gravity is 0.81, based upon weight of the ovendry wood and its volume when green (32). Results of tests of mechanical properties are included in table 1.

The shrinkage of this wood is rather high (32). Shrinkage data are included in table 2. Worked material is rather unstable with changes in humidity (18).

The resistance to attack by fungi is variable. One collection of samples from the Belgian Congo had little resistance to a brown rot, Coniophora cerebella, showing an average loss in dry weight of 21.51 percent. Another set of samples was resistant to the same organism, with a loss in dry weight of only 2.40 percent. This set of samples was also resistant to the white rot fungus, Polyporus versicolor, with a loss in dry weight of 4.40 percent (18).

Both the sapwood and the heartwood apparently are susceptible to attack by powderpost beetles (Lyctidae) (18).

The wood saws well, but slowly. It is easy to plane, lifting long shavings on both surfaces. It polishes very well and takes a beautiful finish. It takes nails easily without splitting and holds the nails firmly (18).

Because of the high volumetric shrinkage of the wood, the log must be sawn into boards immediately after felling. Then, whatever the utilization plans, the quarter-grain material must be used.

When it is properly seasoned, the wood is well suited for carpentry uses as solid lumber or veneer, for interior or exterior joinery, the decoration and fixtures of stores, hardwood floors, and similar products. Because it has high bending and compressive strength, it can be used for heavy framing in buildings and other structures, as well as for wheelwright work, railway ties, and the like (18, 30).

Identifying Features

The growth rings are not very distinct. The pores are fairly uniformly distributed, in radial rows of 2 to 6 or more pores, but often solitary. They are variable in size (but usually medium) and not very numerous, especially in certain areas. The fibers are septate, with small, simple pits. Under the microscope they are seen to be flattened radially in several rows at the limit of the growth ring. The parenchyma surrounds the pores in 1 or 2 deposits and calcium oxalate crystals. The rays are very fine and closely spaced on the transverse section. They are 1 or 2 rows of cells in width, homogeneous, and numerous on the tangential section. The cells are filled with brown gummy deposits and often contain large crystals.

Bombax brevicuspe Sprague
Bombax buonopozense P. Beauv.
Family: Bombacaceae

Bombax brevicuspe is a very large deciduous tree that is widely distributed in the evergreen forest, but never very abundant. It may be up to 115 feet high. The trunk is straight and cylindrical without swelling at the base. It has strong, conical spines that are caducous, but some are always present on the branches and twigs (30).

The heartwood of B. brevicuspe is pinkish when freshly cut, but when it is dry it becomes ocher to light brown with a purplish tint. It is distinct from the rather wide sapwood. The heartwood of B. buonopozense P. Beauv. is not clearly separated from the sapwood; sometimes it is present only as a colored core in the center. The wood of both species lacks luster. It has coarse texture, and the grain is usually straight.

The wood is light in weight but firm and relatively tough. It is easy to cut, but does not take a high polish (14).

Commercial use is not truly feasible unless precautions are taken to preserve the logs and to prevent collapse by carefully kiln drying the lumber (30). B. brevicuspe is considered promising for future general commercial use (25).

Brachystegia leonensis Burtt Davy and Hutch.
Naga
"Bush mahogany"
Family: Leguminosae-Caesalpiniaceae

Brachystegia leonensis is one of the forest giants, sometimes reaching 130 feet in height. Its diameter may exceed 6-1/2 feet, but probably most of the mature trees are not greater than 4 feet in diameter. The trunk is cylindrical, with winged buttresses at the base (3).

The heartwood is light to dark brown, somewhat similar to a low-grade mahogany. Alternating dark and light stripes may be present. The sapwood is about 6 inches wide, white or pale colored, and distinct from the heartwood. The grain usually is deeply interlocked, and quarter-sawn surfaces show a stripe or roe figure. The texture is medium.

The wood weighs from 33 to 48 pounds per cubic foot air-dry, with an average weight of 44 pounds. The test material of B. nigerica, to which B. leonensis is considered similar, has strength properties about equal to those of oak. It is considered harder, tougher, and more resistant to shear, however, than oak. It varies greatly in bending properties (6).

The wood seasons fairly well but is slow to dry. The chief problem is distortion, but there is some tendency toward end splitting and surface checking. Cupping can be serious, and slight collapse sometimes occurs. The British Forest Products Research Laboratory recommends its kiln schedule E, table 6. Tangential shrinkage from green to 12 percent moisture content is 3.5 percent; radial shrinkage is 2.5 percent (6).

Brachystegia leonensis is probably moderately durable. It is occasionally damaged by ambrosia beetles, and the sapwood may be attacked by powderpost beetles. It is reported to be resistant to termites in Nigeria. The heartwood is reported to be extremely resistant to impregnation with preservatives, but the sapwood is permeable (6).

The timber of B. nigerica is moderately hard to cut with machine tools and hard to work with hand tools. It blunts saw teeth fairly quickly and has a moderate blunting effect on cutting edges in most other operations. Bad tearing may occur in planing and molding because of the interlocked grain. It is difficult to obtain smooth surfaces, and therefore the wood is not suitable for finishing treatments. It has a moderate tendency to split during nailing.

The wood should be suitable for manufacture of vehicles and for general construction that does not need great durability. It is technically suitable for the manufacture of plywood (6, 31).

Bridelia micrantha (Hochst.) Baill.
Family: Euphorbiaceae

Bridelia micrantha occurs on river banks from the mouth of the Gambia river to the upper Ivory Coast. It is abundant in all the forest regions, but above all in the secondary forest. It may grow from 80 to 95 feet high in an old secondary forest and 20 inches in diameter, but in the savannah regions it is a very small tree (3).

The sapwood is cream colored or light brown; heartwood is reported to be dark brown. The wood is fine textured with moderate luster, moderately hard, and moderately heavy. The specific gravity is 0.59 based on volume when green and weight when ovendry (32). Certain mechanical properties of this wood are included in table 1.

The wood has rather low shrinkage. Shrinkage data are given in table 2.

The heartwood is said to be resistant to termites (16).

The timber has no commercial value at present, but it is considered promising for future specialized foreign or domestic use (25).

Bussea occidentalis Hutch.

Samanta

Family: Leguminosae-Caesalpiniaceae

In parts of the Ivory Coast Bussea occidentalis is the dominant lower story species of the most northern part of the dense forest. Its growth range descends to the coastal region, following the steep river banks. It also occurs in the deciduous forests of Liberia, Sierra Leone, and Ghana (3, 29).

The tree may be 75 to 90 feet high with a diameter of 2-1/2 to 3 feet. Most of the trees, however, are less than 80 feet high and 2 feet in diameter. There are no buttresses (3, 14).

The lustrous heartwood is blackish or olive brown to dark reddish brown. The sapwood is grayish white or pale brown and up to 2 inches wide. The grain is interlocked, and the wood has coarse texture.

The timber is very hard and heavy. It weighs 60 to 68 pounds per cubic foot at 12 percent moisture content. The specific gravity ranges from 0.87 to 0.98 with an average of 0.94, based on weight when ovendry and volume when green (7, 14).

The wood is very hard to work with all hand tools, but it is not difficult to machine. It is extremely strong and stiff. It is not suitable for cabinet or joinery work or for ordinary flooring (7).

Though it is not of commercial value in world markets at the present time, it can be considered a promising wood for special uses in the future (25).

Caloncoba brevipes (Stapf.) Gilg
Caloncoba echinata (Oliv.) Gilg
Family: Flacourtiaceae

Caloncoba brevipes is a tree 40 to 50 feet high and 8 to 10 inches in diameter. It has a slender bole with no buttresses. It grows on river banks and along the edges of swamps.

The natives use the boles for house posts, but the tree has no commercial timber value at present (14, 19).

Caloncoba echinata is a much smaller tree, usually 20 feet or less in height and about 2 inches in diameter. The wood is used for walking sticks, handles for small implements, and, locally, for making combs, but at present it has no commercial value.

The heartwood of both trees is light brown or pinkish brown. The sapwood is grayish. It has a relatively low luster. The wood is fine textured, and the grain is straight to irregular.

The timber is moderately hard, heavy, tough, and strong. The specific gravity is 0.69, based on its weight and volume when ovendry. It is not difficult to work and finishes smoothly.

The wood is probably not durable (14).

Calpocalyx aubrevillei Pellegrin
Calpocalyx brevibracteatus Harms
Family: Leguminosae-Mimosaceae

Calpocalyx aubrevillei is a large tree up to 80 feet high with a diameter of 2 feet or more. The bole is symmetrical but branches begin low. It grows in the valleys and on river banks (3).

C. brevibracteatus may be from 50 to 80 feet high and 1 to 1-1/2 feet in diameter. Some trees, however, may be 100 to 125 feet high and 3 to 4 feet in diameter. The bole is long, slender, and free of buttresses This species grows in the old secondary forests and sometimes as the understory in a virgin forest, It is found from Sierra Leone to the Cameroons (3, 14).

The heartwood is variegated with shades of brownish red, violet, and black visible. The parenchyma appears as a fine striping on the longitudinal surface. The sapwood is gray. The wood has a rather low luster. The texture is somewhat coarse, and the grain is irregular.

The timber is very hard and heavy. It requires care in seasoning and is difficult to work. The specific gravity for C. brevibracteatus is 0.83, based on weight and volume of the ovendrywood (14). It probably is durable wood.

Neither species is now of commercial importance, but they are considered promising for future general commercial foreign or domestic use (25).

Canarium schweinfurthii Engl.
Aiélé
African elemi
Family: Burseraceae

Although there are numerous species of Canarium in all the tropical regions of the world except South America, C. schweinfurthii is the only one of commercial importance in West Africa. It grows from Sierra Leone to southern Angola and extends eastward to the Sudan and Uganda.

The tree ranges in height from 65 to 150 feet and has a diameter of 3 to 4 feet, but the average mature tree is 100 feet high and 3 feet in diameter. Buttresses may be lacking or very low. The bole is usually cylindrical and clear for from 45 to 90 feet (6, 14, 23, 30).

The heartwood is light brown or beige with a pinkish tint. The sapwood is rather wide and straw colored or white. It is often discolored by fungus stain. The texture is medium, and the grain usually is interlocked. Quartered wood often shows a very fine stripe or roe figure. The timber has a pleasant scent when freshly cut. Brittleheart may occur in large logs (6).

The average weight of the air-dry wood is 33 pounds per cubic foot. The wood is almost useless for steam-bending, for severe buckling and rupture of fibers occurs when it is bent even to a large radius of curvature (6). Some mechanical properties are given in table 1.

The wood seasons rather slowly and fairly well. End splitting may develop, and existing shakes sometimes are extended. Collapse and distortion may be troublesome (6). The British Forest Products Research Laboratory recommends its kiln schedule H, table 8. Shrinkage data for this wood are given in table 2. The timber has moderate dimensional stability in use (23).

The timber is nondurable and is subject to attack by fungi. It is susceptible to attack by ambrosia beetles, and the sapwood is attacked by powderpost beetles. In Nigeria it is classified as nonresistant to termites (6).

The sapwood is permeable and can he given preservative treatment. The heartwood, however, is extremely resistant to impregnation (6).

The timber is easy to work with hand and machine tools. Though the British Laboratory reports the wood has a severe blunting effect on the cutting edges (6), the Uganda Forest Department says the dulling effect is slight (35). Sharp cutters are needed to prevent the material from becoming woolly on the surface of the board. If the cutting angle of the planing knives is reduced to 20°, there is no tearing of quarter-sawn stock. The wood has good nailholding properties and can be stained and polished satisfactorily (6).

This wood has been rather extensively used in Britain for core veneer. The attractively figured wood can be sliced to make decorative paneling.

Carapa procera DC.
Crabwood
Family: Meliaceae

The genus Carapa is widely distributed in both the eastern and western sections of tropical Africa, and it occurs in tropical America from the West Indies and Central America lo Peru and Brazil. The West African species in Liberia is C. procera. It is found on the river banks in the dense rain forests (30).

The tree is 50 to 60 feet tall and usually less than 1-1/2 feet in diameter, although it is listed as a class I tree with a diameter of 2 feet or more. In the Ivory Coast area the trunk is reported to be twisted and covered with branches for much of the bole length. Record, however, reports that the bole of the Liberian trees is long and clear. The trunk is fluted, and there are very small buttresses (14).

In color the heartwood is similar to mahogany, reddish or chocolate brown that becomes darker on exposure. The sapwood is very light brown with a pinkish tint. The wood has a high luster similar to that of mahogany. The grain is straight or interlocked. The texture is medium.

The specific gravity of the wood is 0.79, based on the volume and weight when ovendry. It weighs 54 pounds per cubic foot at 12 percent moisture content (14). Mechanical properties of this wood are listed in table 1.

The wood can be airdried without difficulty and has no special tendency to warp (16). The heartwood is fairly resistant to decay and insect attacks.

The wood is easy to work, finishes smoothly, takes a high polish and stays in place well (14).

Because of the small size of most logs and the heaviness of the wood, the tree is not as widely used as it might be. It is suitable for joinery and building. In Uganda it is used for pit props and even telephone poles (16).

Ceiba pentandra (L.) Gaertn.
Fromager
Fuma
Family: Bombacaceae

Ceiba pentandra is one of the largest trees in Africa. It grows throughout the equatorial region of Africa and in all the tropical regions of the world. In Africa it is found in the dense rain forests, particularly in the more or less old secondary formations. It extends also into the Guinea region and the Sudan. Although it is badly adapted to dry climates because it does not resist brush fires, it has been planted as a shade tree and protected by man. Because it is rare in virgin forests, it is thought that the Old World trees originated in America and were introduced into Asia and Africa many years ago (3, 29).

The tree may be up to 160 feet tall and 6-1/2 feet in diameter. It has large, winged buttresses at the base, but the bole is cylindrical. The young trees are covered with sharp, hard, conical spines that usually disappear in time (3).

The wood is white to very light brown, sometimes with yellowish streaks or with a pinkish cast. It has a dull surface. The texture is coarse, and the grain is usually irregular although it may be straight.

The timber is reported to be easy to season, with very little degrade (21). Shrinkage data are included in table 2.

The wood is not decay resistant and also is subject to attack by insects. It is often stained by fungi if there is delay between felling and seasoning (21).

Ceiba pentandra is very light and soft--the weight ranging from 17 to 28 pounds per cubic foot in the air-dry condition. It becomes brittle when it is dry (21). Mechanical properties for the wood are listed in table 1.

It is used locally for furniture, carved chairs, and masks. It is also suitable for making core stock and containers (29).

Chidlowia sanguinea Hoyle

Family: Leguminosae-Caesalpiniaceae

The monospecific genus occupies a discontinuous area from the Sierra Leone to Ghana. It is rather abundant in the lower story of the dense evergreen forests of the northwestern part of the Ivory Coast and is in the high forest River Cess region in Liberia (25, 29).

The tree is small with a short and twisted trunk. Though it may reach a diameter of 1-1/2 feet (3), it is of no commercial importance at present because of the fork of the trunk. It could be tested as a saw-timber, but it is very hard and fine textured, with cross grain that makes sawing very difficult. It might have some possibilities for future use (29).

Chlorophora excelsa (Welw.) Benth.
Chlorophora regia A. Chev.
Iroko
Mulberry
Family: Moraceae

Species of Chlorophora occur both in South America and in Africa. C. excelsa is widely distributed from French Guinea through the Belgian Congo to Angola, eastward to the southern Sudan, Uganda, and Kenya, and south to Nyasaland and Mozambique. C. regia is more restricted and grows from French Guinea to Ghana. In some areas the trees are present both in the rain and mixed deciduous forests as well as the grass savannah areas (6, 16).

In Liberia C. excelsa may grow over 100 feet tall and 4 feet in diameter. The buttresses are low or sometimes completely absent. Trees 160 feet tall and 8 to 9 feet in diameter occur, with boles free of branches for 70 feet (6, 14).

The heartwood of C. excelsa varies from light yellowish brown to russet or dark chocolate brown. The sapwood is whitish, 2 to 3 inches wide. The texture is rather coarse, and on the tangential surfaces the vessel lines are very conspicuous. The grain is usually interlocked and sometimes irregular. Large, hard deposits of calcium carbonate, called "stone" deposits, are sometimes present in cavities, probably as a result of injury to the tree. They are often enclosed by the wood and not visible until the time of sawing though the wood around them may indicate their presence by its darker color (6). It is questionable whether there are any important differences between the wood of the two species.

The weight of iroko is 41 pounds per cubic foot at 12 percent moisture content (2). The average specific gravity ranges from 0.50 to 0.67, based on the weight of the ovendry wood and its volume when green (32). Limited tests on air-dried material indicate that the wood has moderately good bending properties, although inferior to the well-known bending timbers (6). Values for certain mechanical properties of the wood are included in table 1.

The wood seasons without much degrade. Usually the tendency toward splitting and distortion is very slight. The British Forest Products Research Laboratory recommends its kiln schedule E, table 6, for

this timber. Shrinkage values, which are generally low, are included in table 3 (6, 16).

Iroko heartwood is very decay resistant. Ambrosia beetles and long-horn beetles sometimes damage the wood, and powderpost beetles attack the sapwood. The timber resists termites, but it is not immune to attack.

The heartwood of iroko is extremely resistant to preservative treatment, but the sapwood is permeable (6, 16).

Iroko is moderately easy to work with both hand and machine tools. The dulling of the cutting edges of tools is slight except when deposits of calcium carbonate are very abundant. It finishes smoothly in flat-sawn material, but when there is pronounced interlocked grain the quarter-sawn material tends to pick up, and a reductionin the cutting angle is necessary. It has fairly good nailing and screwing properties The timber can be glued satisfactorily and takes stain well. When a filler is used the wood takes finish well. Iroko produces satisfactory sliced veneer and has been used occasionally as a face veneer far plywood (6, 14, 16).

The timber is of great importance in both East and West Africa. It is valuable for shipbuilding, light flooring, railway cars, interior and exterior joinery, drainboards, window sills and frames, and exterior doors. It has been used for bench tops in chemical laboratories. Iroko is also suitable for piling, dock, and other construction work because it can be obtained in long lengths and is stable and durable. The wood is often bought in converted form to avoid possible losses because of the occurrence of "stone" in the logs (6, 16).

Chrysophyllum africanum A. DC.
Chrysophyllum albidum G. Don
Chrysophyllum giganteurn A. Chev.
Chrysophyllum metallicurn Hutch, and Dalz.
Chrysophyllum obovatum G. Don
Chrysophyllum perpulchrum Mildbr. ex. Hutch. and Dalz.
Chrysophyllum pruniforme (Pierre) Engl.
Lungui
Family: Sapotaceae

At least seven species of Chrysophyllum occur in Liberia, primarily in the western and central areas. Five of the species--C. africanum, C. albidum, C. perpulchrum, C. pruniforme, and C. obovatum--reach a height of 100 feet and a diameter of 1-1/2 to 4 feet. C. metallicum is smaller, and there is no information about C. giganteum. The bole usually is fluted, and there are low buttresses (16, 23).

The wood is light brown or pinkish brown to almost white. The texture is fine to medium, and the grain is straight to interlocked. The luster is rather low.

Most of the species have moderately hard and heavy timber, but some yield moderately lightweight wood. Mechanical properties are given in table 1.

Chrysophyllum africanum from the Belgian Congo is reported to be easy to saw and plane. It takes and holds nails and screws easily, and takes paint and varnish well (23).

The wood has moderate shrinkage. Shrinkage data for two species are given in table 2.

All of the species, except the smaller C. metallicum, are considered promising trees of the group. They are not now of established commercial value, but may have future use in foreign or domestic trade (25).

Cleistopholis patens (Benth) Eng and Diels
Family: Annonaceae

Cleistopholis is a minor forest tree reaching a height of about 60 feet and a diameter of 18 inches. In bark and trunk it resembles basswood (Tilia). Branches are horizontal with blackish twigs.

Wood is very soft, odorless, and tasteless, has an ovendry specific gravity of 0. 28, and weighs 19 pounds per cubic foot at 12 percent moisture. It is light gray or nearly white and lustrous with a coarse texture. Parenchyma is barely visible, in fine wavy or broken concentric bands that are somewhat narrower than the widest rays and spaced 1 to 3 pore diameters apart. Pores are open, visible, rather few and scattered, occurring singly or sometimes in small, radially flattened groups (14).

Cleistopholis is not a common tree and at present has no commercial value.

Coelocaryon preussii Warb.
(Syn. C. klainei Pierre)
Wild nutmeg
Family: Myristicaceae

Coelocaryon preusii is reported from the Dukwia or Duobe river area of Liberia. It grows also in the Ivory Coast, southern Nigeria, the Cameroons, Gaboon, and the Congo. Coelocaryon preusii is a tall rain forest tree growing up to 100 feet in height with a long, clear bole free of buttresses. The diameter may be up to 4 feet (14, 19).

The heartwood is yellowish brown, not sharply distinct from the lighter sapwood, The luster is high, and the wood has a satiny appearance. The texture is medium, the grain generally is straight, and the wood has neither odor nor taste when dry.

The wood is light to moderately heavy and rather soft but firm (14). Values obtained for certain mechanical properties are listed in table 1.

The wood is not resistant to decay or insect attack and is often damaged by small shot-hole borers. It should be converted as soon as it is cut to prevent deterioration (14, 29).

The wood has moderately low volumetric shrinkage (table 2). It is very easy to work, finishes well, and dimensionally stable (14). The large sizes are used for canoes, planks, and timbers. Wild nutmeg is not now of commercial importance, but it is considered promising for future foreign or domestic use (14, 25).

Cola acuminata (P. Beauv.) Schott and Endl.
Cola buntingii Bak. f.
Cola chlamydantha K. Schum.
(Syn. C. mirabilis A. Chev.)
Cola lateritia K. Schum.
Cola nitida (Vent.) Schott and Endl.
Family: Sterculiaceae

There are more than a hundred species of Cola in tropical Africa. Most of them are very small trees or shrubs, but the five species listed above are of timber-tree size (14, 30).

Cola lateritia is a medium-sized tree, up to 50 feet tall and 12 to 15 inches in diameter. It has a twisted bole with large, winged buttresses at the base. It grows in the coastal area of the dense forest.

C. nitida is a large, buttressed tree that is fairly common in the Liberian coastal forest.

C. buntingii is usually less than 30 feet tall and free of buttresses. The bole usually is fairly straight, but sometimes it is gnarled.

C. acuminata is a medium-sized tree that is rather rare in the forest and might have been introduced from Nigeria (14).

There is some variation in the timbers of the various species. The heartwood is light brown in C. acuminata and C. nitida, pinkish brown in C. lateritia, orange brown in C. buntingii, and yellowish brown in C. chlamydantha. The sapwood is white in C. acuminata and C. nitida, grayish in the other species. All of the woods have coarse texture except C. acuminata, which has medium texture. The grain is straight to irregular. The wood is fairly lustrous. C. lateritia has silica present in the rays (30).

The woods of C. buntingii and C. chlamydantha are rather hard and heavy. The other species have moderately heavy to moderately light, medium soft wood.

C. buntingii is reported to require care in seasoning, probably because it is a heavy wood and often has interlocked grain, The specific gravity of C. acuminata is 0.55, based upon weight and volume when ovendry; that of C. buntingii is 0.79; and that of C. lateritia is 0.54 (14).

None of the timbers is reported to be resistant to decay or insect attack. The sapwood is frequently discolored by sapstain (14).

None of the species is in commercial use at the present time. C. buntingii is used for native house construction and C. lateritia is used for casks (14). Among the five, C. chlamydantha is considered to be the best for commercial development in Liberia.

Combretodendron macrocarpurn (P. Beauv.) Keay
Essia
Soap tree
Family: Lecythidaceae

Combretodendron macrocarpurn grows throughout West Tropical Africa from French Guinea to the Belgian Congo and Angola. It is infrequent in the dry high forests, but it is fairly common in the wet forest areas, particularly in Nigeria. It occurs in the southeastern portion of Liberia (6, 19).

The tree may grow 120 or more feet high and 2-1/2 to 3-1/2 feet in diameter. The bole is straight and cylindrical. It is unbuttressed, but it may be swollen at the base (6, 19, 23).

The sapwood is yellowish white, sharply distinct from the heartwood, and about 3 inches wide. The heartwood is rose colored when freshly cut, but when exposed to air it darkens to a reddish brown. Darker bands produce a decorative striped effect in some of the wood. The timber is moderately fine textured, and the grain usually is interlocked. The freshly cut wood has a strong, unpleasant odor that disappears after seasoning.

The wood is moderately hard and heavy with an average specific gravity ranging from 0.62 to 0.78, based on the weight of the ovendry woad and its volume when green (32). Averages of the values obtained for the mechanical properties of the wood are presented in table 1. It is not recommended for most steambending purposes because it buckles and distorts severely even when bent to a rather large radius of curvature (6).

The timber is difficult to season without distortion. The wood dries slowly and is likely to check and split in the process. End splitting, surface checking, and shakes may be very serious. Experiments in

kiln drying the timber indicate that it does not dry satisfactorily from the green condition. The British Forest Products Research Laboratory suggests that fox some uses their kiln schedule C (table 5) modified by increasing relative humidity by 10 percent at every stage, might be satisfactory for material up to 1-1/2 inches in thickness (6). Shrinkage data for this wood are given in table 2.

The wood is decay resistant and apparently resistant to termites in Nigeria. It is sometimes damaged by ambrosia beetles (6).

Combretodendron macrocarpum is rather difficult to work with either hand or machine tools. The sawteeth are overheated by fine sawdust that adheres to the saw packings of circular saws. In planing, a cutting angle of 20° is necessary to prevent tearing of planed surfaces, unless the cutters are very sharp. The wood tends to char in boring and working with the hollow square chisel. It cuts cleanly in other operations however, and does not have an excessive blunting effect on cutting edges. It stains and polishes well, but grain filler is sometimes necessary and care must be used to produce a uniform color,. The hard wood resists the entry of nails and tends to split; preboring is suggested (6). A contradictory report on Belgian Congo wood says the timber is easy to saw and plane, and nails and screws are easily driven into it (23). It is not suitable for the manufacture of plywood (6).

This timber might be suitable for use locally in heavy construction and railway crossties. It has so many unfavorable characteris tics that it is not likely to be of value for more exacting uses.

Copaifera salikounda Heckel

Family: Leguminosae - Caesalpiniaceae

Copaifera salikounda grows from French Guinea to Ghana. In Liberia it occurs in the Loffa River area of the western part of the country (25, 29). The bole may be up to 3 feet in diameter (4).

The heartwood is gray with a pink tint when it is freshly cut, but, after it has been exposed to the air, oxidation gives it a decidedly red or reddish brown color. Since resin canals are present in concentric zones in this wood, the exudations from the canals appear in groups of narrow, blackish lines on the longitudinal surfaces of the wood. The wood has a moderately high luster. The texture is medium, and the grain is usually interlocked and even irregular, but may be straight. Gum exudation may occur.

The wood is moderately hard and heavy. Values obtained for the mechanical properties of this wood are included in table 1. There is no information about its seasoning characteristics. Shrinkage data, however, are given in table 2.

In England the wood has been cut into veneer (4). Information is not available about other possible uses for the wood.

Coula edulis Baill.
Coda
"Walnut"
Family : Olacaceae

Coula edulis is rather abundant in the forest from Sierra Leone to Gaboon. It is a tree of medium size, up to 65 to 70 feet tall and 2 to 2-1/2 feet in diameter. It has a crooked or fluted bole, often forked to within 10 to 13 feet of the ground (14, 23).

The sapwood is white or pale brown and distinct from the heartwood, which is reddish brown and rather dull in appearance. The texture is fine to medium, and the grain is straight to interlocked. There is little figure in the wood because the growth rings are indistinct, the pores are uniformly distributed, and the rays are inconspicuous.

The wood is heavy and hard. Its specific gravity ranges from 0.80 to 0.93, based upon the weight of the ovendry wood and its volume when green (32). The timber is tough and strong but is easily split (14, 23). Average values for certain mechanical properties are presented in table 1.

There is no information about the seasoning characteristics of this wood. Shrinkage data, however, are given in table 2. The wood apparently is resistant to decay (14) though no experimental work has been carried on and data are not available.

The timber saws relatively easily, although somewhat slowly. Planing is rather difficult. Care is necessary to avoid splitting of the wood when nails or screws are inserted, but they hold well. The wood takes paint and varnish well (23).

Coula is suitable for heavy construction, possibly where durability is essential. It is of no present commercial value, but it is considered promising for future specialized foreign or domestic use (14, 25).

Cylicodiscus gabunensis Warms
Okan
Family: Leguminosae-Mimosaceae

Cylicodiscus gabunensis is common in the rain forests from Sierra Leone to the Cameroons and Gaboon. It occurs in the southwestern section of Liberia in the Mano River area (6, 25).

The tree may be 180 or more feet high and 8 to 10 feet in diameter. The usual diameter of commercial logs is 3 to 4 feet. The buttresses are rarely more than 3 feet high. The bole is straight, cylindrical, and without branches for 80 feet (6).

The sapwood is 2 to 3 inches wide and very distinct from the heartwood. It is very light brown with a definitely pink tint, and the heartwood is a deep golden color, often with a greenish cast. On exposure, the sapwood begins to turn reddish brown, and the darker areas create a striped effect with the golden wood. The wood has a moderately high luster. The texture is moderately coarse, and the grain usually is interlocked.

The wood is hard and very heavy. The specific gravity ranges from 0.69 to 0.90, based on the weight of the ovendry wood and its volume when green (32). It weighs 74 pounds per cubic foot at a moisture content of 12 percent (2). Averages of the values obtained for certain mechanical properties are given in table 1. The wood cannot be bent even to moderate radii of curvature without buckling and fracturing the fibers (6).

The timber seasons slowly. Distortion is not serious, but the wood shows a decided tendency to split and check. The British Forest Products Research Laboratory recommends its kiln schedule B (table 4) for this wood (6) Shrinkage data are given in table 2.

The wood is very decay resistant. The sapwood is susceptible to attack by powderpost beetles, but the wood is resistant to termites. The heartwood is extremely resistant to preservative treatment, and even the sapwood is resistant (6).

Okan is rather difficult to work with both hand and machine tools and rapidly dulls cutting edges, In addition, the interlocked grain is so pronounced that it is difficult to obtain a smooth surface in several operations. The wood must be prebored before nailing because it is so hard. It stains and polishes satisfactorily. It is not suitable for the manufacture of plywood because of the hardness and decidedly interlocked grain.

The wood is suitable for piling and wharf decking, because it is durable, hard and heavy, It has high resistance to wear and so is excellent for heavy-duty flooring in factories, but its hardness and the difficulty of maching it are definite handicaps to use (6, 7).

Cynometra ananta Hutch. and Dalz.

Apome

Family: Leguminosae - Caesalpiniaceae

Cynometra ananta is a forest tree growing up to 100 feet tail and 3 feet in diameter. The bole is straight and clear above narrow buttresses 6 to 10 feet high (14). It grows in the evergreen and semievergreen forests of Liberia, Ghana, and the Ivory Coast.

The heartwood is reddish brown, quite distinct from the light brown sapwood. The grain may be straight, but it usually is interlocked. The texture is rather fine.

The wood is very hard and heavy. The average specific gravity is 0.89, based on the weight of the ovendry wood and its volume when green (32). The values obtained for certain mechanical properties are given in table 1.

There is no information available about the seasoning characteris tics of this wood. A similar species from Uganda, however, is reported to warp readily and develop surface shakes and end splits (16). Limited shrinkage data are given in table 2.

The wood is reputed to be highly durable (14).

Cynometra is not easy to work when it is dry, for it is rather flinty to cut across the grain. It can be machined smoothly (14).

The wood is used locally for timbers and posts. It probably is suitable for railway cross ties, bridge timbers, and other heavy construction (14).

Dacryodes klaineana (Pierre) H. J. Lam
Adjouaba
Family: Burseraceae

This species occurs in the Ivory Coast and in the southwestern area of Liberia, in the St. Paul river area.

The tree often is defective in form and is usually of small diameter. It is abundant in the rain forests (25, 30).

The sapwood is thick. It is cream colored, often with a grayish tint and streaks of dark gray. The heartwood is grayish brown with darker streaks; sometimes the central area is reddish brown and the wood near the sapwood has a greenish yellow tint.

The wood is hard and moderately heavy. The average specific gravity is 0.73, based upon the weight of the ovendry wood and its volume when green (32). The results of tests of the mechanical properties of the wood are included in table 1.

The wood is somewhat difficult to work because of its hardness and its silica content (30). It has a rather high percentage of shrinkage in drying. The average volumetric shrinkage is 14. 4 percent, the tangential shrinkage is 8. 3 percent, and the radial shrinkage is ?. 4 percent (30). These values are included in table 2.

The timber has been recommended for railway crossties, for axe handles, and as shafts for the wagons used to draw the logs. In Liberia the timber has no present commercial value but it is considered promising for future specialized foreign or domestic use (25).

Daniellia ogea (Harms) Rolfe ex Hall.
Daniellia thurifera Benn.
Faro F
Copal
Gum Copal
Family: Leguminosae - Caesalpiniaceae

Daniellia ogea and D. thurifera are the most important of the numerous species of Daniellia that occur in West Africa. D. thurifera is abundant in Liberia in the wet, high forest area.

The trees may be up to100 feet high and from 4 to 5 in diameter. The boles are straight, without buttresses, and free of branches for 50 to 65 feet from the ground12(6,14).

The heartwood is light golden brown to reddish brown with darker streaks. The sapwood is usually wide (often from 4 to 7 inches), not sharply distinct from the heartwood, and grayish or straw colored. The texture is moderately coarse, and the grain is straight to interlocked. The wood has a high luster. Growth rings are more or less distinct because of differences in color and because of marginal parenchyma bands, Vertical gum ducts are scattered among the vessels.

The wood is light and moderately soft, but the darker zones are somewhat harder, and the darker heartwood is heavier than the sapwood. The weight of the wood in the air-dry condition varies from 26 to 36 pounds per cubic foot. The timber is not suitable for steam bending. Compression failures are common near the pith (6). Values obtained for certain mechanical properties of Daniellia thurifera are listed in table 1.

The timber seasons fairly rapidly from the green condition and shows little tendency toward degrade. In thick material there might be slight distortion and collapse, but the defects are not severe. The British Forest Products Research Laboratory recommends kiln schedule J, table 9, for this wood (6, 12). Shrinkage data are given in table 2.

The wood is perishable with respect to fungi, It is damaged by ambrosia beetles and sometimes by longhorn beetles. The sapwood

is subject to attack by powderpost beetles. The wood is reported to be nonresistant to termites in Nigeria. The heartwood is impermeable to wood preservatives. The wide sapwood varies in permeability from the moderately resistant resinous inner area to the permeable outer, nonresinous wood (6).

The French report D. thurifera can be satisfactorily impregnated by the pressure method or by hot and cold baths, It requires preservative treatment for uses where decay hazard exists (12).

The timber is easy to work with both hand and machine tools, Interlocked grain causes the tearing of quartersawn material in planing operations. A cutting angle of 20° and sharp, thin cutter knives are helpful in obtaining smooth surfaces. The wood nails well and can be glued satisfactorily. It takes stain readily, but requires filler before polishing (6).

The wood is used for core veneer in Britain. It is suitable for lining for furniture, drawers, and cabinets and for the manufacture of light crates and packing cases. Little of the wood is imported because of the susceptibility of the wide sapwood to degrade (6, 29).

D. thurifera has recognized and established commercial value in the markets of the world at the present time, but little is imported into the United States (25).

Detarium senegalense Gmel.
Dita
Family: Leguminosae- Caesalpiniaceae

Detarium senegalense grows in the forests of western Liberia at the edge of the rain forest zone, The tree may grow to be 125 feet high and 6 feet in diameter. It has low buttresses, and the straight bole is free of branches for 50 to 60 feet (14, 29).

The sapwood is wide, grayish, and resinous. The heartwood is late in forming in the dense forest. It is reddish brown and varies from medium to very dark brown. The luster is high. The wood has rather coarse texture and straight to wavy grain. It has a faint fragrance. Small, vertical gum ducts are present, usually in the marginal parenchyma.

The wood is moderately heavy and hard. Certain mechanical properties are given in table 1.

The sapwood is highly susceptible to insect attack. The heartwood yields a high proportion of defective boards (29). One report, however, says the heartwood is resistant to decay and insect attack (14).

Dita is easy to work and finishes very smoothly. There is some tendency for the fibers to pull out. The wood holds its place well when manufactured (14).

No information is available for the behavior of this wood during seasoning. Shrinkage data are given in table 2,

Detarium senegalense has no established value in world markets at the present time, but it is considered promising for future commercial use (25).

Diospyros sanzaminika A. Chev.
Ebony
Family : Ebenaceae

Diospyros sanzaminika is a tree of the middle story that often forms in small clumps from a single stump. It is 40 to 50 feet tall and is 4 to 6 inches in diameter. The bole is slender and free of branches for most of its length (14).

The heartwood is usually streaked or mottled with gray, white, or brown. It is never solid black. The sapwood is light colored and sometimes very wide. The wood is very fine textured,

Ebony is exceedingly hard and heavy. The weight varies, however, for the dark heartwood is heavier than the light wood. The timber weighs from 45 to 70 pounds or more per cubic foot (21). Values for the mechanical properties are given in table 1.

The hardness of the wood dulls tools, and the wood is difficult to work but it surfaces smoothly and takes a high polish (21).

Information about the seasoning characteristics of ebony is not available. Shrinkage data are given in table 2.

Because of its high elasticity, the wood has value locally for making tool handles. It is used mainly for turnery, inlaid work, and carving (21).

Distemonanthus benthamianus Baill.
Movingui
Family: Leguminosae- Caesalpiniaceae

Movingui grows in the eastern part of Liberia and in many other rain forest areas of West Africa. The average height of the tree is 90 feet, but under the best conditions for growth it may be 125 feet tall. The average diameter is 2-1/2 feet, but it may reach 4-1/2 feet. The bole often has weakly developed buttresses. It is free of branches, cylindrical,. and more or less straight (6).

The sapwood is narrow, straw colored, and distinct from the lemon-yellow to yellowish brown heartwood. Some of the heavier timbers are darker brown and may have dark streaks. Sometimes a yellow deposit is present in the pores that under moist conditions acts as a direct dye on textiles. It can be bleached with bleaching powder. The wood is fine textured and has a high luster. The grain is often interlocked or wavy, and some logs produce beautifully figured timber. Limited tests show that up to 1. 3 percent of silica may be present in the darker, dense wood, although the less dense, pale wood may contain practically none (6, 29).

The wood is usually hard and moderately heavy, weighing 37 to 48 pounds per cubic foot with an average of 42 pounds in air-dry condition. In a limited number of tests its bending properties were rated as moderate (6). The values obtained for certain mechanical properties of the wood are listed in table 1.

The timber apparently can be seasoned with little degrade, but the tests have been very limited. The British Forest Products Research Laboratory recommends kiln schedule F, table 7, for this wood (6). Shrinkage data are given in table 2.

The wood is moderately durable with respect to fungus attack. There is no information about its ability to resist attack by insects in other countries, but in Nigeria it is classified as moderately resistant to termites. The timber is resistant to preservative treatment (6).

The light-colored wood of low density and low silica content has only a moderate blunting effect on cutting edges, but the heavier, darker siliceous wood causes rapid blunting. Gummy material may cause overheating of the saws. Saws with teeth tipped with tungsten carbide are recommended. The timber works fairly readily with other machine and hand tools, It tends to char when bored, but it finishes cleanly in most operations. Because of the interlocked grain, tearing occurs on quartersawn stock in planing and molding unless the cutting angle is reduced to 20°. It stains and polishes well, and only a moderate amount of filler is required. The wood may split when nailed. It can be glued easily (6).

Movingui is used for joinery, door frames, windows, and sills. Because of the presence of the yellow dye, the wood should not be used for laundry equipment or any construction where it is in contact with wet clothes. It has been used for rotary-cut veneer, but it is not considered suitable for plywood (6).

Enantia polycarpa (D. C.) Engl. and Diels
Yellow wood
Moambé
Family: Annonaceae

This tree occurs in Sierra Leone, Ghana, southern Nigeria, and in the eastern part of Liberia. It is the only species of Enantia found in Liberia. The E. chlorantha listed by Cooper and Record (14) was incorrectly identified. It is a forest tree up to 60 feet high. The bole is slender and without buttresses (19).

The wood is a bright clear yellow, usually with a greenish tinge. It has a high luster. The texture is medium, and the grain is straight. The rays are rather conspicuous on all surfaces, but they appear as a "silver grain" figure on the radial surface because of their height.

The timber is rather light in weight, but it is firm and tough. The specific gravity is 0.53, based on ovendry weight and volume. It weighs 36 pounds per cubic foot at 12 percent moisture content (14).

No information is available about the seasoning characteristics of this wood, and there are no shrinkage data.

Enantia has no commercial value at the present time, but it is considered promising for future specialized foreign or domestic use (25). Its use for pulpwood has been suggested and it might be used for general carpentry, boxes, and utility veneer.

Entandrophragma angolense (Welw.) C. DC.

Tiama
Gedu nohor
Edinam
Family: Meliaceae

Entandrophragma angolense is a large deciduous tree of scattered growth in the semi-evergreen forest from French Guinea to Angola and Uganda. It is found also in Fernando Po. It grows as well near the coast as in the interior up to the boundaries of the high forest. It occurs in eastern Liberia (6, 9, 25).

The tree may be 160 feet tall and have an average diameter of 4 to 5 feet or more. It is sometimes strongly buttressed with the winged buttresses extending as much as 20 feet up the trunk. The bole is fairly straight and cylindrical, averaging 60 to 80 feet in length and furnishing 5 to 7 commercial logs (6, 9, 16).

The heartwood is typically a uniform reddish brown, but occasional logs are much lighter colored, sometimes a pale pink not very different from the pinkish gray sapwood that may be 4 inches wide. The heartwood darkens on exposure. The wood has rather uniform medium texture. The grain is interlocked, but the stripe figure produced on the radial surface is rather irregular and broad. It is rarely well-figured. The parenchyma is variable in amount. It surrounds the pores, but it is not conspicuous. Sometimes it also forms concentric bands, but the bands are not conspicuous as in E. condollei.

The wood is lighter in weight than sapele. It averages about 34 pounds per cubic foot when air-dry and 54 pounds per cubic foot in the green condition. It is considered inferior in mechanical properties to sapele. The wood is reported to have poor bending properties, but no exact data are available (6). Certain mechanical properties that have been tested are listed in table 1.

The wood seasons fairly rapidly, but there is a decided tendency toward distortion, and care must he taken from the beginning of the drying process. The wood must be perfectly dry when used. The British Forest Products Research Laboratory recommends kiln schedule A, table 3, for this wood (6, 9, 16). Shrinkage data are given in table 2.

The heartwood is reported to be moderately decay resistant and moderately resistant to attack by termites in Nigeria, but damage by ambrosia beetles is sometimes present. Both sapwood and heartwood are resistant to preservative treatment, the heartwood being extremely so (6, 9).

This wood can be cut rather easily and worked well with both hand and machine tools. The interlocked grain, however, causes it to tear in planing, unless the cutting angle is reduced to at least 15° (6). Ten samples from Liberia were tested for machining properties at the U. S. Forest Products Laboratory. The results of the tests indicate that only 17 percent of the samples were free of defects in planing, 80 percent had good to excellent shaping properties, and 90 percent yielded good to excellent turnings (15). The wood takes and holds nails well. It is easily glued and can be varnished and polished without difficulty, but filler must be used. Decorative veneer can be produced, and the plain veneer is suitable for the manufacture of plywood.

This timber has the same uses as the other commercially important Entandrophragma species. It is used in cabinetmaking--mainly in the form of veneer--for joinery, store interiors, railroad cars, buses, and shipbuilding. It is not recommended, however, for uses requiring dimensional stability(6, 9).

Entandrophragma angolense has an established position in European commerce, both in France and England.

Entandrophragma candollei Harms
Kosipo
Heavy Sapele
Family: Meliaceae

This tree is found scattered in the dense virgin forests from French Guinea to the Belgian Congo and Angola. It is rather rare in the western part of the area and more frequent in the Congo basin. It occurs in the central part of Liberia (11, 30).

It can become a very large tree. The bole is either cylindrical or has a rather pronounced swelling that continues into long ramified roots. The trunk is very straight and from 65 to 95 feet tall. It is 2 to 6-1/2 feet in diameter (11).

The sapwood and heartwood are distinct. The sapwood is grayish white to pale brown and from 1 to 3 inches wide. The heartwood is reddish brown with a purplish tint, becoming darker in time. The texture is rather coarse, and the grain is interlocked to straight. The rather abundant parenchyma lies in concentric bands that form an irregular pattern on the tangential surface, because the parenchyma cells appear darker than the background. A ribbon figure is visible in radial view because of the interlocked grain. The rays often contain small silica granules.

The wood is moderately hard and moderately heavy. It sinks in water when it is green, for it then weighs about 60 pounds per cubic foot. When air-dry, the wood averages about 39 pounds per cubic foot. It is similar in weight and strength properties to sapele (6, 11). Values for certain mechanical properties are included in table 1.

The wood seasons rather slowly and is subject to distortion in drying, It shrinks and swells noticeably in use with changes in moisture content, hence quarter sawing is recommended when it is cut into wide boards. Kiln drying must be done with care or serious deformation will occur. The British Forest Products Research Laboratory recommends kiln schedule A (table 3). Shrinkage data are included in table 2.

The wood has good durability, similar to that of the other species of Entandrophragma. The sapwood is frequently attacked by insects and must be removed (11).

The wood can be worked rather easily, in general, with both hand and machine tools. Certain logs cause rapid dulling of the saws, however, undoubtedly because of the silica content. In planing and molding operations some tearing occurs. A cutting angle of 20" is recommended. Nails and screws penetrate easily and hold well. It takes polish, varnish, paint, and glue without difficulty (6, 11).

Although this wood is similar to the other species of Entandrophragma, particularly to sapele (E. cylindricum) it is heavier, less stable, darker, and less regularly shows the ribbon figure of sapele, hence is not as highly regarded. It is mainly a fine carpentry and cabinetmaking

wood, but it can be equally utilized in naval construction and for rolling stock. In heavy joinery, quartered boards should be used. Some prefer to use it in veneer, where the ribbon-striped or moire sheets are esteemed (11).

The timber is occasionally imported by France, mixed with sapele (11).

Entandrophragma utile (Dawe and Sprague) Sprague
Utile
Sipo
Family: Meliaceae

Entandrophragma utile is widespread in tropical Africa. It is abundant in the Ivory Coast, is in the entire forest of the Cameroons, and is frequent in Gaboon and Uganda. In Liberia E. utile occurs in the south-central area. The tree grows chiefly in the moist, deciduous high forest, but in some areas it is found both in the wetter regions and on the drier hillsides. It prefers semishade forests, but it regenerates naturally in some rather light parts of the forests. Its early growth is slow(6, 8).

The tree may be up to 150 feet tall and 6-1/2 feet in diameter above the base. The bole is straight, cylindrical, and free of buttresses, and may be 70 to 80 feet long (6, 8).

The heartwood and sapwoad are distinct. The heartwood is reddish brown, often rather dark, but it is pale pink when freshly cut. The sapwood is light brown. The wood has moderately coarse texture and usually has interlocked grain that produces a broad ribbon-stripe figure on the radial section. The wood has a faint cedar-like odor when it is freshly cut. Parenchyma is present in irregular, wavy, concentric bands.

Utile is moderately soft and moderately light. It varies from 34 to 47 pounds per cubic foot in the air-dry condition, with an average of 41 pounds per cubic foot. It weighs about 50 pounds per cubic foot when green. Its mechanical properties are usually superior to those of E. angolense. Values for certain mechanical properties are listed in table 1. The wood is not suitable for solid bending, for it buckles severely when bent even to a moderate extent (6, 16).

The wood seasons moderately slowly. There is a definite tendency for distortion in the form of twist to occur, and original shakes extend during drying. In general, however, distortion is not severe. The British Forest Products Laboratory recommends kiln schedule A, table 3, for drying utile (6). Shrinkage data are given in table 2.

Utile is reported to be durable with respect to attack by fungi. It is not resistant to attack by termites, however, and it is sometimes damaged by ambrosia beetles. The sapwood is subject to attack by powderpost beetles, The wood is extremely resistant to preservative treatment (6).

Utile can be worked rather well with both hand and machine tools. It has a slight blunting effect on the cutting edges, As in other species with interlocked grain, tearing occurs in planing and molding under normal conditions, but a reduction of the cutting angle to 15° will help in attaining a clear surface. Although a satisfactory finish can be obtained in most other machining operations, the wood is reported to char in boring. It has fairly good nailing properties. It takes stain and glue satisfactorily and polishes well after a filler has been used (6).

Utile is used for the same purposes as sapele, and the two woods are often mixed in commerce. It is used in cabinetmaking, fine joinery, store fixtures, molding and framing, interior work in ships and railway cars, truck bodies, and decorative veneer. It is used for plywood, but it often shows wild grain (6, 8, 16).

This wood is of established commercial value in the timber markets of the world.

Erythrophleum ivorense A. Chev.
Erythrophleum guineense G. Don
Sasswood
Ordeal tree
tali
Family: Leguminosae - Caesalpiniaceae

The species of Erythrophleum occupy an extensive area in Africa. E. guineense is a mountain species of the semihumid areas of West Africa, from which it extends at low altitudes to the boundaries of the equatorial forest, E. ivorense grows in the dense equatorial forest. At the limits of their respective areas, however,

occurrence of the species undoubtedly overlaps. Bath species are present in Liberia (12, 29).

The trees are from 95 to 130 feet tall and 3 to 6 feet in diameter. Rounded buttresses sometimes rise rather high, but they do not extend far from the base, The bole is rarely very straight and capable of yielding, under the best conditions, only four commercial logs (10, 29).

The sapwood and heartwood are distinct. The sapwood is narrow, yellowish or grayish in color. The heartwood varies in color in the different areas in which the tree grows; the variation cannot be attributed to difference in species. The yellow or orange-brown with russet shading in the heartwood is a warm color, but it darkens in time, more or less depending upon the region of origin. The texture is coarse, and the grain is decidedly interlocked. The parenchyma is abundant in a round- to diamond-shaped sheath about the pores and sometimes confluent. The wood has a moderately high luster.

The timber is moderately hard to hard and very heavy. It usually weighs about 56 pounds per cubic foot in the air-dry condition, but some samples weigh less (6, 10). Values for certain mechanical properties of the wood are listed in table 1.

The timber air dries slowly. There is some tendency to distort, but the wood can be dried in good condition if the boards are properly piled. Kiln drying, likewise, must be conducted very slowly. Shrinkage is moderate. One British report indicates that the woad is stable with only small movement; Belgian Congo and French reports, on the other hand, indicate that the wood is very unstable (6, 10, 23).

The wood is very decay resistant and also resists insects (including termites) and teredos (10, 14, 29).

The wood saws and works slowly and causes some dulling of the tools. Planing is often difficult because of the interlocked grain, but the wood turns well. Nails and screws require preboring to avoid difficulty in driving and possible splitting of the wood. It takes wax and polishes well (10, 23).

Sasswood is an established commercial timber in Liberia and is exported in small quantities from various parts of West Africa, particularly the Ivory Coast, the Cameroons, and French Equatorial Africa. It is essentially a heavy construction timber and is used for exterior carpentry and joinery, for gateways, the construction and planking of bridges, and for railway tics. It could be used for railway cars, trucks, and flooring far schools, public buildings, and warehouses (6, 10, 29).

Fagara leprieurii (Guill and Perr.) Engl
Fagara macrophylla Engl.
Fagara parvifoliola A Chev. ex Keay
Olonvogo
Mafu
Family: Rutaceae

Species of Fagara are shrubs or trees found throughout West Africa, from Sierra Leone to Angola and east to Uganda. Three species, F. leprieurii Engl., F. macrophylla Engl., and F. parvifoliola A. Chev., occur in Liberia. All are reported to grow in the central or southeastern part of the country (23, 25).

Fagara macrophylla is a species assuming many different forms from one end to the other of its range in the equatorial forest. It is characteristic of the secondary brush area in the Ivory Coast, where it is rarely more than 20 inches in diameter. In the secondary forest of the Belgian Congo, the tree attains a height of 95 to 115 feet or more and a diameter of 4 to 5 feet. The trunk is covered up to a certain height with numerous spines, but after a certain age they disappear leaving scars (23, 30). Fagara leprieurii is not common in the deciduous forest of the Ivory Coast. It is rather uniform in appearance and is usually of small size. There is some doubt of the identity of the species from Liberia described by Cooper and Record (14) as a tree 125 feet tall and 4 feet in diameter above high buttresses (14, 30). In the Ivory Coast, F. parvifoliola is a large tree that may be 2-1/2 feet in diameter. It apparently attains a similar size in Liberia (25, 30)

The heartwood and sapwood of the Fagara are not well differentiated. The sapwood is yellowish white. The heartwood is straw-yellow to light yellow-brown. The texture is moderately fine and homogeneous. The grain is interlocked to straight. The wood often shows a stripe figure or moire on the radial surface. The luster is rather high.

These woods are hard and moderately heavy to heavy. The strength properties are high and the timber is elastic (23). Values for certain mechanical properties are listed in table 1.

There is little information about the seasoning characteristics of these woods. Shrinkage is moderate, but the wood is unstable with changes in moisture content (23). Shrinkage values are given in table 2.

The timber is not durable.

They are easy to saw and plane and they finish smoothly. Some care is needed in nailing for the wood is difficult to penetrate, but nails and screws hold well. They take polish and varnish well (23).

These woods are not of commercial importance at the present time, but they are considered to be promising for future use. It could produce useful and decorative material (25). It is used locally for high-grade furniture and cabinetwork. It is suitable for flooring, but only for normal conditions of traffic.

Funtumia africana Stapf
Funtumia elastica (Preuss) Stapf.
Funtumia latifolia (Stapf.) Stapf ex Schltr.
Mutundu
Family: Apocynaceae

Funtumia elastica is the rubber producing tree of Liberia. The other species produce latex, but it is not suitable for rubber production.

Funtumia africana is a tree 75 to 80 feet tall and 1-1/2 to 3 feet in diameter. It has a straight bole without buttresses at the base. The tree grows rapidly and overruns abandoned plantations. It is often found in the secondary brush, but it is likewise abundant as an understory tree in the virgin forests (14, 16, 23). Funtumia latifolia is similar.

The wood of the three species is alike. The sapwood and heartwood are not differentiated. The wood is yellowish white, homogeneous, fine textured, and straight grained, and showing no figure either on flat sawn or quartered material.

Mutundu is rather soft and light. It weighs from 28 to 32 pounds per cubic foot in the air-dry condition and has low strength values (14, 16, 23).

The wood has moderately high shrinkage, but it is rather stable (23). There is no information about its seasoning characteristics.

The timber is probably nondurable. It is subject to sapstain and to attack by stag beetles (14).

The wood is easy to work, takes nails and screws well, and can be painted without too much absorption of the oil and vehicle.

The timber is used locally for doors and planks because it is easy to work. It has been used for low-cost joinery and furniture (14, 16).

Though mutundu has no present value as a commercial timber, it is considered to be promising for future specialized foreign or domestic uses (25).

Garcinia kola Heckel
Garcinia epunctata Stapf.
Chewstick
Family: Guttiferae

There are about 200 species of Garcinia in tropical Africa and tropical Asia. The two species listed above are found in Liberia and in West Africa from Sierra Leone to Nigeria. They occur also in French Cameroons, Gaboon, and the Belgian Congo. Garcinia epunctata is a tree that prefers damp situations. It is an understory tree in many closed forests in Ghana. In Nigeria it grows scattered on the banks of the rivers in the rain-forest zone and is often locally common. In the Belgian Congo it grows in the deep forests as well as in the savanna areas (13, 23).

Carcinia kolais a tree 50 to 60 feet tall. G. epunctata ranges from 40 to 65 feet or more in height, but it is only 1 to 3 feet in diameter and sometimes less than 1 foot. The bole is straight, clean, and evenly tapering. The buttresses are very small or lacking (13, 14, 23).

The wood of these two species is quite similar in appearance and properties. The sapwood is white, sometimes with a green tinge, and

sharply distinct from the heartwood. The heartwood is light brown or olive. The luster is moderate. The wood has a fine and uniform to rather coarse texture, and the grain may be irregular or straight. The parenchyma is abundant, extending as lateral wings from the pores and in concentric bands.

The timber is hard to very hard and heavy. It weighs about 60 pounds per cubic foot at 12 percent moisture content. The specific gravity is about 0.75 based upon the volume of the wood when green and its weight when ovendry (13).

There is no information about the seasoning characteristics of this wood.

It is reported to be resistant to termites and to teredo also, to some extent, but it is subject to decay by fungi (13, 14).

The wood of G. epunctata is difficult to work, but it finishes smoothly and takes a high polish (13, 14). It is used locally for bridge and wharf building and general construction (13). It is of no commercial value at present. The possibilities of it becoming a commercial wood are limited because of the small diameter of the logs, the great weight, and the difficulty of working the wood. It might be suitable for crossties or mine timbers.

Gilbertiodendron sp.
(Formerly Macrolobium [4] sp.)
"African Oak"
Family: Leguminosae - Caesalpiniaceae

The wood of the Gilbertiodendron is light golden brown with a somewhat reddish tinge and has a rather low luster. The texture is moderately

[4] The African species of Macrolobium have been removed from that genus by Leonard and placed in other genera such as: Gilbertiodendron, Pellegriniodendron, Paramacrologuim, and Anthonotha on the basis of various differences in pollen grains, seed germination, etc. The only species of Macrolobium still within the genus are the American species (24).

coarse, and the grain is straight to interlocked. The more or less distinct growth rings are marked by marginal parenchyma or a zone of fewer pores. The rays are very fine, not visible without a lens on the cross section, and low and inconspicuous on the radial section. The parenchyma is abundant. It surrounds the pores and extends as broad, lateral wings that occasionally become confluent. Very narrow marginal bands of parenchyma are present. Pores are small to moderately large. They are rather evenly distributed except in certain areas where they are rather sparse. They are distinct because of the surrounding parenchyma.

The wood is hard and heavy; weighing 47 pounds per cubic foot at 12 percent moisture content. The average specific gravity is 0.73 based on the weight and volume of the ovendry wood. Thus, it is heavier than most of the common shipbuilding woods of equivalent specific gravity. It seems to have fair impact resistance (28). Values for the mechanical properties of this wood are included table 1.

The lumber showed no appreciable degrade because of surface checking, end checking, or warping after air-seasoning, but some of the samples used for testing shrinkage had a tendency to end check in drying (28). The shrinkage values are given in table 2. It is possible that they might have been higher if the sample had had its original "green" volume.

The tests on this wood indicated no potential difficulties would be encountered in maching. A carbide-tipped saw is recommended. The quality of the surface smoothness is good after jointing and planing (28).

On the basis of the favorable results from the limited tests (28), the wood could be generally approved as suitable for ship and boat use.

Guarea thompsonii Sprague and Hutch.
Bosse
Sweet Cedar
Guarea
Black guarea
Family: Meliaceae

Guarea thompsonii is a dominant tree of the rain forests of Ghana, southern Nigeria, and Liberia. It is not so common in the Ivory Coast, but it is found there as well as in Gaboon and the Belgian Congo. In Liberia it occurs in the southwestern area of the country (6, 23, 25).

The trees range in height from 49 feet in the Belgian Congo to 110 feet in other areas. The diameter is from 3 to 4 feet, above the buttresses. The buttresses may be large, but they do not extend more than 6 feet up the trunk. In the Belgian Congo the lower bole is fluted, with lobes that are 3 feet high, but there are no buttresses. The remaining bole is straight and cylindrical and is clear of branches for most of its length (6, 23).

The heartwood is light pinkish brown, somewhat similar to light mahogany, but finer textured. The sapwood is grayish beige and well developed. The grain is straight to interlocked, and the texture is moderately fine. There is a cedary odor when the wood is just cut, and the dry wood sometimes retains the fragrance. The luster is moderately high. Parenchyma is present in narrow, concentric bands.

The timber is moderately heavy and moderately hard. It weighs about 39 pounds per cubic foot, air-dried to 12 percent moisture content. Values for certain mechanical properties are included in table 1. Limited tests show that this wood is suitable for bending to a moderate radius of curvature (6, 23).

The wood seems to season fairly rapidly. Although it shows little tendency to warp, it requires care in drying because it is liable to split and because of resin exudation, which may cause degrade in the seasoned timber. It is moderately stable under changing atmospheric moisture conditions. The British Forest Products Research Laboratory recommends its kiln schedule E (table 6) for drying this wood (6). Shrinkage data are included in table 2.

Guarea is durable with respect to attack by fungi. It is damaged by ambrosia beetles occasionally, and the sapwood is subject to attack by powder-post beetles. It is reported to be moderately resistant to termites in West Africa. The heartwood is very resistant to treatment with preservatives, but the sapwood is permeable (6).

The timber works rather easily with both hand and machine tools. There is a very slight dulling effect on knife edges. The interlocked grain causes some picking up in quarter-sawn material during planing and molding. The wood tends to split when nailed. It stains and finishes well and can be glued satisfactorily. The wood dust irritates the mucous membranes of workers (6, 23).

The wood is used for furniture, interior trim, high-class joinery, and boat and vehicle building. It has moderate resistance to wear when used as flooring. A good grade of plywood is made from the wood in Britain. It should not be used for instrument cases because resin sometimes exudes from the seasoned wood (6).

Hannoa klaineana Pierre and Engl.
Family: Simaroubaceae

Hannoa klaineana is a rather infrequent tree growing in the forests of south central Liberia, but it also occurs in the Ivory Coast. It is a large tree, 90 to 100 feet tall and 3 to 4 feet in diameter. The bole is without buttresses (14).

The wood is nearly white or straw colored without distinction between heartwood and sapwood. It has a rather high luster, no odor, and a slightly bitter taste. The texture is medium to coarse, and the grain usually is straight. The parenchyma is rather abundant in long, narrow wings from the sides of pores. It is often confluent in wavy lines that are visible without a lens.

The timber is light and soft, but firm. There is no information available about its seasoning characteristics.

Unless the wood is dried promptly and kept dry, blue stain will discolor it. Often the ends of the logs will show large, irregular checks or shakes (14).

The wood is suitable for carpentry work that is to be painted (30).

It has no established timber value in world markets at the present time, but it is considered promising for future general commercial use (25).

Haplormosia monophylla (Harms) Harms
Black gum
Family: Leguminosae-Papilionaceae

Haplormosia is a monosepcific genus found in western Liberia and in the Ivory Coast. The tree is over 100 feet tall and 3 to 4 feet in diameter above the high buttresses. The larger trees occur in the deep, swampy forest or on the edges of lagoons. They form small groves in some places. The bole is often short and defective in form (14, 29).

The heartwood is light chocolate brown, often with darker streaks and lighter parenchyma markings. It shows a figure on the tangential surface when the wood is properly cut. The luster is moderate, and the texture is moderately fine. The grain is straight to interlocked. Storied structure may or may not be present.

The timber is very hard and heavy. It is reported to be resistant to termites and to teredo. It works fairly well with proper tools. It has a high percentage of shrinkage, however, and should not be made into furniture until it has dried, stacked for more than a year (14, 29).

It is suitable for piling and for heavy duty saw timbers. It is widely used locally for furniture and other purposes (14, 29).

The wood has no established commercial value in the world markets at the present time, but it is considered promising for future general commercial use (25).

Irvingia gabonensis (Aubry-Lecomte ex O'Rorke) Baill.
Family: Irvingiaceae

Irvingia gabonensis occurs in West Tropical Africa from Senegal to Angola, Ubangi-Shari, and Uganda. It grows in the evergreen rain-forest, mixed deciduous forest, and the deciduous forest. Its best development is in the evergreen rain forest. It is a deciduous tree ranging from 40 to 90 feet tall. The trunk is slender with small buttresses (13, 30).

The wood is pale grayish brown and lusterless. The heartwood is not distinct from the sapwood. The texture is moderately fine, and the grain is interlocked. The parenchyma tissue is abundant in narrow wavy bands less than the diameter of the pores apart.

The timber is hard and heavy. It weighs about 52 pounds per cubic foot, air dried to 12 percent moisture content (13). Values for certain mechanical properties are included in table 1.

There is no information about the seasoning characteristics of this wood. Shrinkage data are included in table 2.

The wood is reported to be durable (13), but there is no record of specific tests that were made.

The great weight of the timber prevents its use for all but the heaviest construction work. The wood has no commercial timber value in world markets at the present time, but it is considered promising for future commercial use, foreign or domestic (25).

Khaya anthotheca (Welw.) C. DC.

Acajou blanc
African mahogany
Family: Meliaceae

Khaya anthotheca occurs in West Tropical Africa from the Ivory Coast to Angola and eastward through the Belgian Congo to Uganda. In Liberia it is found in the south central area. It is a tree of the deciduous and semievergreen forests and develops best on the banks of streams. It is not found in the coastal belt (6, 16, 25).

The tree is deciduous. It may be up to 140 to 180 feet tall and 1 to 4 feet in diameter. The trunk usually is heavily buttressed to a height of 12 feet, but the bole above the buttresses may be clear and approximately cylindrical for 30 to 80 feet. It is only moderately straight in most trees (16).

The heartwood is pink when it is freshly cut. Later it darkens to pinkish brown or deep reddish brown. The sapwood is yellowish brown and about 1-1/2 inches wide. It is not always distinct from the heartwood. Sometimes gum veins are present as a defect in

the wood, the result of injury to the growing tree. The texture usually is coarser than that of American mahogany. The grain is mostly interlocked, but sometimes the wood is straight grained. Brittleheart and natural compression failures are common defects in African mahogany trees.

The wood is moderately light. It weighs from 32 to 35 pounds per cubic foot in the air-dry condition and about 44 pounds per cubic foot when green. The specific gravity is 0.50 on the oven-dry, green volume bases. It has approximately the same strength properties as American mahogany of similar specific gravity. Values for certain mechanical properties are given in table 1. Results of tests indicate that African mahogany is not suitable for most steam-bending purposes (6, 16).

African mahogany can be air dried with very little degrade, except for strongly developed tension wood, which will cause serious distortion. It is recommended that the ends of boards be painted with gloss oil or that a strip of wood be nailed across the end of the board to prevent splitting. The British Forest Products Research Laboratory recommends its kiln schedule F (table 7) for drying this wood (6, 16). Shrinkage data are included in table 2.

On the basis of tests made in Uganda resistance to fungi is rather low for this wood. British tests, however, indicate that the wood is moderately durable. Logs are liable to attack by ambrosia beetles and longhorn beetles. The sapwoodis subject to attack by powder-post beetles. There is no valid information about the resistance of African mahogany to termites. The timber is extremely resistant to preservative treatment (6, 16).

African mahogany works easily with both hand and machine tools and does not dull cutting edges abnormally. When the grain is interlocked there is a tendency for the wood to tear in the planing of quarter-sawn surfaces. Occasional wooliness or roughness of the end surfaces in machining is a disadvantage in the use of this wood. The timber nails and screws well and can be glued satisfactorily. It stains well except for material with interlocked grain that has been incorrectly machined.

The wood is of importance for furniture, paneling, and interior work. It is also used for boat planking, and a high grade of plywood is made from it.

This wood has an established commercial value both in the West African areas and in Uganda. Although it is highly variable in quality, as are most of the other species of Khaya, the best logs are equal to the better known wood, K. ivorensis (16).

Khaya ivorensis A. Chev.
Acajou afrique
African mahogany
Family: Meliaceae

Khaya ivorensis is the best known of the commercial species of African mahogany. It grows to a height of 140 feet, but most trees are 100 to 110 feet with a diameter of 6 feet. The bole is cylindrical and clear for from 40 to 80 feet above the sharp buttresses that are only 4 to 5 feet high.

This tree, unlike K. anthotheca, is found in the rain forests on low-lying land from Liberia to the Cameroons and Gaboon. It occurs in southeastern Liberia (6, 25).

It is often said that the wood of K. anthotheca can be separated from that of K. ivorensis because the former is lighter in color. This is not a reliable feature, however, and there seems to be no other characteristic sufficiently distinct to separate these timbers with certainty after they are converted. The multiseriate rays of K. ivorensis are usually lower than those of K. anthotheca or K. grandifoliola, with few surpassing 1 millimeter.

The mechanical properties of the wood are similar to those of K. anthotheca. Values for certain mechanical properties are listed in table 1. All other characteristics are the same as those described for K. anthotheca. Shrinkage data are included in table 2.

Klainedoxa gabonensis Pierre ex Engl. var. oblongifolia Engl.
Eveuss
Family: Irvingiaceae

Klainedoxa gabonensis is a forest tree ranging from 100 to 150 feet tall. It may have a diameter of 4 to 5 feet. The buttresses are prominent with spreading wings. The tree is frequently scattered

in the rain forest, and it penetrates into the semihumid zone in rising from the valleys. It occurs in Liberia, the Ivory Coast, and Uganda. Other species are found in Gaboon, the Cameroons, and the Belgian Congo (14, 30).

The heartwood is light to dark olive brown. The sapwood is gray. The wood has little luster. The texture is coarse, and the grain may be straight to irregular. The abundant parenchyma appears as distinct white, wavy concentric bands on the cross section. It is associated with the pores with anastomosing winged extensions.

The timber is very hard, heavy, tough, and strong (14). Values for certain mechanical properties are listed in table 1.

No information is available about the seasoning characteristics of this wood. Shrinkage data are given in table 2.

No tests on natural decay resistance have been reported, but the wood is said to be durable (14).

It is suitable for ground poles and timbers. It is of no commercial importance at the present time, but it is considered promising for future general commercial use (14, 25).

Lonchocarpus sericeus (Poir.) H. B. and K.

Family: Leguminosae-Papilionaceae

Lonchocarpus sericeus is distributed in many regions of the coast of West Africa. It has been collected in the southwestern portion of Liberia near the Mano River (25, 29).

The tree usually has a reiatively small diameter, attaining 1 foot or greater diameter outside the bark at breast height or 1 foot beyond the buttresses (25).

The sapwood is usually very wide. The wood has wide concentric bands of parenchyma that are conspicuous on all surfaces without a lens and rather abundant. There are 3 to 4 rows per millimeter on the cross section. The pores are rather few and are completely within the parenchyma bands. The heartwood is greenish yellow,

sometimes veined with brown toward the sapwood. In tangential section the parenchyma often forms an attractive pattern. All cellular elements are storied and ripple marks are visible.

The wood is hard and heavy. The texture is moderately coarse.

This timber is not now of any commercial importance, possibly because of the rather small diameter of the tree and the large percentage of sapwood. It is, however, listed as promising for future foreign or domestic specialized use (25).

Lophira alata Banks ex Gaertn. f.
Azobé, Ekki, Iron wood
Family: Ochnaceae

Locally and in the export trade the wood of Lophira alata is known by several different names. In all of the French African possessions and in France, it is called azobé. In British Africa and England, it is known as ekki. The wood is sold in the United States under both names, azobé and ekki.

There has been some confusion about the correct botanical name for this tree. It has been known as Lophira alata var. procera (A. Chev.) B. Davy, indicating that it is merely a variety of the tree growing in savannah areas, L. alata Banks. It has been named, also, L. procera A. Chev., and this name is preferred by some authors at the present time. In a recent publication, Hutchinson and Dalziel (19) indicate that the valid name for this species of the rain forest is L. alata Banks ex Gaertn. f. The savannah form of the tree is now named L. lanceolata Van Tiegh ex Keay, a separate species.

Azobé is a characteristic tree of the dense rain forests from Sierra Leone to the Cameroons and the Belgian Congo. It is particularly abundant on the low lagoons near the Atlantic Coast. Although it prefers the clay-sand type soils, it can be found occasionally on marshy land.

Azobé may reach a height of 160 to 180 feet and a diameter of more than 6 feet at breast height. Although there are no buttresses, the swollen base may extend for 12 feet up the trunk. The bole often is free of branches for 80 to 100 feet, but it may have a slight sweep (6, 11, 30).

The sapwood is about 2 inches wide. It is lighter in color than the heartwood and distinct from it. The heartwood is purplish brown to chocolate, somewhat mottled because of the light-colored numerous parenchyma bands and abundant light deposits in the pores. The wood has a very low luster. The grain usually is interlocked, and the texture is coarse and uneven.

Azobé is very hard and heavy. It weighs from 56 to 71 pounds per cubic foot at a moisture content of 12 percent (6, 13). The specific gravity ranges from 0.74 to 0.97 based on volume when green and weight when ovendry (13, 32). The mechanical properties of azobé are excellent, particularly with respect to compression. The average values for mechanical properties are included in table 1. There is no information about the bending properties of azobé based upon test data, but it is reported to be not suitable for steam-bending purposes (6).

Azobé is an extremely refractory wood to season. It dries very slowly and severe splitting and some distortion are apt to occur during seasoning. Care must be taken in piling the wood. The British Forest Products Research Laboratory recommends its kiln schedule B for azobé (6). This schedule, suitable for timbers that are very prone to check, is given in table 4. The shrinkage data are given in table 2. The wood is rather stable in use and shows relatively little response to variations in atmospheric moisture content. Its slowness to swell or shrink permits its use in construction exposed to the sun, rain, and sea (11).

Azobé is rated the most durable timber on the west coast of Africa. It is resistant, although not immune, to attack by termites. Ambrosia beetles occasionally damage the wood. Maritime structures in France, Belgium, and Holland have remained intact after more than 20 years of service. Piers were found in excellent condition after 12 years of standing in brackish water infested with teredos. In a temperate climate the wood is almost rot-proof (6, 11).

Azobé is difficult to work with both hand and machine tools because it is so hard and usually has interlocked grain. When the wood is dry, it has a rapid blunting effect upon the cutting edges of the tools. The green wood has a much less severe effect. It can be planed satisfactorily if some care is taken to avoid the tearing that might occur. The wood chars easily in boring, but it cannot be

nailed without preboring. The gluing properties are variable, but they usually are good (6). A filler is needed for finishing the wood because of the coarse texture. It takes paint and varnish well (23).

The high durability and hardness of azobé make it particularly suitable for piling. It is regarded as superior to reinforced concrete for all hydraulic works or structures, such as landing stages, piling, wharves, dams, or locks (11). It is available in rather large squared beams of good length. In Africa it is used untreated for such heavy construction work as bridges and wharves and also for railway ties. In the United Kingdom it is used for mine shaft guides and heavy surface structures. It has been used successfully for filter press plates and frames in contact with hot acid. It is a good heavy-duty flooring timber for warehouses and factories where a very smooth surface is not essential. Azobé is too heavy for plywood manufacture (6).

Growth rings are not distinct in azobé. The pores are rather large and visible without a lens. Many of the pores are almost completely plugged with light-colored deposits. They are moderately evenly distributed, solitary or in groups of 2 to 3 pores, but sometimes in oblique lines. They are not numerous. The vessel lines are very distinct as light lines on the longitudinal surfaces. The parenchyma is abundant in broad, wavy, concentric bands that are lighter than the background material. The parenchyma is visible without a lens on both the transverse and longitudinal surfaces. The rays are fine and usually visible only with a lens on the cross and tangential surfaces. They are not distinct on the radial surface.

Lovoa trichilioides Harms
(Syn L. klaineana Pierre ex Sprague)
Dibétou
Tigerwood
Family: Meliaceae

The botanical name formerly used for tigerwood is Lovoa klaineana Pierre ex Sprague, but botanists now agree that this name is merely a synonym for the older one, L. trichilioides Harms. Thus L. trichilioides is now the legitimate scientific name because of the rules of priority in nomenclature.

Tigerwood has been marketed in the United States as Congowood, lovoa wood, "African walnut," "Benin walnut," and "Nigerian golden walnut." The French trade name is dibétou. Although tigerwood resembles walnut (Juglans nigra L.) in color, especially when it is figured with dark streaks, it is very different in structure and is not related botanically to walnut. Any trade name that has "walnut" in combination with African place names is misleading.

Tigerwood is a tree of the rain forests of tropical West Africa. It has a vast area of distribution from Sierra Leone through the Cameroons, Caboon, and the central forest of the Belgian Congo. Usually the tree is scattered through the forest and rarely forms pure stands. It seems to be more abundant in the coastal zone of the Gulf of Guinea than in the interior. In Nigeria it is one of the dominant trees of the rain forest.. It occurs occasionally in the deciduous forest on the banks of streams, but usually it prefers forests with over 100 inches of rainfall (13, 30).

Tigerwood trees may be 120 to 130 feet high and 3-1/2 to 4 feet in diameter. Trees 145 feet high and up to 6 feet in diameter occur in the Belgian Congo. The bole is cylindrical with rounded flutes or small buttresses at the base. It is 60 or more feet long (6, 13, 23).

Tigerwood is moderately hard and moderately heavy. It weighs about 34 pounds per cubic foot in the air-dry condition at a moisture content of 12 percent and about 49 pounds per cubic foot when green (6). The average specific gravities of the woods of five trees from the French African colonies range from 0.41 to 0.51 based upon the ovendry weight of the wood and its volume when green. Values for the mechanical properties of the same woods are given in table 1. Although no test data are available, this wood is thought to be suitable for making solid bends of moderate radii of curvature (6).

Tigerwood seasons fairly rapidly with little degrade, although existing shakes might extend slightly and some distortion occur. The British Forest Products Research Laboratory suggests kiln schedule E, table 6, for this wood (6).

The shrinkage values are rather low to moderate. The average volumetric shrinkage for the French African samples ranges from 6.8 to 11.2 percent (32). Shrinkage data for tigerwood are included in table 2.

Tigerwood is moderately decay resistant but is subject to damage by ambrosia beetles and longhorn beetles. The sapwood may be attacked by powderpost beetles. Tests in Nigeria indicate that the wood is moderately resistant to termites. The heartwood is reported to be extremely resistant to impregnation with preservatives, and the sapwood is moderately resistant (6).

The wood is not difficult to work with either hand or machine tools. It finishes cleanly in most operations if the tools are kept sharp. Charter-cut material tends to pick up in machining, because of the interlocked grain. A cutting angle of 15° should be used for the knife. The timber takes nails and screws well, but precautions must be taken to avoid splitting. It stains, polishes, and glues very well (6, 23).

Tigerwood is often highly figured and is suitable for decorative paneling. It is excellent for cabinetwork, furniture, and decorative interior joinery. The lighter colored wood can be stained to resemble mahogany and substituted for it in making small boats, equipment for boats, radio cabinets, or furniture. It can be used for flooring (6, 13).

The growth rings are not very distinct, but they are more readily visible to the unaided eye than with a lens. The boundary between the rings appears as a fine, light-colored line that is the result either of more numerous pores or a band of marginal parenchyma cells. The pores are moderately large, often more numerous at the beginning of a growth ring, but otherwise uniformly distributed. They are solitary, or in radial rows of 2 to 5 pores, or in small clusters of irregular size. They may be filled with dark brown gummy deposits. The pitting on the walls of the vessels is minute. The parenchyma is not very abundant and is indistinct with a lens. It partially surrounds the vessels, often extending as a lateral wing that may become confluent with the parenchyma of an adjacent vessel. Marginal parenchyma is sometimes present. The rays are fine to moderately wide, up to 5-seriate, and less than 50 cells high. They are not very numerous. They are visible without a lens on the cross section and form a distinct fleck on the radial section. They are sometimes arranged in echelon. Traumatic vertical secretory canals may be rare or frequent in tigerwood. They occur in concentric bands 1 to 3 rows wide and are filled with black, gummy deposits. They are surrounded by thin-walled epithelial cells. The canals are visible on all surfaces and form the dark streaks that make some boards highly decorative.

Macaranga spp.
Family: Euphorbiaceae

There are more than 200 species of Macaranga in tropical Africa, some of which are climbing shrubs or small spiny trees of the understory. Two of the species in Liberia, Macaranga barteri Muell. Arg. and M. hurifolia Beille may be 35 to 50 feet high, but they rarely exceed 16 inches in diameter. The trees speedily invade abandoned agricultural land and grow so rapidly that they cannot be ignored (14, 30).

The timbers of the various species are quite similar in appearance and properties. The heartwood is very light brown, with a purplish tinge. The sapwood is white and quite distinct from the heartwood. The wood has a silky luster and a medium fine texture. The pores are small but distinct, rather numerous, and mostly in small, radially flattened rows or clusters. The vessel lines are distinct on longitudinal surfaces. The parenchyma is scarcely visible with a lens. It forms irregular tangential rows varying in length, sometimes the result of the joining of winglike extensions from the pores. The rays are very fine and low, distinct only with a lens on the cross and tangential sections.

The wood is light and soft. The average specific gravity of two species tested is 0.32, based upon the weight of the ovendry wood and its volume. It weighs about 23 pounds per cubic foot at a moisture content of 12 percent (14). The modulus of rupture averages 7,095 pounds per square inch, and the modulus of elasticity is 1,161 at 1,000 pounds per square inch in static bending tests at 12 percent moisture content. The maximum crushing strength is 4,535 pounds per square inch in tests of compression parallel to the grain. The average side hardness is 430 pounds and the end hardness is 610 pounds (14).

There is no information about the seasoning properties of this wood. The timber is probably not resistant to decay or insect attack.

Macaranga is easy to work, finishes smoothly, and is reported to hold its place well when manufactured.

Although the wood is suitable for many of the purposes for which the soft pines can be used, the small size of the tree makes it of doubtful value as a timber tree. The fibers are of moderate length, however, sometimes rather long, and the walls are thin. The timber thus might be of primary interest as pulpwood (30, 14).

Mammea africana Sabine
(Ochrocarpus africanus Oliv)
Oboto
Bastard Mahogany
African Mammee apple
Family: Guttiferae

A semideciduous tree, Oboto is found in the mixed deciduous forest of a large area from the Sierra Leone to Angola and the Belgian Congo and to a small extent in the evergreen rain forest. It prefers a rather wet environment and sometimes forms small stands on alluvial soil inundated at flood periods (13, 23, 30).

The tree is from 50 to 130 feet high and has a diameter of 2-1/2 to 3 feet. The bole is slender, straight, and cylindrical. The base of the trunk is swollen and more or less lobed (19, 23, 30).

The sapwood is light golden brown, often with a pinkish tinge, and distinct from the reddish brown, violet-tinged heartwood. Blackish resinous dots are more or less abundant on the surfaces of the wood. These are exudations from the horizontal resin canals in the rays. The luster is rather low, the texture moderately coarse to coarse, and the grain straight to interlocked.

Oboto wood is hard and moderately heavy to heavy. It weighs 44 to 57 pounds per cubic foot when air-dry to 12 percent moisture content. The specific gravity ranges from 0.58 to 0.72, with an average of 0.64, based on the weight of the ovendry wood and its volume when green (13, 32). The results of tests of mechanical properties are included in table 1.

The wood has a moderately high shrinkage value. The volumetric shrinkage ranges from 11.9 to 14.6 percent, with an average value of 13.6 percent. The timber is rather unstable when manufactured (23, 32).

The wood is reported to be decay-resistant but not termite-proof (13, 14).

The timber saws easily and can be planed without difficulty in spite of the interlocked grain. Mortise and tenon joints are easily made and hold well. The wood takes nails and screws well. It is difficult to paint or polish because it exudes oily, resinous material (23).

The African mammee-apple tree is regarded locally as an excellent general utility timber for local use. It is used for carpentry, joinery, and interior decorative purposes. In Ghana the wood is used for piling and in Liberia it is used for furniture as well as planks (13).

Identifying Characteristics

The growth rings are not distinct. The pores usually are solitary, only rarely in radial pairs, and often plugged with tyloses and a yellowish solid material. The parenchyma is difficult to see, even with a lens. It is around the pores and in fine, irregular lines between the rays. The rays are very fine and distinct only with a lens on a cross section. Large, horizontal canals are present in fusiform rays. They are sometimes distinct on the tangential surface under a lens, and are visible but not conspicious on the radial surface. The fiber tracheids have distinct bordered pits in a single row. The shorter vascular tracheids have similar bordered pits, but in several rows.

Manilkara lacera Dubard
"African pearwood"
Family: Sapotaceae

African pearwood is found in the southwestern part of Liberia and in the coastal area of the Ivory Coast (25). The tree is tall and straight with a diameter of 2 feet or greater (25). The wood is uniformly reddish brown or red, and without Ester. The texture is fine and the grain is straight.

The growth rings are not distinct. Pores, visible under a lens, are arranged in long to short radial chains. The rays are very fine and low, not distinct without a lens on any section. The parenchyma is in fine concentric bands that are independent of the pores. Silica is present in the rays of the wood.

The timber is hard and heavy. The specific gravity is 0.85, based on the weight of the ovendry wood and its volume when green (32). The values for the mechanical properties of this wood are given in table 1.

The volumetric shrinkage from the green to the ovendry condition is 14.3 (table 2) (32).

There is no information about the durability of this wood. It is probably resistant to fungus organisms, but not to insects. The silica granules in the cells probably would cause dulling of the saws and knives.

It is suitable for furniture manufacture, inlay work, and veneer.

Mimusops heckelii Hutch. and Dalz.
Rubber tree (Liberia)
Makore
Family: Sapotaceae

The trees that produce makore timber are found scattered in the moist high forest zone from Sierra Leone to Nigeria. In Liberia they are found in the southeastern area near the Grand Cess River (6, 25).

They are from 120 to 150 feet high, with diameters up to 9 feet, although harvested trees average about 4 feet. The boles are long, clean, straight, and cylindrical, usually without buttresses, and up to 100 feet long. Very large trees are reported to be likely to shatter when felled, but most logs exported have sound heartwood and are free of defects.

The heartwood and sapwood are readily distinguished. The heartwood is pinkish or purplish brown to deep red. The sapwood is very pale, pinkish or somewhat yellowish, and 2 to 3 inches wide The grain may be straight, but often it is interlocked and produces a mottled broken stripe or broken roe figure when the wood is quarter-sawn.

Sometimes the wood has irregular veins of a darker color that produce an attractive figure. The texture is rather fine and uniform. Silica is present in the wood.

The wood is moderately heavy, with a weight of about 39 pounds per cubic foot in the air-dried condition at 12 percent moisture content and 53 pounds per cubic foot when green (6). It is moderately hard. Its mechanical properties are weaker than one would expect from its weight and hardness (26). The values for the specific gravity and mechanical properties are given in table 1. The heartwood can be bent to curves of moderate radus, but the sapwood will buckle and rupture even with moderate bending and is not at all suitable for most steam-bending purposes (6).

The wood seasons at a moderate rate and shows little degrade. There is slight distortion, but some twisting may occur. The area around knots may show a small amount of splitting. The British Forest Products Research Laboratory suggests kiln schedule H (table 8) for drying makore (6).

Makore from the Ivory Coast has an average volumetric shrinkage of 11.0 percent in tests conducted at the Centre Technique Forestier Tropicale (table 2).

Makore is very durable with respect to attack by fungi. It is sometimes damaged by ambrosia and longhorn beetles, however, and the sapwood may be attacked by powder-post beetles. Tests in Nigeria show that the timber is resistant to attack by termites. The heartwood is reported to be extremely resistant to preservative treatment, and the sapwood is moderately resistant (6).

Makore cuts fairly easily with both hand and machine tools, but because of its hardness and the presence of silica granules in the cells, the cutting edges of knives and saws are rapidly blunted. Green timber has less dulling effect than the dry wood. Saw teeth tipped with tungsten carbide are needed for wood with a moisture content below 20 percent. The wood takes a good finish, but in planing quarter-sawn material, a cutting angle of 20 degrees is necessary to prevent tearing. The wood tends to char when bored. Very little grain filler is needed, and the wood stains and polishes very well. The wood glues satisfactorily but tends to split when nailed. There must be adequate provision for the removal of dust, for the timber contains irritants that may affect the nose and throat of the worker (6, 26).

Makore compares favorably with mahogany for furniture and fine decorative work. Both solid wood and veneer are used, and the

timber is valued whether plain or figured. It is important for fine joinery and interior fittings, also, and is suggested for motor vehicle framing, exterior doors, laboratory benches, sills, thresholds, and flooring. It may be used for rollers for the textile industry and turnery (6,26).

Certain difficulties in obtaining logs must be noted. The trees are widely separated by other species in the forest. They are large, heavy, and will not float in the rivers in the green condition (26). Nevertheless, the wood is of established commercial value and is accepted in the timber markets of the world (25). From 35,000 to 350,000 cubic feet are exported annually from British territories in Africa, and more than 350,000 cubic feet from the French possessions (31).

Mitragyna spp.
"Poplar", abura
Family: Rubiaceae

This wood was first described as Mitragyna stipulosa O. Kuntze, but since then the wood has been described as M. ciliata Aubrev. and Pellegr. Since there is now confusion as to the tree name of the timber that is described in the literature, it seems best to use only "spp." rather than one species name. The two woods apparently are nearly identical in appearance and properties.

Abura occurs in West Tropical Africa from Sierra Leone through Liberia and other coastal countries to the Cameroons and Gaboon. It is common in narrow belts along streams in the grass plains and in low-lying swampy parts of the deciduous and evergreen forests. It is sometimes in almost pure stands (13, 23, 26). It is probable that most of the wood exported is M. ciliata, since it is from the rain forests where M. stipulosa does not grow.

The trees are from 100 to 130 or more feet high, and 3 to 4 feet in diameter. The trunk is free of buttresses, although there maybe a slight blunt thickening at the base. The bole is straight and cylindrical (6, 13, 23).

The sapwood and heartwood usually are not differentiated. The wood is a uniform light yellowish brown, usually with a pinkish tinge.

Some logs show a small amount of grayish-brown heartwood that is irregular in outline. The grain may be straight or interlocked. There is little or no figure in this timber and the texture is moderately fine and uniform. The wood has a dull planed surface.

The wood is moderately soft and moderately light. It weighs from 29 to 43 pounds per cubic foot, air-dry at 12 percent moisture content, with an average of 35 pounds, and about 55 pounds per cubic foot when freshly sawn (6, 13). The specific gravity ranges from 0.38 to 0.54, based on the weight of the ovendry wood and its volume when green (13, 32). The results of tests of mechanical properties are included in table 1. Limited tests indicate that abura cannot be bent to any moderately small radius of curvature without buckling (6).

The timber seasons easily and rapidly, and can be kiln-dried without degrade if all shakes are cut out when the wood is sawn. The British Forest Products Research Laboratory recommends kiln schedule K (table 10) for this wood (6). The shrinkage values for abura are given in table 2.

Abura is nondurable with respect to attack by fungi. Ambrosia beetles cause damage to the logs in West Africa, and the sapwood is susceptible to attack by powderpost beetles. Tests in Nigeria indicate that the wood is not resistant to subterranean termites. The sapwood forms a large portion of the tree, and is permeable to preservatives, while the small proportion of heartwood is moderately resistant (6).

The working characteristics are generally good, but some logs cause such severe blunting of tools that carbide-tipped teeth are necessary for saws. It is not possible to detect such logs in advance, so all tools must be capable of handling the material in order to prevent delay in production. The wood usually works readily both with hand and machine tools, and finishes cleanly if the tool edges are sharp. Abura has satisfactory gluing and nailing characteristics, but thin-gage nails are recommended. It stains and polishes very well. The larger logs are suitable for plywood manufacture; uniform and smooth veneer can be produced, but it has little luster and the color sometimes fades (6).

Abura is used by the natives for carving, barrels, doors, canoes, and housebuilding. In Nigeria it is used for light construction work, furniture, and battery boxes. The wood is reported to show no signs of corrosion after contact with acid for more than 5 years (13).

Although the wood is not important in the United States, it is valued in England for light construction work where resistance to decay is not important. It is used for interior cabinet work and as a substitute for other furniture woods, for joinery, decorative moldings, and other interior work (6).

Identifying Features

Growth rings are present because of an increase in the density of the fibers, but they are not very conspicuous. The pores, which are just within the limit of vision without a lens, are numerous and evenly distributed either solitary or in radial groups of 2 to 6. Vessel pit-pairs are small and vestured. The parenchyma is visible under a lens as very fine broken tangential lines between the rays. The rays cannot be seen without a lens on cross section, but they are distinct as brown flecks on the radial section. The rays are decidedly heterogeneous. The fiber-tracheids have distinct bordered pits.

Monodora myristica (Gaertn) Dunal
Calabash Nutmeg
Family: Annonaceae

Calabash nutmeg is found in the Grand Bassa and River Cess areas of south-central Liberia. It occurs also in Ghana, southern Nigeria, the British Cameroons, and from French Cameroons to Uganda and Angola. Found primarily in the swamps (14, 19), it may be up to 60 feet tall.

The wood is very light brown with greenish-brown streaks near wound areas, and has a high luster. The texture is rather coarse, and the grain is usually straight. The wood is moderately hard and moderately heavy, but it is not durable (14). It is easy to work, finishes smoothly, and holds its place well when manufactured.

Morinda germinata DC
Family: Rubiaceae

The tree grows in the equatorial forest of Mayombe and the lower Congo, as well as in southwestern Liberia, and is reported to be abundant (14, 34).

The tree is 25 to 30 feet tall and 5 to 6 inches in diameter (14). The wood is yellow, hard, and resistant (34).

Morus mesozygia Stapf
Difou
Family: Moraceae

Difou grows on the edge of the humid rain forest on the Ivory Coast, Togo, Nigeria, the Cameroons, Oubangui - Chari, and western Liberia.

It is a large tree, up to 95 feet tall and up to 2 feet in diameter. The bole is straight and cylindrical with buttresses at the base. The buttresses are large and irregular, but they are not too pronounced (23).

The sapwood is grayish white, distinct from the yellow heartwood. After it is cut, the heartwood becomes golden, and after long exposure to air it is golden brown. The wood has a moderately high luster. The texture is moderately coarse, and the grain is straight to interlocked.

The wood is hard and rather heavy. The specific gravity is 0.79, based on the weight of the ovendry wood and its volume when green. In static bending tests on 2- by 2-centimeter green specimens, the modulus of rupture was 23,515 pounds per square inch.

The wood shows moderate shrinkage. The volumetric shrinkage is 10 percent, expressed as a percentage of the green dimension in shrinkage from the green to the ovendry condition (32). The wood is rather stable when manufactured (23), and is easy to saw, but interlocked grain causes a little trouble in planing. Some precautions are necessary to make nails and screws penetrate, but once in they hold well. The wood takes an excellent polish and takes paint and varnish perfectly (23).

The wood is not now of commercial importance, but it is considered promising for future use, either foreign or domestic (25). It is classed as a heavy hardwood, but it may be useful for rotary or sliced veneer and for joinery (31).

Growth rings apparently are present, marked by areas that lack pores or parenchyma bands. The pores are solitary or in radial rows of 2 or 3 pores that are visible without a lens, and are completely occluded with tyloses. The parenchyma is abundant and readily visible without a lens. It is in the form of wavy, concentric bands, each as wide as the diameter of the pores. The rays are not distinct on cross section without a lens, but they are quite distinct with one because they are lighter than the background. They are not distinct on the radial surface, since they are the same color as the background. They are 3 to 4 cells wide and moderately low.

Musanga cecropioides R. Br.
(Syn. M. smithii R. Br.)
Corkwood
Family: Moraceae

Corkwood occurs in tropical Africa, the Ivory Coast, Uganda, and Liberia. In the Belgian Congo it is found along the roads in the secondary forest. The tree requires a high humidity and grows extremely rapidly, but it dies as soon as it is overtopped. In Liberia, corkwood forms nearly pure stands as it invades clearings. It spreads vegetatively by means of aerial runners (14, 23).

The tree may be 40 to 65 feet tall with a diameter of 1 to 2-1/2 feet. It has prop roots that may extend from more than 9 feet above the base (14, 23).

The heartwood is not distinct from the sapwood. Both are grayish white with a somewhat pinkish tinge, coarse textured, with a rather high luster. The wood is very soft and light (specific gravity is 0.33, based on the ovendry weight and the volume of the green wood (32)). The results of tests of mechanical properties are included in table 1.

The shrinkage of corkwood is moderate. The average longitudinal shrinkage is 12.5 percent from the green to the ovendry condition. The wood, which is moderately unstable when manufactured (32), is easy

to saw but difficult to plane. Assemblage is difficult, although nails and screws penetrate readily and hold well. It is almost impossible to polish the wood, and when painted, too much paint is absorbed (23).

The tree is of no commercial value at present, but it is considered promising for future specialized foreign or domestic use (25).

Growth rings are not distinct. The pores are primarily solitary, but sometimes they occur in radial rows of 2 or 3. They are completely occluded with tyloses. The parenchyma surrounds the pores and is irregularly distributed; chambered crystals are present. The rays are distinct without a lens on cross section, but not very distinct on radial section because they are the same color as the background. There are numerous crystals in the rays.

Oldfieldia africana Benth and Hook f.
"African Oak"
Family: Euphorbiaceae

Oldfieldia africana grows between Sierra Leone and the western section of the Ivory Coast.

The tree is very large, often over 100 feet tall and 4 to 5 feet in diameter. The bole is long and clear, with low buttresses and prop roots (14, 30).

The heartwood is brown or reddish brown, and the sapwood is grayish olive, not sharply demarcated, and sometimes with a greenish stain. The luster is rather low. The wood has a slightly bitter taste. The texture is medium fine and the grain is irregular, often interlocked.

The timber is very hard, heavy, tough, and strong. The specific gravity, based upon the weight and volume of the ovendry wood, is 0.97. The weight at 12 percent moisture content is 62 pounds per cubic foot (14). The strength values, based upon tests of a very limited amount of material, are included in table 1.

There is no information about the seasoning characteristics of this wood, but it is said to hold its place well (14). The timber is difficult to work when it is dry, but it finishes smoothly (14).

The wood is reported to be highly durable and immune to attack by shipworms. There is a report of a ship built in 1741 that had planks of this wood intact as late as 1850 (14, 29).

The tree furnishes one of the best timbers for heavy, durable construction on the African Coast. It is used locally for keelsons for boats and is suitable for constructions subjected to water, such as bridges, bridge floor planking, and floodgates (14, 30).

The wood has an established value in the commercial markets of the world (25).

Ongokea gore (Hua) Pierre
Angueuk
Kosin
Family: Olacaceae

Kosin occurs in southweatern Liberia and from the Ivory Coast to the Belgian Congo. It is a large tree of the virgin "dry land" forest, but it is well represented also in the forests that are flooded. In the Belgian Congo the tree may be 130 feet high. The trunk is cylindrical, straight, without buttresses, but sometimes lobed at the base. The bole may be 80 feet long and 4 feet in diameter (20).

The heartwood is yellowish. The texture is moderately fine and homogeneous. The grain is somewhat interlocked, and the luster is moderately low.

The wood is hard and heavy. The specific gravity ranges from 0.75 to 0.81, with an average of 0.78, based upon weight of the ovendry wood and its volume when green. The mechanical properties of the wood are included in table 1.

The wood has a moderately high average volumetric shrinkage of 13.8. The average tangential shrinkage, however, is 11.2 percent and the average radial shrinkage is 4.5 percent (32). The wood, though reported to split in drying (20). is much used locally for carpentry (20).

Identifying Features

Growth rings are not distinct. The pores, which are not numerous, are medium sized and almost exclusively solitary. Rays are 2 to 3 cells wide and are heterogeneous, with 1 to 4 rows of uniseriate upright cells. Uniseriate rays are moderately numerous. Crystals are abundant in chambered cells. The fiber-tracheids have distinct and numerous bordered pits.

Pachypodanthium staudtii Engl. and Diels
Family: Annonaceae

Pachypodanthium staudtii is a large-boled forest tree from 60 to 90 feet high and 2 feet in diameter (19, 29).

There is little distinction between the heartwood and sapwood. The wood is light yellowish or greenish brown, not very lustrous. The texture is rather coarse, but the grain usually is straight. The growth rings are faintly distinct because of a difference in the distribution of the bands of parenchyma. The pores are distinct without a lens, not numerous, and uniformly scattered either as solitary pores or in radial pairs. The vessel lines are distinct on the longitudinal surfaces. The parenchyma is in fine parallel lines spaced 1/2 to 1/3 pore diameter apart, but finer and more closely spaced in the late wood. The rays are quite conspicuous on the cross section and are much wider than the horizontal bands of parenchyma. They appear as high, distinct flecks on the radial surface, slightly darker than the background.

The wood is moderately hard, tough, and strong. The specific gravity of one sample tested at Yale University is 0.76, based upon weight and volume of the ovendry wood. The weight is 47 pounds per cubic foot at 12 percent moisture content. The modulus of elasticity in static bending tests is 2,850,000 pounds per square inch, and the modulus of rupture is 20,170 pounds per square inch. The maximum crushing strength is 8,680 pounds per square inch. The average side hardness is 2,035 pounds (14).

The wood is easy to work, finishes smoothly, and is reported to be durable (14). The timber is not now of commercial value, but it is considered promising for future specialized foreign or domestic use (25).

Panda oleosa Pierre
Family: Pandaceae

Panda oleosa is the only species known of the genus Panda. It is a tree of the dense rain forests, where it is moderately distributed. It is sometimes abundant in the lower story, with a trunk that branches rather low. It is found in the Ivory Coast in the transition zone between the dense shade forests and forests with seasonal changes rather rarely; it occurs oftener in humid areas. It extends from Liberia and the Ivory Coast to the Congo (29).

The wood is yellowish brown or grayish. The color often is not uniform because the wood is susceptible to the staining fungi. The luster is moderately low. The grain is straight to interlocked, and the texture is fine.

The timber is moderately hard and moderately heavy, with a specific gravity of 0.67 when air dry, and a weight of 42 pounds per cubic foot. The wood is easy to work, and it takes a smooth finish. It is suitable for veneer and general utility (22).

Identifying Features

Growth rings are not distinct. Pores are visible only under a lens and are numerous. They are occasionally solitary, but usually they are in radial groups of 2 to 8. They are medium sized with small, alternate pits. The perforation plates are simple, or scalariform with 2 to 5 heavy bars. The parenchyma is distinct under a lens. It forms a closely spaced, uniseriate reticulum with the rays that is quite conspicuous. The heterogeneous rays are 1 to 5, mostly 3 to 4 cells wide and usually less than 30 cells high on tangential section. Crystals are numerous in the marginal ray cells.

Parinari excelsa Sabine
(Syn. Parinari tenuifolia A. Chev.)
Parinari glabra Oliv.
Parinari robusta Oliv.
Rough-skin plum
Graham-Sougue
Family: Rosaceae

The genus Parinari has numerous species in the tropical and sub-tropical regions of the world. It is represented in South America, the Philippines, and East and West Africa. There are many trees of several different species in Liberia. They occur in the south-eastern and south-central regions primarily, but some species are also in the southwest (25).

Parinari excelsa is a large tree that may be 150 feet high and 5 feet in diameter. The average mature tree, however, is smaller. Normally the bole is straight and cylindrical and has short, rounded buttresses, but in some areas the bole is fluted and the buttresses are high and narrow (6, 14).

The woods of all the species are very similar in structure and appearance. The sapwood is yellowish white with a fragrance of honey or beeswax when it is freshly cut. The heartwood ranges in color from light pinkish or grayish brown to reddish or chocolate brown. The wood has little luster. The texture is moderately coarse and the grain is almost always decidedly interlocked. Silica is rather abundant in the ray cells.

The wood is hard and heavy. It weighs 43 to 55 pounds per cubic foot when air-dry at 12 percent moisture content, and averages about 46 pounds per cubic foot. The average green weight is 71 pounds per cubic foot at 80 percent moisture content (6).

The average specific gravity of woods from the Ivory Coast ranges from 0.72 to 0.89, based upon the weight when ovendry and the volume of the green wood, with an average of 0.80 (32). Mechanical properties of wood specimens, are included in table 1. The wood can be bent to a moderate radius of curvature if it is steamed and then supported by a metal strap and an end-pressure device (6).

The timber is very difficult to season from the green condition, because it dries very slowly and checking and splitting are common. Distortion may be severe, and it is suggested that thick material be air dried before it is kiln dried, for more economical and satisfactory results. The British Forest Products Research Laboratory recommends its kiln schedule B (table 4) for this wood (6). An increase in humidity of 10 percent is suggested for material over 1-1/2 inches thick (6). The shrinkage values for this timber are rather high (table 2).

The wood probably is moderately durable with respect to attack by fungi, but no test results are available. There is no information about resistance to insect attack. The timber is moderately resistant to preservative treatment (6).

It is rather difficult to work the wood with either hand or machine tools. The cutting edges of the tools rapidly become blunted, probably because of the silica present in the ray cells. If the tools are sharp, the material cuts cleanly in most operations, but it often tears in planing. Freshly felled logs or wood with a high moisture content can be cut satisfactorily with ordinary saws, but dry timber requires carbide-tipped saws. The wood takes glue well, but it tends to split when nailed. It is technically suitable for the manufacture of plywood, although it is considered unsuitable for British mills (6).

None of the species of Parinari has any established commercial timber value in world markets or even in the countries where they grow, probably because of the abrasive action of the timber. It cannot be used economically when resawing and machining of seasoned wood are required. It might be used in large sizes for construction purposes and converted, when green, with circular saws. Even then, however, stellite-tipped inserted teeth may be economically necessary (6, 25).

Identifying Features

The growth rings are not distinct. The pores, readily visible without a lens but not numerous, are solitary and are arranged more or less diagonally. The parenchyma is in distinct concentric bands, several cells wide, that are not more than one pore width apart. The rays are 1 to 2 rows wide. The fibers have conspicuous bordered pits on the tangential walls.

Parkia bicolor A. Chev.
Locust bean
Family: Leguminosae - Mimosaceae

The locust bean tree sometimes reaches a height of 100 feet and a diameter of 4 feet. It may have tall, narrow buttresses or low, basal swelling. The tree is very common in the drier areas of Liberia, particularly near the deciduous forest. In the Ivory Coast it is found in the dense rain forest (14, 29).

The heartwood is light brown with darker irregular streaks, while the sapwood is nearly white. The texture is coarse, and the grain is straight or interlocked. The growth rings are not very distinct. The pores are fairly large, widely spaced, and distinct without a hand lens. They are frequently solitary but also in radial rows of 2 or 3, marked on the longitudinal surfaces by deep vertical grooves. The rays are inconspicuous on any surface. The parenchyma surrounds the pores, often with wing-like extensions that may be confluent.

The timber is rather light and soft, but it is firm and tough. In limited tests at Yale University, the specific gravity was 0.41, based upon weight and volume of the ovendry wood. The wood weighs 29 pounds per cubic foot at 12 percent moisture content.

The timber is very easy to cut but it saws rather woolly. It can be finished smoothly when it is dry (14). Locust bean probably is not durable. The wood is not now of commercial importance in world markets, but it is considered promising for future foreign or domestic use (25).

Pausinystalia lane - poolei Hutch
Family: Rubiaceae

This species of Pausinystalia is a rather infrequent forest tree in the western part of Liberia.

The tree may be 100 feet tall and 4 feet in diameter. The bole is straight and clear, up to 40 or 50 feet long. There are low buttresses (14).

The wood, pale brown when first cut, becomes pinkish and eventually the surface is light olive brown. The heartwood-sapwood boundary is not very distinct. The wood has little luster, is fine textured, and the grain is straight to irregular.

The timber is moderately hard and heavy. In limited tests at the Yale School of Forestry, the specific gravity was 0.68, based upon weight and volume of the ovendry wood. The wood weighs 45 pounds per cubic foot at 12 percent moisture content (14).

The wood is easy to work, can be finished very smoothly, and holds its place well (14). Although there are no test results, the wood is probably not very resistant to decay or attack by insects (14).

The timber is not at present of commercial importance in world markets, but it is considered promising for future use because of the size of the trees (25).

Pentaclethra macrophylla Benth.
Mubala
Oil-bean Tree
Family: Leguminosae-Mimosaceae

Pentaclethra macrophylla is widely distributed in Africa, from Liberia and the Ivory Coast to Gaboon, the Middle Congo, and the Belgian Congo. It does not form pure stands and usually grows at the edges of the forest. It is one of the first species that appears in the savannah in the course of reforestation. In Liberia the tree is abundant, especially in areas of second growth in the southeast (14, 25, 29).

The tree is 60 to 95 feet tall, with a diameter of 1-1/2 to 2 feet. The trunk is slightly sinuous but cylindrical. It is strongly buttressed up to 5 feet from the ground in the Congo, but it is apparently unbuttressed in Liberia. The clear bole may be 45 to 60 feet long (14, 23).

The heartwood and sapwood are distinct. The sapwood is grayish or nearly white; the heartwood is reddish brown to olive brown, with a moderately high luster. The texture is coarse, and the grain is irregular or even interlocked. Parenchyma is abundant, and forms rounded borders around the pores, which makes them readily distinct

without a lens. Some masses of parenchyma cells are not associated with the pores. The rays are not distinct without a lens on the cross section and are inconspicuous on the radial section. White deposits fill some of the pores and are distinct as white streaks on the longitudinal section.

The wood is hard and heavy. The average specific gravity is 0.87, based on the weight of the ovendry wood and its volume when green. The range is from 0.82 to 0.92 (32). Mechanical properties are included in table 1.

The timber requires care in seasoning. The average volumetric shrinkage is 11.3 percent, based upon shrinkage from the green to the ovendry condition expressed as a percentage of the dimension when green (table 2). The range is from 10.5 to 12.4 percent (32).

The wood is not very stable in service (23), but it is said to be highly resistant to decay and insect attack (14).

This timber is easy to saw, but it is difficult to plane because of the irregular grain. Framing is difficult to assemble but very firm when completed. Nails and screws are easily driven in, but certain precautions are necessary to avoid splitting the wood. The surfaces are difficult to polish, but they take paint and varnish well (23).

There is at present no commercial value for the wood, but it is considered promising for future general commercial use, foreign or domestic (25). The timber is used locally for planks and timbers (14).

Identifying Characteristics

The growth rings are not very distinct. The pores are primarily solitary, but occasionally in groups of 2 or 3. They are not crowded, with only 4 to 6 per square millimeter. The rays are numerous but very fine, 1 to 2 or occasionally 3 rows of cells in width, usually in echelon. The parenchyma is abundant around the pores, either rounded or diamond-shaped because of wing-like extensions. Masses of parenchyma are sometimes independent of the pores. The pitting on the vessel walls is vestured.

Pentadesma butyracea Sabine
Tallow Tree
Family: Guttiferae

The tallow tree is one of several species of Pentadesma that are all native to tropical Africa. It grows throughout Liberia.

The tree is 75 to 90 feet tall and 2-1/2 to 3 feet in diameter. It usually has high, narrow buttresses and a straight, clear bole (14, 19).

The heartwood is light brown with a rather low luster. The texture is very coarse. Concentric rows of parenchyma appear as light-colored bands on the cross section. The rays are distinct without a lens on the cross section and appear as silver flecks on the radial section. The growth rings are more or less distinct because of darker bands of cells.

The wood is rather hard and heavy. The average specific gravity is 0.88, based on the weight of the ovendry wood and its volume when green. The range is from 0.76 to 0.96 (32). Mechanical properties are included in table 1.

Phyllanthus discoideus (Baill.) Muell. Arg.
Family: Euphorbiaceae

Species of the genus Phyllanthus are scattered throughout the world. Discoideus occupies a vast area of West Africa from the savanna regions to the secondary formations in the dense forest. In Liberia it occurs in the eastern section (25, 30).

The tree is sometimes 60 feet high and 2 feet in diameter. The bole is clear and unbuttressed (14). The wood is light reddish brown throughout with little luster. The texture is moderately fine and the grain may be straight or interlocked.

The timber is rather hard and heavy. In limited tests at the Yale School of Forestry, the specific gravity was 0.73, based upon weight and volume when ovendry. The wood weighs 46 pounds per cubic foot at 12 percent moisture content. Mechanical properties are included in table 1.

The wood has been used for the manufacture of furniture. It is of no commercial value at present, but it is considered promising for future specialized foreign or domestic use (25, 30).

Piptadeniastrum africanum (Hook. f.) Brenan

(Syn. Piptadenia africana Hook. f.)
Dabema
"African greenheart"
Family: Leguminosae-Mimosaceae

"African greenheart" is one of the most common trees in Liberia. It is a light-loving species and is often found at the edge of the forest and near villages. It occurs from Senegal to the Cameroons and Angola and from Nigeria to the Sudan and Uganda (6, 23).

The tree often is 120 to 160 feet high, with a diameter of 3 to 4 feet, sometimes to 5 feet or more. The bole is straight and cylindrical, 30 to 50 feet above the buttresses. The very large, wide-spreading, plank-type buttresses may be 10 to 15 feet high (6, 14, 23).

The sapwood is dirty white to pale straw colored, 2 inches or more wide. The heartwood is light yellowish brown to golden brown. The grain is typically interlocked and produces a broad stripe figure in quarter-sawn material. The texture is coarse but even. Freshly cut wood has an unpleasant odor that disappears when it is dried. It may become discolored in contact with iron.

The wood is moderately hard and moderately heavy. It weighs from 39 to 49 pounds per cubic foot when air dried to 12 percent moisture content, with an average of about 43 pounds. In the green condition it weighs about 70 pounds per cubic foot (6). The average specific gravity ranges from 0.53 to 0.71, with an average of 0.60 percent, based upon the weight of the ovendry wood and its volume when green (32). Mechanical properties are included in table 1. Although this wood has good strength properties, it has pronounced interlocked grain and thus should not be used where strength is needed in small sections such as ladder rungs. It is considered to be unsuitable for solid bent work because it distorts severely during the steaming profess and the bending operation (6).

The wood is variable in its seasoning characteristics, and it seasons slowly. In some timbers there is a decided tendency to collapse and distort. When that occurs, reconditioning is not effective in removing the collapse. The shrinkage is moderate (table 2). The British Forest Products Research Laboratory (6) recommends its kiln schedule A (table 3) for this wood.

"African greenheart" is rated moderately durable with respect to fungus attack. Logs are sometimes attacked by ambrosia beetles in Africa, and the sapwood may be attacked by powderpost beetles. The wood is considered to be resistant to termites in Nigeria, but South Africa reports that the resistance to severe attacks does not last beyond 3 years. Heartwood is resistant to preservative treatment and the sapwood is moderately resistant.

The wood is fairly easy to work with hand or machine tools, and it has only a moderate blunting effect on cutting edges. Saw teeth, however, are blunted rather rapidly because of the interlocked grain. Tearing in planing and molding can be avoided if a cutting angle of 10° is used. The wood tends to char in boring, but a fairly clean finish can be obtained in other operations. It glues well and has moderately good nailing properties. It stains and polishes satisfactorily, but a grain-filler is necessary. Fine sawdust from various machining operations may irritate the mucous membrane of the nose and throat unless provision is made for dust removal. The wood is unsuitable for the manufacture of plywood (6, 23).

The timber might be used as a substitute for oak in vehicle manufacture. It can be used in heavy construction in structural sizes. It should not be used for small dimension stock. It can be used for flooring, but only in dwelling houses, for it has moderate to low resistance to wear. Conversion and grading to specification should be done in the country of origin (6).

Identifying Features

Growth rings may or may not be distinct with the unaided eye on cross section. The growth boundary may be marked by a broken line of parenchyma, or there may be a dark zone with few pores or even a zone of more numerous pores. The pores are distinct without a lens, few to rather few, and evenly distributed except at the margins of the growth rings. They are mostly solitary but are also in radial

rows of 2 to 4 pores. The pit-pairs are large and vestured. The parenchyma, variable in abundance, surrounds the pores and sometimes forms lateral wings that may become confluent. It also forms narrow, discontinuous marginal bands in some areas. The rays are moderately fine, readily visible under a lens on cross and tangential sections, and not conspicuous on the radial surface. The fibers are septate. Crystals are present in chambered parenchyma, and both rays and vessels have gummy deposits.

Protomegabaria stapfiana (Beille) Hutch.
Family: Euphorbiaceae

Protomegabaria has only two species, both in tropical Africa. In the Ivory Coast it is a moderately large tree up to 65 feet tall and 2 feet in diameter. It has no buttresses when growing in the high forest, where it reaches its best development. When it grows in swampy areas, however, it has prop roots and a low-branching bole. It is fairly abundant, but scattered as an understory tree in the high forest, and it forms small stands in swampy areas (14, 30). It occurs in southeastern Liberia.

The heartwood is pale yellowish brown, little differentiated from the sapwood. It is fairly lustrous. The texture is medium and the grain usually is straight. Growth rings are not distinct. The pores, not visible without a lens, are numerous, and occur singly or in small radial groups. The rays are very distinct on the cross section and produce high, silvery flecks on the radial surface. There are crystalliferous cells in the rays. The fibers are very long and have thick walls.

The wood is of medium density. In limited tests at Yale University, the specific gravity was 0.66, based upon weight and volume of ovendry wood. It weighs 44 pounds per cubic foot, and it is hard, with a value in hardness tests of 1,700 pounds end grain and 1,520 pounds side grain for material at 12 percent moisture content (14).

The timber probably is not resistant to decay. It is not difficult to work, and it finishes smoothly (14).

The wood is more attractive than that of Uapaca, but the form of the tree often is so poor that little interest has been shown in it.

It has no present commercial value, but it is considered promising for future specialized foreign or domestic use (25).

Pterocarpus santalinoides L' Her. ex DC.
Family: Leguminosae - Papilionaceae

This is one of two species of Pterocarpus that occur in the Ivory Coast. It is the only one reported from Liberia, where it grows in the southeastern part. It is found in the dense forest, on the banks of streams, and it ascends up to the edge of the Sudan zone (14, 29).

The tree is medium large and has wide buttresses. The bole may be divided (14).

P. erinaceus has been reported from Sierra Leone and may extend into Liberia.

The heartwood and sapwood are almost indistinguishable and nearly white throughout, except for a reddish-violet color near wounds. The wood is rather lustrous, with medium-fine texture and generally straight grain. The growth rings are not distinct. Pores are few and scattered, occurring singly or in radially flattened groups of 2 to 5. The parenchyma is in irregular tangential lines connecting the pores. The rays are minute (uniseriate and homogeneous), not visible without a lens on the cross section and inconspicuous on the radial section. Ripple marks are present, scarcely distinct but fairly regular. All elements are storied.

The wood is rather light in weight, but it is moderately tough and firm. It is not durable in contact with the ground. It is easy to work and finishes smoothly. The timber is sometimes used locally for building, and is suitable for boxes and general carpentry if not used in exposed places (14).

The wood has no commercial value at present, but it is considered promising for future specialized foreign or domestic use (25).

Pycnanthus angolensis (Welw.) Warb.
Syn. P. Kombo (Baill.) Warb.
Illomba
"White cedar"
Family: Myristicaceae

Illomba grows in the forests of all parts of West Africa from French Guinea to Angola and east to Uganda (6, 19). It is a forest tree from 100 to 120 feet tall with a diameter of 2-1/2 to 5 feet and a long, straight bole. Buttresses are very small or absent (6, 19, 23).

The wood is grayish white to pinkish brown when dry, with little distinction between heartwood and sapwood. If the logs remain in the forest, however, or if there is delay in conversion, the wood is likely to show fungus stain. It has a very disagreeable odor when freshly cut, but it disappears upon drying. The texture is rather coarse and the grain is usually straight. The luster is fairly low.

The timber is rather light in weight but moderately hard to soft. The average specific gravity of specimens tested in the Centre Technique Forestier Tropicale ranges from 0.39 to 0.51, with an average value of 0.44, based upon the weight of the ovendry wood and its volume when green (32). Air-dry timber at 12 percent moisture content weighs 32 pounds per cubic foot (6). Mechanical properties are included in table 1.

The wood has a moderately high shrinkage. Average volumetric shrinkage ranges from 10.7 to 16.0 percent, with an average (table 2) of 12.5 percent (32). Although no seasoning tests have been made, it is reported that the wood is prone to split and may distort severely. The British Forest Products Research Laboratory suggests their kiln schedule C (table 5) for this timber.

Illomba is not resistant to fungus attack and can be readily stained, It is sometimes damaged by ambrosia and longhorn beetles. The sapwood is very susceptible to attack by powderpost beetles. It apparently is not resistant to termites. It is permeable, however, and takes preservative treatment (6).

The wood is easy to saw and to plane, for there is no interlocked grain. It takes nails readily and they hold well. It is difficult to polish, and it absorbs too much paint. The timber can be glued satisfactorily (6, 23).

Illomba is a lightweight, low-grade timber that can be used for core veneer in plywood suitable for boxes. It could be used in carpentry or for the backs of drawers and cupboards. It is of recognized and established commercial value in Liberia and is sent to world markets (6, 25).

Identifying Features

The growth rings are not distant. The pores (very few), which are readily visible without a lens, are solitary or in radial rows of 2 or occasionally 3 pores. The parenchyma is not readily visible; it surrounds the pores in 1 to 2 rows of cells. The rays are rather closely spaced, readily distinct under a lens. They form conspicuous brown flecks on the radial surface. The fibers are long, with an average length of 1.8 microns.

In the microscopic study of the structure, the following details can be noted:

1. The pit-pairs on the vessel walls are large, 12 microns in diameter.

2. Vessel perforation plates usually are simple, but scalariform plates are sometimes present.

3. The rays are decidedly heterogeneous, up to 3 to 6 cells wide, but all the cells are large. Tanniferous tubes frequently are present in the rays.

Rhizophora racemosa G. F. W. Mey.
Paletuvier rouge
Red mangrove
Family: Rhizophoraceae

The red mangrove is the commonest mangrove in West Africa. It occurs from the mouth of the Senegal River in Senegal through the the coastal regions of Sierra Leone and the Ivory Coast to the Belgian Congo and Angola. In Liberia it is reported from the Sino basin (19). The tree forms pure stands on the edges of lagoons and the estuaries of rivers where the tide exerts its activity (26).

Red mangrove may be up to 130 feet high or it may be part of a shrubby tangle only 12 to 30 feet high. Trees 65 feet high and 2 feet in diameter are common in the Cameroons. The bole may be straight, but it often is twisted. Prop roots up to 15 feet long extend from the trunk to the ground (19, 26).

The heartwood and sapwood are sharply distinct; the sapwood is brownish white and the heartwood is reddish brown. The texture is fine, and the grain may be interlocked or straight.

The wood is very hard and heavy. Average specific gravity ranges from 0.94 to 0.98, with an average of 0.96, based upon the weight of the ovendry wood and its volume when green (32). Mechanical properties are included in table 1.

Red mangrove has a very high shrinkage and is extremely unstable in use. The average volumetric shrinkage ranges from 16.7 to 17.1 percent, with an average value of 16.9 percent (table 2). Drying must be carefully controlled, for the wood has a tendency to warp and check on the surface (26, 32).

The heartwood is practically immune to decay, but the sapwood is susceptible. Small logs used for posts or piling must be heavily impregnated with preservative before they are used (26).

In sawing this very hard wood on the bandsaw, one must use a very slow speed, with the pitch of the saw tooth 16 to 20 mm. and the angle of attack 15 to 16 degrees. The saw uses much power, in spite of the slowness of operation, and the saw blades wear out rapidly. Planing operations are slow, but they are fairly easy to do. Assembly is difficult and is insecure unless the work is done

in an area where the humidity is constant. Nails and screws are difficult to insert, but they hold well (26).

Red mangrove has been used for many years in the Cameroons for railway ties and for staves, but not extensively. It could be used for hydraulic equipment, mine props, or even telegraph poles, although the young trees are not often straight and the cost of transporting them to other countries is high. They could, however, be used for the footing of poles, for they have higher resistance than concrete and are cheaper. Mangrove is suitable for wine and alcohol casks because of its high tannin content, which helps to preserve the liquids. The staves remain stable so long as the casks are full, for the saturation point is low (26).

Identifying Features

Growth zones are distinct because of areas of fewer pores that appear darker and sinuous. The pores are very small, very numerous, and rather irregularly distributed; solitary or in groups of 2 pores. The parenchyma is not distinct. The rays are fine, closely spaced, and visible only under a lens on cross section, but quite high and distinct on the radial section. Under the microscope the following features are important:

1. The vessels have scalariform pit-pairs with pits closely spaced and extending from wall to wall in longitudinal section.

2. The perforation plates are scalariform with a few thick bars.

3. The rays are homogeneous with very small procumbent cells. Crystals are numerous in the rays, and gummy deposits are present.

Ricinodendron heudelotii (Baill) Pierre ex Pax
(Syn. Ricinodendron africanum Muell. Arg.)
Erimado
Family: Euphorbiaceae

Ricinodendron is a tree typical of the secondary forest, and it is quite common on the site of abandoned farms. It is widely dispersed

in tropical Africa from French Guinea to Angola, the Belgian Congo, Uganda, and other areas of East Africa. It is considered to be one of the fastest growing native species (13, 23).

The tree is variable in size. It may become very large, up to 100 feet or more tall and almost 5 feet in diameter, but sometimes it is a small tree only 20 to 30 feet high. It is usually medium sized, however, with a height of up to 70 feet and a diameter of about 2-1/2 feet. The trunk is cylindrical, without buttresses or with very short ones. It is provided with very large, ramifying roots. The bole is often low-branched, and is not well formed when it is old (13, 23, 30).

The heartwood is not distinct from the sapwood. It is white with a yellowish tinge, but if often appears grayish because of fungus stain. The texture is rather coarse and the grain is straight. The wood has little luster.

The timber is very soft and light. The specific gravity ranges from 0.29 to 0.41, based upon the weight of the ovendry wood and its volume when green. The weight is 12 to 30 pounds per cubic foot, air-dry at 12 percent moisture content (13, 21).

The volumetric shrinkage is high and the wood is not stable when worked (23). There is no information about other seasoning characteris tics.

Ricinodendron is not resistant to fungus attack and is readily stained. No information is available about its resistance to insect attack.

The wood is easy to saw, but it is difficult to plane because the fibers lift up. The assembly of parts is not firm. Nails and screws enter easily, but they do not hold. It is impossible to polish the wood. It is not suitable for painting because it absorbs too much color (23).

The timber is used locally for carving and for making stools, plates, ladles, floats for fishing nets, and coffins. A similar species, Ricinodendron rautanenii Schinz from south tropical Africa, has been tested at the British Forest Products Research Laboratory. It was found to be too soft for plywood but suitable for lightweight sandwich cores (6). The long, thin-walled fiber cells in this wood are suitable for paper pulp (30).

Identifying Features

The growth rings are not distinct unless the end surface is moist; the boundary is marked by a line of slightly darker tissue. The pores vary from medium sized to large. They are few in number and readily distinct without a lens. They are solitary or in radial rows or clusters of 2 to 5 pores. The parenchyma, which is moderately abundant, but not visible without a lens, is in numerous, very fine lines from one ray to another that form a fine network. The rays are very narrow, just within the limit of vision without a lens.

Microscopic Features

Vessel elements are short to very long, up to 1,000 microns. Intervascular pit-pairs are very large. Fiber-tracheids are up to 2,050 microns long, with rather large bordered pits mostly on the radial walls. The parenchyma contains abundant crystals in chains or sometimes as several crystals in a single cell. The rays are mostly uniseriate, very occasionally partially biseriate, and more or less homogeneous.

Sacoglottis gabonensis (Baill.) Urb
Ozouga
"Cherry"
Family: Humiriaceae

Sacoglottis is characteristic of the dense rain forest in the Ivory Coast and in Liberia, particularly in swampy areas that extend almost into the mangrove formation (14, 29).

The tree is 80 to 100 feet tall and 3 to 4 feet in diameter. The bole is fluted and buttressed, sometimes very large but often short and irregular (14, 29).

The heartwood is a reddish or purplish brown that becomes yellowish after long exposure to light. It has a moderate luster. The texture is medium and the grain is usually interlocked.

The wood is hard and heavy. The average specific gravity is 0.81, based upon weight of the ovendry wood and its volume when green (32). Mechanical properties are included in table 1; shrinkage data are included in table 2.

The timber is fairly easy to work, finishes smoothly, and can take a high polish. It is probably moderately resistant to decay.

The wood is used locally for box lumber, planks, and timbers (14).

Identifying Features

Growth rings apparently are absent. The pores are few in number and almost entirely solitary. They are just visible without a lens. White gummy deposits often plug the lumina. The parenchyma is rather sparse, in short tangential lines not very distinct even under a lens. The rays are invisible without a lens on the cross and tangential sections; they are low and inconspicuous on the radial surface.

Microscopic Features

Vessels rarely show pitting because they are solitary. The perforation plates are scalariform, with 15 to 25 rather thick bars. The rays are 2 to 3 rows of cells in width and less than a millimeter high. They are decidedly heterogeneous, with many rows of square or upright cells at either end. Rays are often joined vertically. Reddish, gummy deposits fill the cells. The fiber-tracheids have numerous, rather large bordered pits on both the radial and tangential walls.

Santiria trimera (Oliv.) Aubrev.
(Pachylobus trimera (Oliv.) Guillaumin)
(Santiriopsis balsamifera (Oliv.) Engl.)
(Pachylobus balsamifera (Oliv.) Guillaumin)
Family: Burseraceae

In certain conditions of the soil, these trees often are elevated from the ground for a distance of 6 feet by large prop roots. Sometimes they have thin, winged buttresses above, with small aerial roots at

the base. The bole is cylindrical and straight, but it is rather short and has a diameter of only 16 to 20 inches. The trees are found in the St. Paul and St. John river areas in southwestern and south-central Liberia (25, 30).

The heartwood and sapwood are not very distinct. The color is a uniform yellowish white or grayish. The rays are 1 to 2 rows wide, except for the fusiform rays that contain resin canals. The pores are moderately small, with the largest pores less than 0.150 millimeter in diameter. The fibers are moderately thick walled.

The wood is rather soft and moderately light. The average specific gravity is 0.52, based on the weight of the ovendry wood and its volume when green (32). Mechanical properties of the wood are included in table 1.

The shrinkage is moderate. The average volumetric shrinkage is 12.9 percent (table 2) from the green to the ovendry condition expressed as a percentage of the green dimension (32).

The wood has no commercial value at present in Liberia, and it is of rather doubtful future value because of the size of the bole (25).

Sarcocephalus diderrichii DeWild

Bilinga
Brimstone
Family: Rubiaceae

This tree, called "brimstone" in Liberia, has a wide distribution in the equatorial forest from French Guinea to the Cameroons. It occurs in the transition zone between the freshwater swamp forest and the rain forest, often in almost pure stands on the banks of streams (6, 26).

It is a large tree, from 115 to 160 feet tall and 3 to 6 feet in diameter at breast height. The trunk is without buttresses, but old trees have small, thick swellings that extend not more than 3 feet above the ground. The bole is slender, cylindrical, and free of branches for 65 to 100 feet (6, 23, 26).

The heartwood is a distinctive uniform golden yellow or orange-brown color. The sapwood is pinkish yellow, about 2 inches wide, and clearly differentiated. The grain usually is interlocked or irregular, but straight-grained material does occur. The texture is moderately fine and the luster is medium.

The wood is heavy and moderately hard to hard. The average specific gravity ranges from 0.63 to 0.79, with an average of 0.69, based upon the weight of the ovendry wood and its volume when green (32). The average weight of the wood at 12 percent moisture content is 46 pounds per cubic foot, and when green it is 70 pounds per cubic foot (6). Mechanical properties of this wood are included in table 1. Avery limited number of tests indicates that this wood is probably poorly suited to steam bending (6).

The wood can be dried quickly with little checking or warping when it is quartersawn. Material that is flatsawn, however, may show a large amount of checking and splitting, with sometimes serious distortion. Thicker sizes of timber should be classed as slow to season. The British Forest Products Research Laboratory recommends its kiln schedule E (table 6) for this wood. The shrinkage (table 2) is moderately high (32). The wood is fairly stable in use, but only perfectly dry, quartersawn wood should be used for cabinet making (26).

Brimstone has very high natural durability with respect to fungus attack. It is occasionally subject to damage by ambrosia beetles, but it is reported to be resistant to attack by termites in West Africa. The heartwood is moderately resistant to preservative treatment, but the sapwood is permeable (6).

The timber can be worked fairly easily with both hand and machine tools without any significant dulling of the blades. The flatsawn material planes to a smooth finish, but the quartersawn wood is apt to pick up under the plane because of the interlocked grain. The cutting angle should then be reduced to 10° to obtain a satisfactory finish. Assembly is somewhat difficult to complete and it is not very strong. Care must be taken to avoid splitting in nailing, but once in, the nails and screws hold well. It is easy to polish the wood after a moderate amount of filler is used, and it takes paint and varnish well. It probably can be glued satisfactorily. This wood is not suitable for plywood manufacture. The veneer sheets cut from it are only satisfactory when they are 2 millimeters or more thick (6, 23, 26).

Because of its durability the wood ran be used for piling, docks, and decking on wharves. It is suitable and attractive for flooring for normal pedestrian traffic. It can be used for furniture, pianos, and cabinet work, as well as for general construction work (6, 26).

Identifying Features

The growth rings are not usually distinct. The pores are moderately large to large, distinct without a lens, solitary, few per square millimeter, not uniformly distributed, and often in diagonal rows. The rays are fine, closely spaced, and not distinct without a lens. The parenchyma is not distinct even under a lens. It is in very fine, short lines, irregularly distributed,

Microscopic Features

The rays are decidedly heterogeneous with numerous upright cells, 2 to 3 rows wide. Gum deposits are present. The fibers have large, numerous bordered pits.

Scytopetalum tieghemii (A. Chev.) Hutch and Dalz.
Sourwood
Family: Scytopetalaceae

Sourwood belongs to a small family of trees that grows only in tropical West Africa and the Congo. It is the only species of Scytopetalum that grows in Liberia, and it has been reported from the southeastern part of the country, in the area of the D'Bor (Dubo) River (14, 30).

It is a medium-sized tree, 50 to 60 feet tall and 12 to 16 inches in diameter. It has a long, clear bole and almost no buttresses (14).

The heartwood is uniformly light pinkish or grayish brown; the sapwood is yellowish white. It becomes discolored by blue stain to a great depth rather rapidly. The texture is medium to coarse and the grain is irregular. The wood has little luster.

The timber is moderately heavy, with an average specific gravity of 0.63, based upon the weight of the ovendry wood and its volume when green. The wood is softer than its density would lead one to

expect (32). Mechanical properties are included in table 1; shrinkage data are included in table 2.

Sourwood is not resistant to decay and is readily damaged by blue stain (14, 30).

The wood is rather difficult to work, because the interlocked grain causes woolliness in planing (14). It is not suitable for carpentry work. It might have use for local construction work, provided that precautions are taken to increase its durability by preservative treatment if it is for exterior work (30).

It is of no commercial value at, the present time, but the form and size of the tree, together with its abundance in certain areas, are considered promising for future specialized foreign or domestic use (25, 30).

Identifying Feature

The growth rings are marked by areas of fewer parenchyma bands. The pores are visible without a lens, few in number, somewhat irregularly distributed, and either solitary or in radial rows of 2 or 3 or small groups. The parenchyma forms very fine, numerous tangential lines that create a meshwork with the rays. The rays are visible without a lens on the cross section, but are not distinct on the tangential section.

Microscopic Features

The parenchyma is in uniseriate tangential rows. The rays are mostly 3 to 4 rows wide but may be up to 6. They are heterogeneous with several marginal rows of upright cells, and usually less than 1 millimeter high. The vessels have rather small, alternate bordered pits and mostly simple perforation plates, although some scalariform plates with up to 12 bars usually are present. The ray-to-vessel pitting is usually large and scalariform.

Sterculia oblonga Mast.
(Syn. Sterculia elegantiflora Hutch. and Dalz.)
Eyong
Yellow sterculia
Family: Sterculiaceae

There are numerous species of Sterculia scattered across all the tropical and subtropical regions of the world. This species in Liberia is one of two species of large trees of the dense, moderately wet forest of the southeastern part of the country. In Nigeria and the Cameroons it is more frequent in the deciduous forests, but the trees attain larger size in the rain forest (6, 25).

Sterculia trees are 80 to 120 feet tall and 2 to 3 feet in diameter. The bole is free of branches for 50 to 70 feet and is straight and cylindrical. Buttresses extend sharply up to 12 feet (6).

The heartwood ranges from yellowish white to pale yellowish brown. The sapwood is not distinct and may he 4 to 8 inches wide. The grain is somewhat interlocked and the texture is moderately coarse. The wood has a harsh feel. It has a very disagreeable odor when freshly cut that disappears after the wood is seasoned. The high rays produce a conspicuous silvery fleck on the quartersawn wood.

The timber is moderately hard and heavy. The average specific gravity is 0.61, based upon the weight of the ovendrywood and its volume when green. The weight ranges from 43 to 52 pounds per cubic foot at 12 percent moisture content, with an average of 49 pounds. The weight of the green wood is 57 to 63 pounds (5, 6). Mechanical properties are shown in table 1. Yellow sterculia can be bent to moderate radii of curvature if small knots are not present (6).

The wood is slow to season, and surface checks often develop and shakes extend. End splitting may be a problem, and cupping tends to be a serious defect in timbers that show slight collapse. The British Forest Products Research Laboratory (6) suggests their kiln schedule C (table 5).

Yellow sterculia is not durable with respect to fungus attack. Logs must be converted rapidly to avoid blue stain. The wood is sometimes damaged by ambrosia beetles, and tests in Nigeria indicate it is not resistant to termites. Although the sapwood is permeable to preservatives, the heartwood is extremely resistant (6, 30).

The wood is fairly easy to cut with machine tools but difficult to work by hand. It has a moderate dulling effect on cutting edges. The tools must be very sharp to produce a smooth finish, for the coarse texture tends to be fibrous. The wood is unsuitable for turning, but it stains and polishes without difficulty. It takes nails well, except for a tendency to split when nailed near an edge. It has variable but generally good gluing properties. The wood seems to be suitable for plywood manufacture (6).

The uses of the timber are somewhat restricted because of its poor seasoning qualities and its lack of durability. Since its hardness is greater than the specific gravity would lead one to expect, it might be used as a substitute for oak in certain types of interior joinery and for ash in making agricultural equipment. It is suitable for furniture and for construction work where durability is not important (6).

Yellow sterculia is not now of commercial importance in Liberia, but it is considered promising for future specialized foreign or domestic use (25).

Identifying Features

The growth rings are not distinct. The pores are rather large, few in number, either solitary or in radial rows of 2 to 4 pores. They are uniformly distributed. The parenchyma is abundant, in rather regular tengential bands that are distinct without a lens, and surrounding the pores. The rays are readily visible without a lens on cross section, as wide as the parenchyma bands and forming a regular screen-mesh pattern with them. On the radial section, the high rays form a conspicuous silvery fleck.

Microscopic Features

The vessels have moderately small, alternate pit-pairs and fine spiral thickening. Perforation plates are simple. The parenchyma is storied. Rays are of two sizes, the larger ones up to 10 or more cells wide and more than a millimeter high. They are decidedly heterogeneous and have sheath cells. Large crystals are present in both the parenchyma and the rays. The fibers have small, simple pits.

Strephonema pseudocola A. Chev.
Family: Combretaceae

This species of Strephonema is the only one in west tropical Africa that attains tree size. It is reported from southwestern Liberia in the Lofa and St. John River areas, and also from southeastern Liberia in the Dukwia River zone (19).

The tree may be up to 70 feet tall and 12 to 15 inches in diameter. The bole is slender and unbuttressed (14, 19).

The wood is tan or olive colored, with no distinct sapwood area. The luster is rather low, the texture is medium, and the grain is irregular. Vessel lines are distinct on the longitudinal sections.

The timber is hard and rather heavy. The specific gravity averages 0.62, with a range of 0.60 to 0.64, based upon the weight of the oven-dry wood and its volume when green (32). Mechanical properties are included in table 1.

The average volumetric shrinkage is moderate (table 2), ranging from 13.3 to 14.3 percent (32). There is no information available about the seasoning characteristics of this wood. The timber is not durable (14).

Strephonema is not easy to work, for it is rather splintery, but it takes a smooth finish (14).

The wood is not used even locally, but it should be of some value for construction work that requires strength and toughness rather than resistance to decay (14). The small size of the trees make its future value for commerce doubtful (25).

Identifying Features

The growth rings are not distinct. The pores are readily visible without a lens, irregularly scattered, and mostly solitary. The parenchyma is abundant, surrounding the pores, with long wing-like extensions that often become confluent, and with isolated patches that simulate concentric bands with the aliform parenchyma. The rays are very fine, not distinct on the cross section without a lens.

Microscopic Features

The bordered pits on the vessels are alternate, medium-sized, and vestured. Vasicentric tracheids are present. The rays are heterogeneous, with several rows of upright cells, and two rows wide. Some fibers are septate.

Strombosia glaucescens var. lucida J. Leonard
(Syn. Strombosia pustulata Oliv.)
Afina
Family: Olacaceae

Afina is the only species of Strombosia in West. Africa. It is widely distributed and abundant locally (6).

The tree usually is less than 60 feet tall and 18 inches in diameter. It has a straight bole with no buttresses (14).

The heartwood is light brown with dark purplish brown streaks. The sapwood is distinct, yellowish and rather wide. The wood is somewhat lustrous, is fine textured, and has moderately straight grain.

The timber is very hard and heavy. The average specific gravity is 0.79, based upon the weight of the ovendry wood and its volume when green. The weight is 59 pounds per cubic foot, air dried to 12 percent moisture content (32). Mechanical properties of the wood are included in table 1. The shrinkage is moderately high (table 2), and the wood is reported to be durable (14).

The heartwood is difficult to cut across the grain because it is somewhat flinty. Otherwise the wood is rather easy to work, takes a smooth finish, and polishes well (14).

Afina has already been used successfully in offices where the pedestrian traffic is heavy. Tests on flooring show that it has high resistance to abrasion and wears smoothly. It has been used also for native poles and posts, because it is strong and durable when the bark is not removed from the part in the soil. It is used locally for house construction also (6, 29).

The wood is not now of commercial value in Liberia, but it is considered promising for future specialized foreign or domestic use (25).

Identifying Features

The growth rings are more or less distinct because of variations in color at the boundaries. The pores are very small and rather numerous. They are in radial rows of 2 or more pores, uniformly distributed. The parenchyma is visible under a lens as very fine tangential lines that form a meshwork with the rays. The rays are fine, but they are visible on the cross section.

Microscopic Features

The perforation plates of the vessels are scalariform, with up to 10, sometimes more, rather thick bars. The vessel pitting is opposite. The rays are 2 to 4 cells wide and are decidedly heterogeneous. Crystals are present, and the fibers have simple pits.

Symphonia globulifera L. f.
(Syn. Symphonia gabonensis var. macrantha Hutch. and Dalz.)
Ossol
Family: Guttiferae

The same species of Symphonia occurs in Central America and the northern portion of South America as well as in Africa, from Sierra Leone to the Cameroons, Gaboon, Belgian Congo, Angola, and Uganda. In Liberia it grows in the Dukwia River and New Cess River area. The tree is common on swampy land or bottomlands (19, 23, 30).

The tree may be 80 to 95 feet tall in various areas of its distribution, with a diameter of 3 to 5 feet. The trunk is straight and very slender, without buttresses. Some of the larger trees have hollow trunks. Very small trees, only 8 inches in diameter, are frequently seen because the seeds have been widely scattered by wild animals (23, 26, 30).

The sapwood is yellowish white, sharply demarcated from the orange or reddish yellow heartwood. The wood has a moderate luster; the texture is moderately coarse and the grain is straight.

The wood is moderately hard and heavy. The average specific gravity is 0.67, based upon the weight of the ovendry wood and its volume when green (32). Mechanical properties are included in table 1. Bending

properties of African Ossol have not been tested, but the same species from British Guiana buckles when bent to any great extent. Since the South American wood is similar in every respect to the African, even to the weight of 42 pounds per cubic foot at 12 percent moisture content, it is probably that both should be used only for bends of large radii (6).

The average volumetric shrinkage of this wood is 12 percent, and it is moderately stable (32). There is no information about the seasoning characteristics either of this wood or the American material.

Tests of durability have not been made, but the American wood is reported to be durable with respect to fungi and the African timber is said to be at least moderately durable. It probably is not immune to attack by longhorn beetles, powderpost beetles, or termites. Heartwood of the American trees is extremely resistant to preservative treatment, and the sapwood is resistant. There is no information about the African wood, but it probably is similar (6).

Ossol is easy to saw and it planes without difficulty. Mortises and tenons are readily made and hold well. The wood is easily polished and it takes paint well (23). The American wood tends to split when nailed (6).

The wood probably would find a market as lumber for general carpentry, at least locally. A disadvantage is the variable color of the wood, which ranges from grayish yellow to orange yellow. The least attractive boards, however, will readily assume a warm brown tone when treated with a 1 to 2 percent solution of soda. The wood produced satisfactory veneer for plywood in recent tests in the United States (30).

This species is not now of commercial importance, but it is considered promising for future foreign or domestic use (25).

Identifying Features

The growth rings are not distinct. The pores are large, solitary or in groups of 2 or 3, and plugged with tyloses and yellow gummy deposits. The parenchyma is distinct without a lens as irregular, wavy tangential lines or concentric bands that connect but do not include the pores. Parenchyma also surrounds the pores and forms winglike extensions that may become confluent. The rays are visible without a lens on cross section and produce a silvery fleck on the radial surface.

Microscopic Features

The intervessel pit-pairs are alternate, and large. Vessel-to-ray pitting is oval to elongate. The rays are heterogeneous, with few rows of upright ray cells, to homogeneous. They are 1 to 7 but mostly 3 to 4 rows wide and up to 2 millimeters or more high. Crystals are present in some ray cells and in the parenchyma.

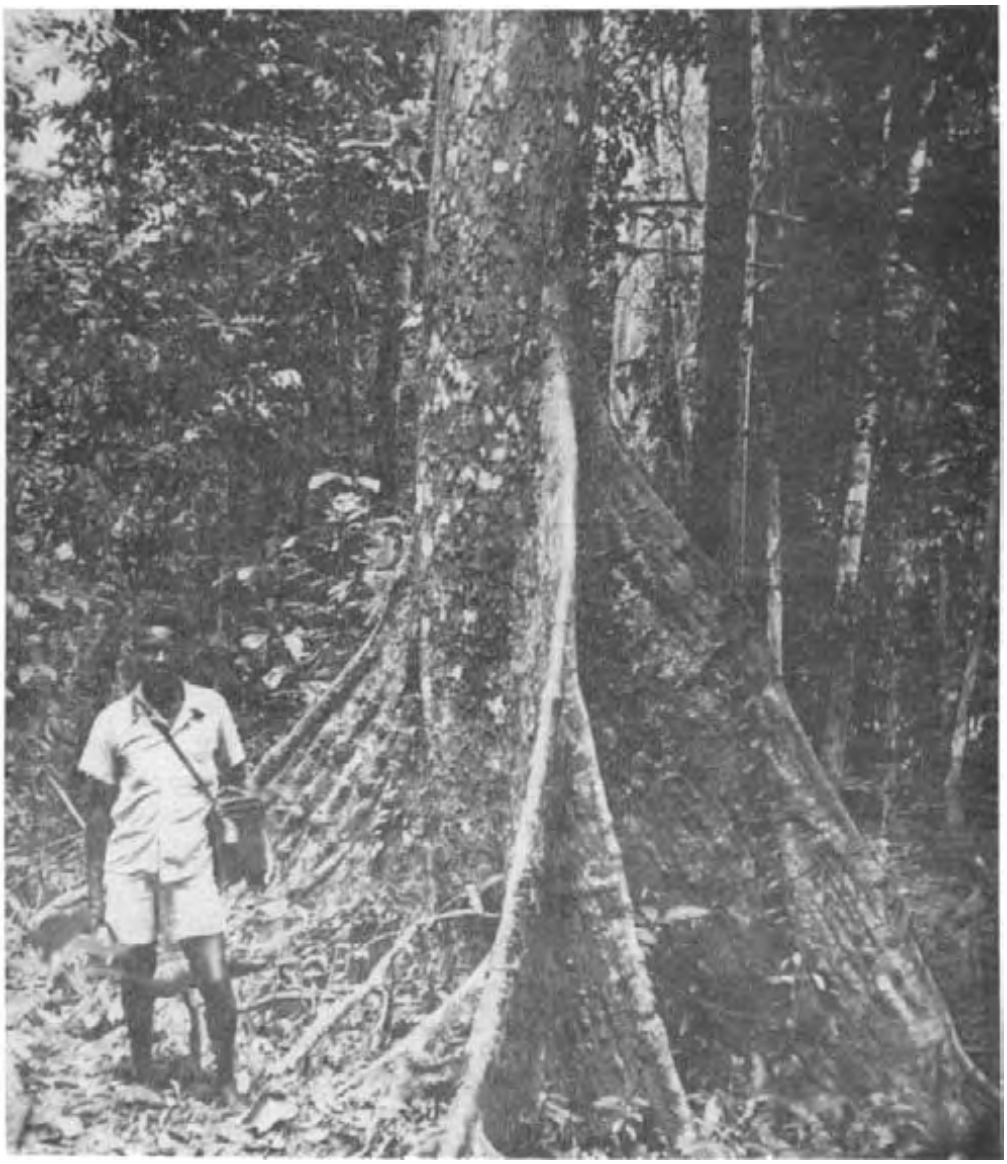
Tarrietia utilis (Sprague) Sprague
Whismore
Niangon
Wishmore
Family: Sterculiaceae

Wishmore occurs in the rain forests of Sierra Leone, Liberia, the Ivory Coast, and the southwestern part of Ghana. It is not present in Nigeria, but reappears in the Cameroons and Gaboon. It grows on dry plateaus and also in low, swampy areas in certain parts of its range (6). When it appears in a forest, it tends to predominate.

The average height of the tree is 100 feet, with a diameter of 1 to 3 feet. Occasional trees may be 130 feet high and more than 3 feet in diameter. The bole length is 65 feet, but it may be 105 feet when the trees reach the higher limits. The bole is cylindrical and well formed when the trees grow on well-drained sites, but in swampy areas it is twisted and irregular. Arched, plank buttresses develop while the tree is still very young (6).

The heartwood and sapwood are not clearly distinct. The heartwood varies from pale pink to reddish brown; the sapwood is lighter colored and about 3 inches wide. The grain is oftenwavy and interlocked, so that quartersawn boards show an irregular stripe figure. In addition, the large rays form a distinct reddish brown fleck when the wood is accurately quartersawn. The texture is rather coarse, and the timber feels greasy.

Wishmore has a wide range in weight, from 32 to 47 pounds per cubic foot in the air-dry condition at 12 percent moisture content. It weighs 55 pounds per cubic foot when green, at 65 percent moisture content (6). In tests of woods from French West Africa, the specific gravity ranged from 0.57 to 0.64, with an average of 0.62 based



Typical buttress on a Wishmore tree.

ZM 115 858

upon the weight of the ovendry wood and its volume when green (32). Mechanical properties are included in table 1. Brittleheart that is 5 to 8-1/2 inches in diameter may be present in the wood. The timber is suitable for bends of moderate radii of curvature, but the bending properties vary greatly in different samples (6).

Wishmore presents only minor seasoning problems, and it dries fairly rapidly. A small percentage of the wood may show a tendency to twist. There may be slight end splitting and surface checking. Very slight collapse may develop on a few boards. The British Forest Products Research Laboratory (6) suggests its kiln schedule E (table 6) for this wood.

The average volumetric shrinkage of Wishmore from the French African countries ranges from 9.3 to 15.5 percent (32). These and other shrinkage data are included in table 2. The wood is not sensitive to atmospheric moisture changes when dry.

Wishmore is moderately durable with respect to attack by fungi, but damage by ambrosia beetles is sometimes present. The sapwood is readily attacked by powderpost beetles. The heartwood is extremely resistant to preservative treatment, and even the sapwood is resistant (6).

The wood is easy to work with both machine and hand tools. It does not dull the cutting edges to any appreciable extent. When the ripsaw produces fine sawdust, the rather large proportion of it trapped between the blade and the cut surface of the wood tends to overheat the saw. A rather long bite per tooth must therefore be used to produce coarser sawdust. In limited tests of machining properties at the U. S. Forest Products Laboratory, 90 percent of the samples of Wishmore were free of defects when planed, 70 percent were free of defects when shaped, and 90 percent were free of defects when turned. The defect in planing was chipped grain, which occurred chiefly on quartered material. The surface roughness that made some of the shaped pieces defective was of the type that can be planed off. The timber stains and polishes well, but it requires a rather large amount of filler. Sometimes the exudation of gum creates difficulties in finishing. The wood takes glue satisfactorily, but it tends to split when nailed (6, 15).

Wishmore is a general-purpose wood for carpentry, joinery, and construction. It can be used for turning and molding. The traction

caused by the oily surface may be a disadvantage in some cases when the wood is used for flooring, but in other instances it may be desirable. It is used for agricultural implements and is suitable for shutters. In continental Europe the wood is approved for ship-building and greenhouses. It is suitable for veneer and plywood, but the plywood tends to distort.

Identifying Features

The growth rings are fairly distinct because of an increase in fiber density and the presence of marginal parenchyma. The wood is diffuse-porous. The pores are visible without magnification and are solitary or in radial groups of 2 to 3. They are often plugged with red gum. On the longitudinal surfaces the vessel lines are conspicuous because of their size and the gummy deposits.

The parenchyma is visible on a wet surface under a lens. It surrounds the pores with several rows of cells and sometimes is aliform with short wings that may become confluent and connect several pores. Short, broken lines of parenchyma occur between the rays and sometimes continuous marginal parenchyma is present. The rays are distinct without a lens on all surfaces, but they are conspicuous on the radial surface. Red gum is present in the cells. Ripple marks are present, but they are not distinct because the fibers and parenchyma are storied but the rays are not.

Terminalia ivorensis A. Chev.

Idigbo
Framiré
Emeri

Family: Combretaceae

Terminalia ivorensis occurs in French Guinea, Sierra Leone, Liberia, Ivory Coast, Ghana, southern Nigeria, and the British Cameroons. It grows in parts of the rain forest and throughout the deciduous forest areas. The tree may be 100 to 150 feet high and 3 to 4 feet in diameter. The buttresses are broad and blunt, but the bole usually is clean and straight, 65 to 70 feet above the buttresses. Sometimes fluted boles develop (6, 19).

The wood is yellowish or pale yellowish brown, rarely with a pinkish brown color. There is little distinction between the heartwood and the sapwood.

The texture is moderately fine to rather coarse. The grain is straight to slightly interlocked or with local irregularities. Quartersawn timber may thus show an irregular stripe figure. The boundary of a growth ring often is marked by a band of fibers in which vessels are virtually absent. This produces a characteristic pattern in plainsawn boards. The wood has a high luster. Brittleheart may be present.

The timber is soft to moderately hard, and light to moderately heavy. In tests made at the French Centre Technique Forestier Tropicale, the average specific gravity ranged from 0.40 to 0.60, based upon the weight of the ovendry wood and its volume when green (32). In tests made at the U. S. Forest Products Laboratory on the same bases, the average specific gravity of six samples of wood was 0.42 (15).

Wood containing brittleheart weighs 23 to 46 pounds per cubic foot, air dried to 12 percent moisture content. Sound wood usually weighs from 30 to 39 pounds per cubic foot, with an average of 34 pounds. The green wood weighs about 50 pounds per cubic foot (6). Mechanical properties of the wood are included in table 1. It is difficult to bend this wood without buckling, and the timber is thus unsuitable for steam bending purposes (6).

The wood can be dried readily with little or no checking. There is almost no distortion. The British Forest Products Research Laboratory recommends its kiln schedule J (table 9). The percentage of shrinkage in drying is rather low (table 2).

Emeri is a durable wood with respect to attack by fungi. Ambrosia beetles and longhorn beetles sometimes cause damage, and the sapwood is often attacked by powderpost beetles. The data on its resistance to attack by termites in West Africa are conflicting. The heartwood is extremely resistant, and the sapwood is moderately resistant to preservative treatment (6).

The timber is fairly easy to work with both hand and machine tools. It usually causes little blunting of the edges. Quartersawn material often tears a little in planing unless the cutting angle is reduced to 20" or less. In limited tests of machining properties at the U. S.

Forest Products Laboratory, 90 percent of the samples were free of defects in planing, 36 percent were free of defects in shaping, and 67 percent were free of defects in turning. When the end grain was cut in shaping, tearouts developed, a typical occurrence in light woods of this type (15). The wood sometimes chars in boring operations. Although the coarse grain requires a filler, the wood takes stains and polishes with good results, and it can be glued satisfactorily. Nails and screws penetrate and hold well (6, 26).

Emeri is recommended for all fine carpentry, joinery, and construction because of its stability, ease of working, durability, and attractive appearance. It is suitable for flooring in domestic buildings where light to moderately heavy conditions of traffic prevail. It is unsuitable for drainboards or kitchen tabletops, because it contains a yellow substance that will stain wet fabrics. The tannin content of the wood causes it to stain when in contact with iron. In addition, metals in contact with the wood should either be protected or they should be relatively resistant to corrosion, for the wood is slightly acid (6).

Identifying Features

The growth rings are distinct to conspicuous on the end and longitudinal surfaces because of a marginal band of fibers without vessels. The pores are distinct without a lens, medium sized to large, and not very numerous. They are solitary or in groups of 2 to 5 pores, often with shining, iridescent tyloses. They are conspicuous on the longitudinal surfaces as coarse grooves. The parenchyma is usually not abundant. It surrounds the pores and often extends into small, wing-like projections. The rays are fine, faintly visible on the end section without a lens, and distinct, but not conspicuous, on the radial section. Concentric bands of vertical resin ducts, probably traumatic in origin, are sometimes present.

Special Note: --The bordered pit-pairs on the vessel elements are vestured. The fibers are libriform with simple pits. The rays are 1 to 4, (mostly 2 to 3), seriate, and up to 25 or 30 cells high.

Terminalia superba Engler and Diels
Limba
"Korina"
Family: Combretaceae

Limba is a well-known timber tree that occurs throughout West Africa, from the Sierra Leone to the Belgian Congo and Angola. It is found chiefly in the equatorial rain forest of the west coast, but it is also in the deciduous forest areas. Sometimes it is cultivated near villages as a source of timber (6, 13, 19). In the Middle Congo, plantations were begun in 1950 in an attempt to make up the deficit between the number of the trees cut and the ability of the limba forests to reconstitute themselves.

Limba is a very large tree, from 60 to 150 feet high and sometimes up to 200 feet. The diameter of the bole above the buttresses may be 4-1/2 feet or more. The rather wide, spreading buttresses may extend up the bole for 8 feet or more. The bole is straight and cylindrical, often free of branches for from 65 to 95 feet in the taller trees (6, 13, 23).

The heartwood and sapwood of limba are usually not readily differentiated. The wood is grayish white or pale yellowish brown throughout, but a sapwood zone up to 5 or 6 inches thick may be detected by the presence of starch and the susceptibility to powder-post beetle attack. Some logs, however, have an irregular zone of dark heartwood with grayish brown or blackish markings that cause the timber to resemble walnut. The grain ranges from straight to somewhat interlocked, and the texture is moderately coarse but homogeneous.

Both the density and the hardness are extremely variable in limba. The average specific gravity ranges from 0.40 to 0.57, based upon the volume when green and the weight when ovendry (32). Part of the variability may be due to the presence of lightweight brittleheart in some logs. The weight of sound timber usually ranges from 30 to 39 pounds per cubic foot in the air-dry condition at 12 percent moisture content. It weighs about 55 pounds per cubic foot in the green condition (6). This timber apparently has not been tested for wood bending characteristics. Mechanical properties are given in table 1.

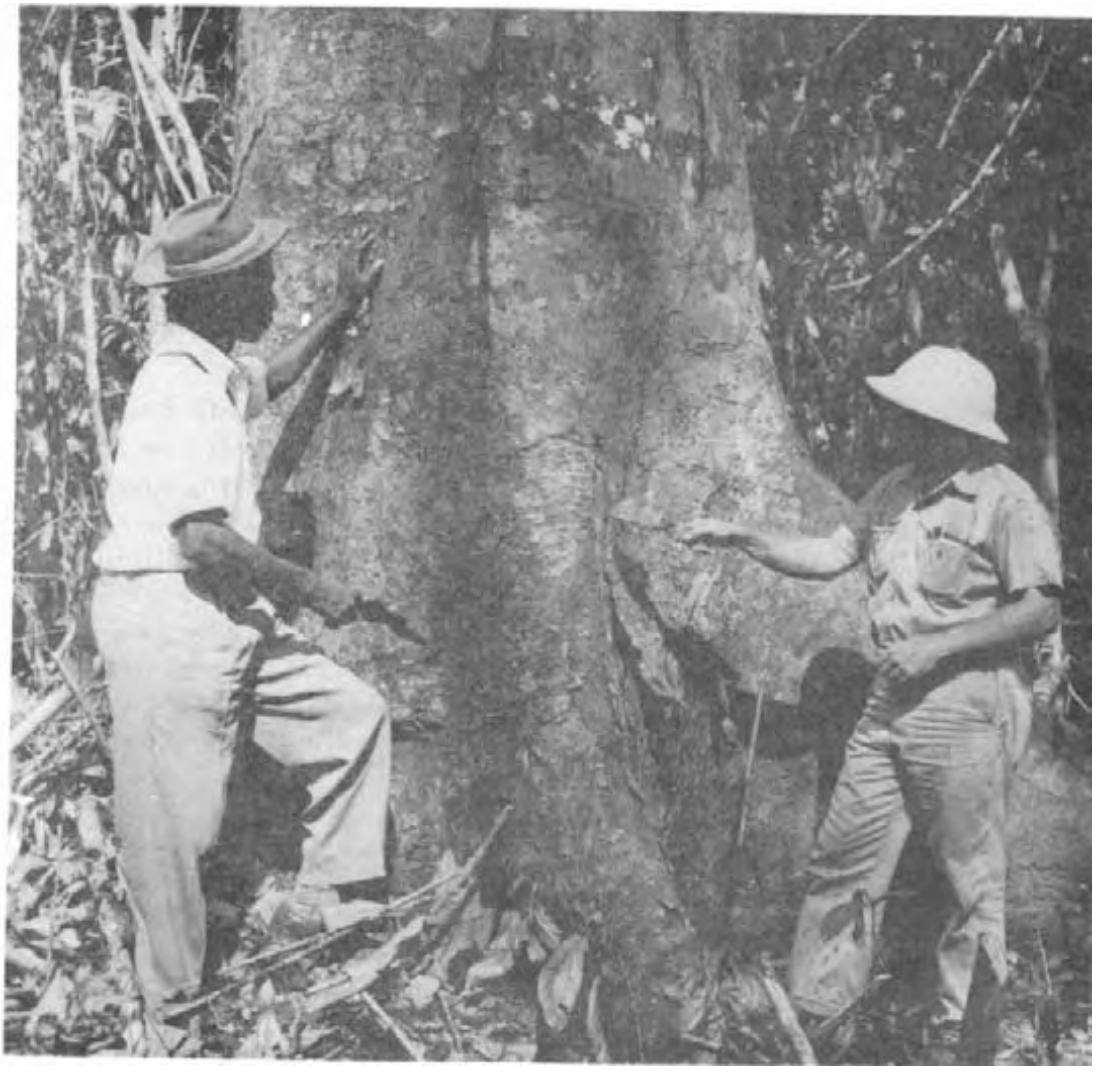
There is no information about the air-seasoning properties of limba, but it is assumed to be similar to Terminalia ivorcnsis in this respect. The British Forest Products Research Laboratory (6). suggests their kiln schedule J (table 9) for this wood.

The shrinkage of limba is moderately low (table 2). The dimensional stability of the wood is reported to be moderate, with only small movement (6, 23).

Limba is not a durable wood with respect to attack by fungi. The logs are frequently damaged by ambrosia beetles, and the sapwood is extremely susceptible to attack by powderpost beetles. The wood is not resistant to attack by termites in West Africa. It is reported to be moderately resistant to treatment with preservatives (6).

The timber is easy to work with both hand and machine tools and has only a moderate dulling effect on the cutting edges. Sometimes the interlocked grain causes difficulty in planing, but if a cutting angle of not more than 20° is used the tendency of the wood to pick up can be avoided. Mortise and tenon joints are easily made and hold well. The wood has a slight tendency to split in nailing and screwing, but the nails and screws hold well. Limba polishes well when a filler is used, and it takes stains, paint, and glue well. Logs are cut into veneer, particularly for core veneer in Britain. Selected logs free from insect attack can be used for face veneer. Veneer cut from the black heartwood is difficult to dry.

In the United States limba is used for architectural paneling and woodwork and contemporary blond furniture, including cases for spinet pianos. Quartered and sliced veneer is plentiful, and lumber is available. The wood is used locally for bridges, shingles, and houseposts. It is suitable for use in boxes and packing cases, but it is now too valuable for other purposes to be put to such use. It has been tested for use as a pulpwood in England, but it shows rather high consumption of chemicals and produces a dark pulp. It nevertheless is suitable for kraft pulp, for it is similar in quality to the pulp made from obeche (Triplochiton scleroxylon K. Schum) (6, 13).



An unusually large Tetraberlinia tree in the Gola National Forest.

ZM 115 854

Identifying Features

The growth rings usually are distinct and sometimes are conspicuous. Their boundaries often are undulating and are marked by rows of thicker walled fibers or marginal parenchyma. The pores are large, distinct without a lens, and plugged with iridescent tyloses. They are solitary or in groups of 2 to 3 (occasionally to 5) and not very numerous. The vessel lines are distinct as deep scratches on the longitudinal surfaces. Parenchyma tissue is moderately abundant and is very distinct under a lens. It surrounds the vessels and extends as lateral wings that often form wavy bands connecting the vessels. It also forms narrow, discontinuous bands of marginal parenchyma. The rays are very fine and are visible only under a lens on the cross section. They are visible without a lens but inconspicuous on the radial surface.

Microscopic Features

The large, alternately bordered pit-pairs on the vessel walls are vestured. Large, elongated, solitary crystals are present in some parenchyma cells. The rays are homogeneous and almost entirely uniseriate.

Tetraberlina tubmaniana J. Leonard
(Syn. Dideletia ssp. Monopetalanthus ssp.)
Ekop
Liberian pine
Family: Leguminosae - Caesalpiniaceae

Tetraberlinia tubmaniana is a recently classified species from the Western Province of Liberia. Its range is confined to the heavy rainfall areas, where it is very common. Most of the mature trees do not exceed 4 feet in diameter, although occasional trees are larger. The trees are tall, straight, without large buttress, and reach a height of 120 to 150 feet.

The sapwood is light colored with a pinkish tinge and distinct from the reddish brown heartwood. The wood has a luster, is moderately

coarse textured, and has an attractive grain pattern. It is moderately hard with a specific gravity of 0.65 based on weight of the ovendry wood and its volume when green. Weight of the wood is 39 pounds per cubic foot at 12 percent moisture content. Mechanical properties of this wood are included in table 1.

Machining tests made on this wood by the U. S. Forest Products Laboratory indicate that no potential difficulties would be encountered in planing, shaping, or turning (15). The wood works well with hand tools and is favored for house and similar construction in Liberia. Sliced veneer and plywood furniture have been made from this wood, although rotary cutting and complete veneer tests have not been made.

Pores are visible without a hand lens. They are mostly single, but occasionally divided into 2 or 3 sections by fine lines of parenchyma that also surround the pores. Irregular-width bands of parenchyma are present. Rays are fine to very fine, spaced 2 to 3 per pore diameter. Some specimens of the wood fluoresce under ultraviolet light.

Tetrapleura tetraptera (Schum and Thonn.) Taub.
Family: Leguminosae-Mimosaceae

Tetrapleura tetraptera occurs in the Ivory Coast, Liberia, the Cameroons, and the Congo. It is a tree of the second class in secondary formations of the tropical rain forest, and it is found up to the limits of the dense, deciduous forest (29).

The heartwood is pinkish brown, becoming reddish in time and developing a coppery hue. The sapwood is pale tan and well differentiated from the heartwood. Pith flecks may be present. The texture is moderately coarse, and the grain is straight to strongly interlocked.

The timber is moderately heavy with a specific gravity of 0.54 based upon the weight of the ovendry wood and its volume when green (32). Mechanical properties are included in table 1. Shrinkage values are included in table 2.

At the present time the wood is used only locally because of the small diameter and short length of the logs. It is considered promising, however, for future specialized foreign or domestic use (25, 29).

Trichoscypha arborea (A. Chev) A. Chev.
Family: Anacardiaceae

Although several species of Trichoscypha occur in both East and West Africa, only T. arborea and a smaller tree, T. ferruginea, are in Liberia. Trichoscypha arborea is rather common in the eastern part of the country. It is also found scattered in the rain forests of the Ivory Coast (25, 30).

The tree is 75 to 80 feet tall and is without buttresses. The diameter of the trunk is never very large, usually less than 20 inches (14, 29).

The wood is greenish or pinkish tan, sometimes streaked with both colors. The grain often is interlocked, and the texture is rather fine.

The timber is moderately hard and heavy. The average specific gravity ranges from 0.65 to 0.73 based upon the weight of the ovendry wood and its volume when green (32). The average volumetric shrinkage ranges from 14.2 to 19.1 percent (32). The wood probably is nondurable, but there is no valid information about its durability.

T. arborea is not an important sawtimber because of the small diameter of the logs. It is used locally, however, in native construction. It has some industrial importance in the production of paper pulp, both alone and in a mixture of pulpwoods (30).

Identifying Features

The growth rings are not distinct. The pores are just within the limit of vision without a lens and are evenly distributed. They are mostly solitary, but also in radial multiples of 2 to 3. They are not very numerous, The rays are not visible without a lens and are very fine. They are distinct, but not conspicuous, on the radial surface as small, lustrous flecks. The parenchyma surrounds the vessels and is visible under a lens.

Microscopic Structure

The fibers are nonseptate. The rays are heterogeneous, 1 to 3 cells wide. Small resin canals are present in some rays, and silica is present in the rays, but not abundantly.

Triplochiton scleroxylon K. Schum
Obeche
Ayous
Samba
Family: Sterculiaceae

Obeche is present in the forests of the west coast of Africa from Liberia to the Cameroons. It is one of the dominant trees in this vast area, and it soon covers abandoned plantations. It is a light-loving tree of rapid growth that prefers dry situations (6, 26).

The tree is large, often reaching 130 to 150 feet in height with a diameter of 3 to 5 or even 6 feet above the buttresses. In spite of numerous variations, the buttresses are quite distinctive. They may extend 20 feet or more up the trunk and have sharp, slender wings. The bole is very straight, but not always cylindrical. It is free of branches for 80 feet or more (6, 26).

The wood is creamy white to straw color without a clear distinction between heartwood and sapwood. The sapwood is usually 3 to 4 inches wide. Obeche has a rather coarse texture and often has interlocked grain, which produces a stripe figure when the wood is quartersawn. It has a very high luster. The disagreeable odor present in green wood disappears upon drying. Very large logs often contain brittleheart.

Obeche is one of the lightest utility hardwoods in general use. The average specific gravity ranges from 0.29 to 0.44 based upon the weight when ovendry and the volume of the green wood (32). The wood weighs about 24 pounds per cubic foot when air-dried to 12 percent moisture content and 35 pounds per cubic foot in the green condition (6). Mechanical properties are included in table 1. Limited bending tests indicate that the wood may be used for producing solid bends of moderate radii of curvature, but slight wrinkling on the edges of the bends occurs (6).

Obeche presents no problems in seasoning. It dries very rapidly and well with almost no tendency to split or for existing shakes to extend. Slight distortion occurs at times, and knots may split slightly. The British Forest Products Research Laboratory (6) suggests its kiln schedule L (table 11) for this wood.

The average volumetric shrinkage ranges from 7.1 to 11.2 percent (table 2) based upon shrinkage from the green to the ovendry condition (32).

Obeche is highly susceptible to attack by fungi, particularly blue stain, and is classified as nondurable. Damage by ambrosia beetles occurs frequently in logs and sometimes even in standing trees. Longhorn beetles also attack obeche. The sapwood may be damaged by powderpost beetles, and tests in Nigeria indicate that the wood is not resistant to termites. The heartwood is resistant to treatment with preservatives, but the sapwood is permeable (6).

Obeche is easy to work with both hand and machine tools and has but slight dulling effect on the cutting edges. Sharp-edged tools are necessary to prevent crumbling in cutting, particularly on the edge grain, but the wood finishes cleanly and smoothly when the correct tools are used. Obeche does not turn well by hand, for it is rather soft. It takes nails and screws well, but they do not hold well in rough use. Staining, painting, and gluing present no difficulties (6, 26).

The homogeneity and lightness of obeche, together with the ease with which it can be made into rotary-cut veneer, makes it very desirable for plywood, provided that the logs are not stained in transit. It is used as a substitute for softwood in many industries, and it is made into linings for drawers, cupboards, and similar parts in the light furniture industry. It is suitable for interior joinery, carpentry, and packing cases (6, 26).

The wood is widely used in France and England, and it is imported by the United States. The veneer is abundant and inexpensive.

Identifying Features

The growth rings usually are distinct, because of an increase in the density of the fibers in the marginal zone. The pores are large and

distinct without a lens. They are not numerous and are irregularly distributed, either solitary or in radial groups of 2 to 5. The lumina are sometimes filled with tyloses. The rays are readily visible without magnification on the cross section as fine, white lines. They are visible, but not conspicuous, on the radial section. The parenchyma forms a fine network with the rays. It is visible under a lens in very delicate, short, tangential lines not connected with the pores. Ripple marks are distinct and regular, the result of storied structure in both the parenchyma and fibers.' The rays are not storied.

Uapaca guineensis Muell. Arg.
Uapaca esculenta A. Chev. ex Aubrev. and Leandri
Uapaca heudelotii Baill.
Uapaca paludosa Aubr. and Leandri
Rikio
"Red Cedar"
Family: Euphorbiaceae

There are about 40 species of Uapaca in tropical Africa and Madagascar. The trees of the dense forest areas are usually of moderate height with prop roots at the base. They occur in swampy land or on the banks of bodies of water such as lagoons or rivers. Savannah species also exist, but in a much reduced size. In Liberia, U. esculenta has been collected from the St. John River area, U. guineensis and U. paludosa from the Dubwe River area, and U. heudelotii from the Sangwin River area (25, 30).

Uapaca guineensis is a forest tree 75 to 90 feet tall and 2 to 3 feet in diameter. It has thick prop roots and a fluted bole. U. heudelotii is smaller, up to 50 feet tall and 2 feet in diameter when it grows in the high forests, but shorter and with coppice shoots when it grows along river banks. U. esculenta is widely distributed and attains a diameter of 2 feet. U. paludosa is a tree of the swampy forests near lagoons (14, 30).

All of the Liberian species of Uapaca have woods that are remarkably similar. The heartwood is grayish red to chocolate brown, not well differentiated from the light-brown sapwood. The wood is without figure except when quartersawn, has little luster, and is moderately fine to moderately coarse. The grain is straight to irregular.

The wood is moderately hard and moderately heavy. The average specific gravity or Uapaca guineensis is 0.57, based upon the weight of the ovendry wood and its volume when green. The specific gravities of U. heudelotii and U. paludosa are 0.61 and 0.68, respectively (32). Strength values for three species of Uapaca, based upon tests made on specimens 2 by 2 centimeters in size, are included in table 1.

All the species have a rather high percentage of shrinkage (table 3). The wood is moderately stable (23), and is reported to be highly durable (14).

The species of Uapaca are easy to saw and plane. Mortise and tenon joints are easily made and hold well. The wood is so dull that polishing is useless, but it takes paint well (23).

Although the quartersawn wood is rather attractive, the texture is rather coarse and thus limits the use to sawtimber only. There is a large amount of waste, and since there is a rather high percentage of silica present, the timber is not likely to be exported in log form to be sawn into boards. It is used locally for small rafters, charcoal, wood for gas generators (for which U. guineensis is preferred over the other species), and for firewood (30).

Identifying Features

The growth rings are not distinct. The pores are solitary or in radial groups of 2 or 3 pores. They are numerous and distinct without a lens. The parenchyma is scarcely visible under a lens on the end surface, in irregular, short groups of cells. The rays are distinct under a lens on cross and tangential sections. They are often up to 3 millimeters or more high.

Microscopic Features

The vessel pit-pairs are large, and the perforation plates are simple. The parenchyma surrounds the vessels and occurs in scattered strands, which often contain chambered crystals. The rays are high and up to 4 or 5 rows wide. They are decidedly heterogeneous, with numerous upright marginal cells. Crystals are often present. The fibers have simple pits and occasionally are septate. The ash and silica content of the wood is very high.

Vitex micrantha Gurke
Family: Verbenaceae

Vitex micrantha occurs in the Ivory Coast and the western section of Liberia.

The tree sometimes becomes 60 to 70 feet tall and 2 to 2-1/2 feet in diameter. It lacks buttresses, but it has a fluted or angular bole (14).

The wood is nearly white or light yellowish brown, with a rather high luster. The texture is medium, and the grain usually is straight.

The timber is moderately light, with a specific gravity of 0.46, based upon the weight of the ovendry wood and its volume when green (32). It is firm and rather strong, Mechanical properties of the wood are included in table 1. Shrinkage values are included in table 2.

The wood is easy to work. It finishes smoothly and takes a good polish, and is probably stable when worked. It apparently is not resistant to insect attacks or decay (14).

Local uses for the wood include light construction, general millwork, joinery, plywood, and similar uses where ease of working and pale color are more important then great strength or attractive figure (14).

Identifying Features

The growth rings are distinct because of the presence of marginal parenchyma. The pores are variable in size, with a tendency toward ring-porosity. The pores are not very numerous, and the larger ones tend to form diagonal rows. The parenchyma is in narrow, marginal layers and in a narrow ring about the pores. The rays are distinct on the cross section, low but rather conspicuous on the radial section.

Xylopia aethiopica (Dunal) A. Rich.
Okala
Guinea pepper tree
Family: Annonaceae

In Liberia, Okala is found in the central area near the St. John River. It occurs in West Africa from Senegal to Nigeria and the Congo. It prefers very wet terrain and is most abundant in the inlets along the coast in the inundated forests of the central Congo area (23, 25).

Other species of Xylopia that occur in Liberia are X. staudtii Eng. and Diels, X. rubesceus Oliv. and X. quintasii Eng. and Diels. (19).

The tree may be up to 60 feet high and less than 20 inches in diameter in most areas, but it is reported to be 115 to 130 feet high with a diameter of 20 to 30 inches in the Congo. The bole is straight and rather slender. The base has small, low prop roots and sometimes a tuft of aerial roots (19, 23, 29).

There is little distinction between the heartwood and sapwood. The wood is white, with an olive or yellowish tint. The texture is moderately coarse, and the grain usually is straight. The timber shows almost no figure on the longitudinal surfaces.

The wood is moderately hard and moderately heavy, with a specific gravity of 0.40 based upon the weight of the ovendry wood and its volume when green, in limited tests. It weighs 26 pounds per cubic foot at 12 percent moisture content (14).

Okala is easy to saw and relatively easy to plane. Mortise and tenon joints are easily made and hold fairly well. Nails and screws penetrate easily and hold rather well. Polishing is unnecessary. The wood takes paint well without excessive absorption (23).

The wood is used locally for the supporting poles for houses, for stakes, and for small boards, because of its termite resistance. The flexibility of the wood causes it to be used for small boats as oars and paddles and as handles for spears. The tree, however, rarely has a bole of sufficiently large diameter to make it an important timber tree, even though occasional trees are quite tall (23).

Identifying Features

Growth rings are more or less distinct because of areas of dense fibers. The pores are solitary or in radial rows of 2 to 4. They are visible without a lens and are not crowded. The parenchyma forms a regular meshwork with the rays. It is in tangential bands rather uniformly spaced less than a pore width apart, about the width of the rays. The rays are rather fine, often a millimeter in length.

Microscopic Features

The rays are homogeneous and 1 to 4 cells wide. The fibers have numerous small pits on all walls. The pits are distinctly bordered. The vessel pitting is alternate and rather small.

APPENDIX

Check List of Liberian Woods

This list includes verified species of trees from which herbarium or wood specimens have been collected in Liberia.

Genera	Species	Family
Acioa	barteri (Hook. F. ex Oliv) Engl.	Rosaceae
	dinklagei Engl.	
	scabrifolia Hua	
	whytei Stapf.	
Afraegle	paniculata (Schum. and Thonn) Engl.	Rutaceae
Afrolicania	elaeosperma Mildbr	Rosaceae
Afzelia	africana Sm	Caesalpiniaseae
	bracteata T. Vogel and Benth	
Albizia	adianthifolia (Schum) W. F. Wight	Mimosaceae
	ferruginea (Guill. and Perr.) Benth.	
	lebbek (L.) Benth.	
	zygia (DC) J. F. Macbr.	
Allanblackia	floribunda Oliv.	Guttiferae
Alstonia	congensis Engl.	Apocynaceae
Amanoa	braceosa Planch.	Euphorbiaceae
	strobilaceae Mull Arg.	

Genera	Species	Family
Amphimas	pterocarpoides Harms	Caesalpiniaceae
Annona	glabra Linn.	Annonaceae
Anopyxis	klaineana (Pierre) Engl.	Rhizophoraceae
Anthocleista	nobilis G. Don	Loganiaceae
Anthonotha	crossifolia (Baill) J. Leonard	Caesalpiniaceae
	ernae (Dinkl.) J. Leonard	
	explicaus (Baill.) J. Leonard	
	fragrans (Bak.) Excell and Hillcoat	
	macrophylla P. Beauv.	
	obanensis (Bak.) J. Leonard	
	vignei (Hoyle) J. Leonard	
Anthostema	senegalense A. Juss.	Euphorbiaceae
Antiaris	africana Engl.	Moraceae
	welwitschii Engl.	
Antidesma	laciniatum	Euphorbiaceae
	var. nembranaceum Mull. Arg.	
	oblonga (Hutch.) Keay	
Antrocaryon	micraster A. Chev and Guillaum	Anacardiaceae
Aporrhiza	urophylla Gilg	Sapindaceae
Araliopsis	tabouvensis Aubrev. and Pellegr.	Rutaceae
Aubrevillea	kerstingii (Harms) Pellegr.	Mimosaceae

Genera	Species	Family
Aubrevillea	platycarpa Pellegr.	Mimosaceae
Avicennia	nitida Jacq.	Verbenaceae
Baphia	nitida Lodd.	Papilionaceae
	polygalacea (Hook. f.) Bak	
	pubescens Hook f.	
	spathacea Hook f.	
Beilschmiedia	mannii (meisn.) Benth. and Hook. f.	Lauraceae
Berlinia	bracteosa Benth	Caesalpiniaceae
	confusa Hoyle	
	grandiflora (Vahl) Hutch. and Dalz.	
	occidentalis Keay	
	tomentella Keay	
Bersama	abyssinica (Fres.) subsp paullinioides	Melianthaceae
	var. paullinioides Verdcourt	
Blighia	sapida Konig	Sapindaceae
	unijugata Bak	
	welwitschii (Hiern) Radlk.	
Bombax	brevicuspe Sprague	Bombacaceae
	buonopozense P. Beauv.	
Brachystegia	leonensis Burtt Davy and Hutch.	Caesalpiniaceae

Genera	Species	Family
Bridelia	grandis Pierre ex Hutch.	Euphorbiaceae
	micrantha (Hochst.) Baill.	
Brieya	fasciculata De Wild.	Annonaceae
Bussea	occidentalis Hutch.	Caesalpiniaceae
Caloncoba	brevipes (Stapf) Gilg	Flacourtiaceae
	echinata (Oliv.) Gilg	
Calpocalyx	aubrevillei Pellegr.	Mimosaceae
	brevibracteatus Harms	
Canarium	schweinfurthii Engl.	Burseraceae
Canthium	glabriflorum Hiern	Rubiaceae
Carapa	procera DC.	Meliaceae
Corynanthe	pachyceras K. Schum	Rubiaceae
Cassia	sieberiana DC.	Caesalpiniaceae
Cassipourea	afzelii (Oliv.) Alston	Rhizophoraceae
	barteri (Hook. f.) N. E. Br.	
	firestoneana Hutch and Dalz ex cooper and record	
Cathormion	altissimum (Hook. f) Hutch and Dandy	Mimosaceae
Ceiba	pentandra (Linn.) Gaertn.	Bombacaceae
Chidlowia	sanguinea Hoyle	Caesalpiniaceae

Genera	Species	Family
Chlorophora	excelsa (Welw.) Benth.	Moraceae
	regia A. Chev.	
Chrysobalanus	ellipticus Soland. ex Sabine	Rosaceae
Chrysophyllum	africanum A. C.	Sapotaceae
	albidum C. Don	
	giganteum A. Chev.	
	metallicum Hutch and Dalz	
	obovatum C. Don	
	perpulchrum Mildbr	
	pruniforme (Pierre) Engl.	
Claoxylon	hexandrum Mull. Arg.	Euphorbiaceae
Cleistanthus	polystachyus Hook f. ex Planch.	Euphorbiaceae
Cleistopholis	patens (Benth.) Engl. and Diels.	Annonaceae
Coelocaryon	oxycarpum Stapf.	Myristicaceae
	preussii Warb.	
Coffea	liberica Baill.	Rubiaceae
	robusta Linden	
Cola	acuminata (P. Beauv.) Schott. and Endl.	Sterculiaceae
	buntingii Bak f.	
	caricaefolia (G. Don) K. Schum.	
	chlamydantha K. Schum.	

Genera	Species	Family
Cola	digitata Mast.	Sterculiaceae
	heterophylla (P. Beauv.) Schott and Endl	
	lateritia Var maclaudi (A. Chev.) Brenan and Keay	
	nitida (Vent.) Schott and Endl.	
	simiarum Sprague ex Brenan and Keay	
Combretodendron	macrocarpum (P. Beauv) Keay Exell	Lecythidaceae
Conopharyngia	crossa Stapf	Apocynaceae
	chippii Stapf	
	durisusima Stapf	
	longiflora Stapf	
Copaifera	salikounda Heckel	Caesalpiniaceae
Coula	edulis Baill.	Olacaceae
Craterispermum	candatum Hutch.	Rubiaceae
	laurinum Benth.	
Croton	macrostachyus Hochst. ex Del.	Euphorbiaceae
Crudia	senegalensis Planch. ex Benth.	Caesalpiniaceae
Cryptosepalum	tetraphyllum (Cook. f.) Benth.	Caesalpiniaceae
Cussonia	barteri Seemann	Araliaceae
Cylicodiscus	gabunensis Harms	Mimosaceae
Cynometra	ananta Hutch. and Dalz.	Caesalpiniaceae
	leonensis Hutch. and Dalz.	

Genera	Species	Family
Dacryodes	klaineana (Pierre) H. J. Lam	Burseraceae
Dalbergia	ecastaphyllum (L.) Taub.	Papilionaceae
	heudelotii Stapf	
Daniellia	ogea (Harms) Rolfe ex Holl.	Caesalpiniaceae
	thurifera Benn.	
Desmostachys	vogelii (Miers) Stapf	Icacinaceae
Detarium	senegalense J. F. Gmel.	Caesalpiniaceae
Dialium	aubrevillei Pellegr.	Caesalpiniaceae
	dinklagei Harms	
	guineense Willd.	
Dichrostachys	glomerata (Forsk.) Chiov.	Mimosaceae
Didelotia	engleri Dinkl. and Harms	Caesalpiniaceae
	unifoliolata J. Leonard	
Diospyros	gabonensis Gurke	Ebenaceae
	heudelotii Hiern	
	kamerunensis Gurke	
	sanza minika A. Chev.	
	thomasii Hutch and Dalz	
Discoglypremna	caloneura (Pax) Prain	Euphorbiaceae
Distemonanthus	benthamianus Baill.	Caesalpiniaceae
Drypetes	aubrevillei Leandri	Euphorbiaceae
	afzelii (Pax) Hutch.	

Genera	Species	Family
Drypetes	aylmeri Hutch. and Dalz.	Euphorbiaceae
	chevalieri Beille	
	gilgiana (Pax) Pax and K. Hoffm.	
	inaequalis Hutch.	
	ivorensis Hutch. and Dalz.	
	principum (Mull. Arg.) Hutch.	
Duboscia	viridiflora (K. Schum.) Mildbr.	Tiliaceae
Enantia	polycarpa (DC.) Engl. and Diels	Annonaceae
Entandrophragma	angolense (Welw.) C. DC.	Meliaceae
	candollei Harms	
	cylindricum (Sprague) Sprague.	
	utile (Dawe and Sprague) Sprague	
Ericoelum	kerstingii Gilg ex Engl.	Sapindaceae
	racemosum Bak.	
Erythrina	mildbraedii Harms	Papilionaceae
	senegalensis DC.	
Erythrophleum	ivorense A. Chev.	Caesalpiniaceae
Erythroxylum	mannii Oliv.	Erythroxlaceae
Eugenia	salacioides Laws. ex Hutch and Dalz.	Myrtaceae
	whytei Sprague	
Fagara	leprieurii (Guill. and Perr.) Engl.	Rutaceae
	macrophylla Engl.	

Genera	Species	Family
Fagara	parvifoliola A. Chev. ex Keay	Rutaceae
Ficus	barterii Sprague	Moraceae
	capensis Thunb.	
	exasperata Vahl	
	kamerunensis Warb. ex mildbr. and Burret	
	leprieuri Miq.	
	lyrata Warb.	
	macrosperma Warb. ex Mildbr. and Burret	
	mucuso Welw. ex Ficalho	
	ottoniifolia (Miq.) Miq.	
	sagittifolia Warb. ex Mildbr and Burret	
	vogeliana (Miq.) Miq.	
	vogelii (Miq.) Miq.	
Funtumia	africana Stapf	Apocynaceae
	elastica Stapf	
	latifolia Stapf	
Gaertnera	cooperi Hutch and Dalz	Loganiaceae
Garcinia	epunctata Stapf	Guttiferae
	kola Heckel	
	polyantha Oliv.	
Gilbertiodendron	bilineatum (Hutch. and Dalz J. Leonard	Caesalpiniaceae
	ivorense (A. Chev.) J. Leonard	

Genera	Species	Family
Gilbertiodendron	preussii (Harms) J. Leonard	Caesalpiniaceae
Gluema	ivorensis Hubr. and Pellegr	Sapotoceae
Guarea	cedrata (A. Chev.) Pellegr	Meliaceae
	thompsonii Sprague and Hutch.	
Hannoa	klaineana Pierre and Engl.	Simaroubaceae
Haplormosia	monophylla (Harms) Harms	Papilionaceae
Harrisonia	abyssinica Oliv.	Simaroubaceae
Harungana	madagascariensis Lam. exPoir.	Hypericaceae
Heisteria	parvifolia Sm.	Olacaceae
Hirtella	butayei (DeWild.) Brenan	Rosaceae
	fleuryana A. Chev.	
Homalium	africanum (Hook. f.) Benth.	Samydaceae
	letestui Pellegr.	
	molle Stapf	
	smythei Hutch. and Dalz.	
Hymenocardia	lyrata Tul.	Euphorbiaceae
Hymenostegia	afzelii (Oliv.) Harms	Caesalpiniaceae
Icacina	mannii Oliv.	Icacinaceae
Irvingia	gabonensis (Aubry-Lecomte ex O'Rorke) Baill.	Irvingiaceae
Kaoue	stapfiana (A. Chev.) Pellegr.	Caesalpiniaceae
Khaya	anthotheca (Welw.) C. DC:	Meliaceae

Genera	Species	Family
Khaya	ivorensis A. Chev.	Meliaceae
Kigelia	elliptica Sprague	Bignoniaceae
Klainedoxa	gabonensis Var oblongifolia Engl.	Irvingiaceae
Lannea	welwitschii (Hiern.) Engl.	Anacardiaceae
Lecaniodiscus	cupanioides Planch. ex Benth.	Sapindaceae
Leptonychia	occidentalis Keay	Sterculiaceae
Lindackeria	dentata (Oliv.) Gilg	Flacourtiaceae
Loesenera	kalantha Harms	Caesalpiniaceae
Lonchocarpus	sericeus (Poir.) H. B. and K.	Papilionaceae
Lophira	alata Banks ex Gaertn. F.	Ochnaceae
Lovoa	trichilioides Harms	Meliaceae
Maba	cooperi Hutch and Dalz.	Ebenaceae
Macaranga	barteri Mull. Arg.	Euphorbiaceae
	heterophylla (Mull. Arg.) Mull. Arg.	
	heudelotii Baill.	
	hurifolia Beille	
	spinosa Mull. Arg.	
Maesobotrya	barteri var sparsiflora (Sc. Elliot) Keay	Euphorbiaceae
Mammea	africana Sabine	Guttiferae
Manilkara	lacera Dubard	Sapotaceae
	multinervis Dubard	
Mareva	micrantha Mull. Arg.	Euphorbiaceae

Genera	Species	Family
Markhamia	tomentosa K. Schum.	Bignoniaceae
Memecylon	blakeoides G. Don	Melastomataceae
	golacnse Bak. f.	
	lateriflorum (G. Don) Brem.	
	polyanthemos Hook. f.	
Microdesmis	puberula Hook. f. ex Planch.	Euphorbiaceae
Millettia	rhodantha Baill.	Papilionaceae
Mimusops	heckelii Hutch. and Dalz.	Sapotaceae
Mitragyna	stipulosa O. Kuntze	Rubiaceae
Monodora	brevipes Benth.	Annonaceae
	myristica (Gaertn.) Dunal	
Monopetalanthus	compactus Hutch. and Dalz.	Caesalpiniaceae
	pteridophyllus Harms	
Morinda	geminata DC.	Rubiaceae
	lucida Benth.	
Morus	mesozygia Stapf	Moraceae
Musanga	cecropioides R. Br.	Moraceae
Myrianthus	arboreus P. Beauv.	Moraceae
	libericus Rendle	
	serratus (Trecul.) Benth. and Hook f.	
Napoleona	leonensis Hutch. and Dalz.	Lecythidaceae
	vogelii Hook. and Planch.	

Genera	Species	Family
Necepsia	afzelii Prain	Euphorbiaceae
Neostenanthera	hamata (Benth.) Exell	Annonaceae
Nesogordonia	papaverifera (A. Chev.) R. Capuron	Sterculiaceae
Newboldia	laevis Seem.	Bignoniaceae
Newtonia	aubrevillei (Pellegr.) Keay	Mimosaceae
	duparquetiana (Baill.) Keay	
Ochthocosmus	africanus Hook f.	Ixonathaceae
Octoknema	borealis Hutch. and Dalz.	Octoknemataceae
Oldfieldia	africana Benth. and Hook f.	Euphorbiaceae
Omphalocarpum	elatum Miers	Sapotaceae
Oncoba	brachyanthera Oliv.	Flacourtiaceae
Ongokea	gore (Hua) Pierre	Olacaceae
Oricia	suaveolens (Engl.) Verdoorn	Rutaceae
Ouratea	reticulata (P. Beauv.) Engl.	Ochnaceae
Oxystigma	mannii (Baill.) Harms	Caesalpiniaceae
Pachypodanthium	staudtii Engl. and Diels	Annonaceae
Pachystela	brevipes Engl.	Sapotaceae
Panda	oleosa Pierre	Pandaceae
Parinari	aubrevillei Pellegr.	Rosaceae
	chrysophylla Oliv.	
	congensis F. Didr.	
	excelsa Sabine	

Genera	Species	Family
Parinari	glabra Oliv.	Rosaceae
	kerstingii Engl.	
	macrophylla Sabine	
	robusta Oliv.	
Parkia	bicolor A. Chev.	Mimosaceae
	filicoidea Welw. ex Oliv.	
Pausinystalia	lane-poolei Hutch.	Rubiaceae
Penianthus	zenkerii (Engl.) Diels	Menispermaceae
Pentaclethra	macrophylla Benth.	Mimosaceae
Pentadesma	butyracea Sabine	Guttiferae
Phyllanthus	discoideus (Baill) Mull. Arg.	Euphorbiaceae
Piptadeniastrum	africanum (Hook. f.) Brenan	Mimosaceae
Placodiscus	pseudostipularis Radlk.	Sapindaceae
	splendidus Keay	
Plagiosiphon	emarginatus (Hutch. and Dalz.) J. Leonard	Caesalpiniaceae
Pleiocarpa	mutica Benth.	Apocynaceae
Premna	hispida Benth.	Verbenaceae
Protemegabaria	stapfiana (Beille) Hutch.	Euphorbiaceae
Pseudospondias	microcarpa (A. Rich.) Engl.	Anacardiaceae
Pterocarpus	santalinoides L'Her. ex DC.	Papilionaceae
Pterygota	macrocarpa K. Schum.	Sterculiaceae

Genera	Species	Family
Pycnanthus	angolensis (Welw) Warb.	Myristicaceae
Randia	acuminata Benth.	Rubiaceae
	genipaeflora DC.	
Rauvolfia	vomitoria Afz.	Apocynaceae
Rhizophora	racemosa G. F. W. Mey	Rhizophoraceae
Ricinodendron	heudelotii (Baill.) Pierre ex Pax	Euphorbiaceae
Rinorea	elliotii Engl.	Violaceae
Saccoglottis	gabonensis (Baill.) Urb.	Humiriaceae
Sakersia	africana Hook f.	Melastomataceae
Santiria	trimera (Oliv.) Aubrev.	Burseraceae
Sarcocephalus	diderrichii DeWild.	Rubiaceae
Scottellia	coriacea A. Chev. ex. Hutch. and Dalz.	Flacourtiaceae
	leonensis Oliv.	
Scytopetalum	tieghemii (A. Chev.) Hutch. and Dalz.	Scytopetalaceae
Sideroxvlon	aylmeri Scott	Sapotaceae
Soyauxia	floribunda Hutch.	Medusandraceae
Spathodea	camuanulata P. Beauv.	Bignoniaceae
Spondianthus	preussii Engl.	Euphorbiaceae
Spondias	mombin Linn.	Anacardiaceae
Sterculia	oblonga Mast.	Sterculiaceae
	tragacantha Lindl.	

Genera	Species	Family
Strephonema	pseudocola A. Chev.	Combretaceae
Strombosia	glaucescens Var. lucida J. Leonard	Olacnceae
Symphonia	globulifera Linn f.	Guttiferae
Syzygium	owariense (P. Beauv.) Benth.	Myrtaceae
	rowlandii Sprague	
	staudtii (Engl.) Mildbr.	
Tamarindus	indica Linn	Caesalpiniaceae
Tarrietia	utilis (Sprague) Sprague	Sterculiaceae
Terminalia	ivorensis A. Chev.	Combretaceae
	superba Engl. and Diels.	
Tetraberlinia	tubmaniana J. Leonard	Caesalpiniaceae
Tetrapleura	chevalieri (Harms) Bak F.	Mimosaceae
	tetraptera (Schum. and Thonn.) Taub.	
Tetrorchidium	didymostemon (Baill.) Pax and K. Hoffm	Euphorbiaceae
Treculia	africana Decne.	Moraceae
Trema	guineensis (Schum. and Thonn.) Ficalko	Ulmaceae
Tricalvsia	biafrana Hiern.	Rubiaceae
Trichilia	heudelotii Planch. ex Oliv.	Meliaceae
	prieureana A. Juss.	
Trichoscypha	arborea (A. Chev.) A. Chev.	Anacardiaceae
	baldwinii Keay	

Genera	Species	Family
Trichoscypha	cavalliensis Aubrev. and Pellegr	Anacardiaceae
	longifolia (Hook. f.) Engl.	
	smythei Hutch. and Dalz.	
Triplochiton	scleroxylon K. Schum.	Sterculiaceae
Turraeanthus	africanus (Welw. ex C. DC.) Pellegr	Meliaceae
Uapaca	esculenta A. 'Chev. ex Aubrev. and Leandri	Euphorbiaceae
	guineensis Mull. Arg.	
	heudelotii Baill.	
	paludosa Aubrev. and Leandri.	
Uvariopsis	guineensis Keay	Annonaceae
Vismia	guineensis (Linn.) Choisy	Hypericaceae
Vitex	chrysocarpa Planch	Verbenaceae
	grandifolia Gurke	
	micrantha Gurke	
	oxycuspis Baker	
	rufa A. Chev.	
Voacanga	obtusa K. Schum.	Apocynaceae
Ximenia	americana Linn	Olacaceae
Xylia	evansii Hutch	Mimosaceae
Xylopia	aethiopica (Dunal) A. Rich	Annonaceae

Genera	Species	Family
Xylopia	quintasii Engl. and Diels	Annonaceae
	rubescens Oliv.	
	staudtii Engl. and Diels	
	Villosa Chipp.	

Literature Cited

(1) Anon.
1948. Timber News. Vol. 56, No. 2113, p. 419. Nov.

(2) Armstrong, F. H.
1953. The Strength Properties of Timber. Forest Products Research Bulletin, No. 28, Department of Scientific and Industrial Research. Her Majesty's Stationery Office, London. 41 pp.

(3) Aubréville, A.
1936. La Flore Forestière de la Côte d'Ivoire. Vol. 1-3, Paris.

(4) Brazier, J. D.
1955. Bubinga and Allied Timbers. Timber Technology, Vol. 63, No. 2191, pp. 237-239.

(5) British Forest Products Research Laboratory.
1955. The Strength Properties of Timber: The 2-Cm Standard for Tests of Small Clear Specimens. 27 pp. Forest Products Research Bulletin No. 34, Dept. of Scientific and Industrial Research. Her Majesty's Stationery Office, London.

(6) British Forest Products Research Laboratory.
1956. A Handbook of Hardwoods. Department of Scientific and Industrial Research, Forest Products Research, Her Majesty's Stationery Office, London, 269 pp.

(7) British Imperial Institute
1930. Imperial Institute Bulletin, No. 3, Vol. 28, pp 131-138. London.

(8) Centre Technique Forestier Tropicale.
1947. Assié--sipo (Entandrophragma utile Sprague), Bois et Forêts des Tropiques, No. 3, 3rd Trimestre, pp 39-42. Nogent-sur-Marne (Seine) France.

(9) Centre Technique Forestier Tropicale.
1948. Tiama (Entandrophragma angolense C. DC.) Bois et Forêts des Tropiques. No. 8--4th Trimestre, pp. 395-398. Nogent-sur-Marne (Seine) France.

(10) Centre Technique: Forestier Tropicale.
1949. Tali (Erythrophleum micranthum Harms) Bois et Forêts des Tropiques, No. 9, 1st Trimestre, pp. 67-70, Nogent-sur-Marne (Seine) France.

(11) Centre Technique Forestier Tropicale.
1950. Kosipo (Entandrophragma candollei Harms), Bois et Forêts des Tropiques, No. 15, 3rd Trimestre, pp. 251-254, Nogent-sur-Marne, (Seine), France.

(12) Centre Technique Forestier Tropicale.
1955. Faro (Daniellia thurifera J. J. Benn.), Bois et Forêts des Tropiques, No. 44, pp. 17-20. Nogent-sur-Marne (Seine), France.

(13) Chalk, L., Davy, J. Burtt, Desch, H. E., and Hoyle, A. C.
1933. Forest Trees and Timbers of the British Empire. Vol. II--Twenty West African Timber Trees, 108 pp., Oxford, Clarendon Press.

(14) Cooper, G. Proctor, and Record, Samuel J.
1931. The Evergreen Forests of Liberia, Yale University School of Forestry, Bull. No. 31, New Haven, Conn., 153 pp.

(15) Davis, E. M.
1957. Some Machining Properties of Nine Liberian Hardwoods. Report No. 2093, 4 pp. U. S. Dept. of Agriculture, Forest Service, Forest Products Lab., Madison, Wis.

(16) Eggeling, W. J., and Harris, C. M.
1939. Forest Trees and Timbers of the British Empire, Vol IV, Fifteen Uganda Timbers, 120 pp., Oxford, Clarendon Press.

(17) Eggeling, William J. Revised and enlarged by Ivan R. Dale.
1951. The Indigenous Trees of the Uganda Protectorate, Government of the Uganda Protectorate, Entebbe, Uganda, Africa. 491 pp.

(18) Fouarge, Joseph, Gerard, G., and Sacre, E.
1953. Bois du Congo (Congo Woods), Publications de l' Institut National pour l' Etude Agronomique du Congo Belge, Brussels, 424 pp.

(19) Hutchinson, J., and Dalziel, J. M. Revised by Keay, R. W. J.
1954. Flora of West Tropical Africa, Vol. 1, Part 1, 295 pp. Second edition, Crown Agents for Oversea Governments and Administration. London.

(20) L'Institut National Pour L'Etude Agronomique du Congo Belge.
1948. Flore du Congo Belge et du Ruanda-Urundi, Vol. 1, Brussels, 446 pp.

(21) Jay, B. Alwyn.
1950. Timbers of West Africa. Timber Development Association, Ltd. London 98 pp.

(22) Kribs, David A.
1950. Commercial Foreign Woods on the American Market. The Pennsylvania State College, State College, Pennsylvania.

(23) Lebacq, Lucien.
1954. Bois Congolais. Le Hainaut Economique, Vol. 8, Nos. 3 and 4, 324 pp. Mons, Belgium.

(24) Leonard, J.
1957. Genera des Cynometreae et des Amherstieae africaines. pp. 214-215, Palais des Académies, Rue Decale 1, Brussels.

(25) Mayer, Karl R.
1951. Forest Resources of Liberia. 69 pp. USDA and USDS Agriculture Bull., No. 67, Washington, D. C.

(26) Méniaud, Jean.
1931. Nos Bois Coloniaux. 386 pp. Exposition coloniale internationale de Paris, Commission de synthése and Comite Economiqué Colonial, Paris.

(27) Méniaud, Jean.
1950. L'Azobé et ses utilisations. (Azobe and its Utilization) Bois et Forêts des Tropiques, No. 15, 3rd trimestre. pp. 261-266. Published by Societé pour le Developpement de l'utilisation des Bois Tropicaux, Paris.

(28) New York Naval Shipyard.
1955. Report of Evaluation on African Oak (Macrolobium sp. (now Gilbertiodendron sp.)). Lab. project 5740-10, Progress Report 1, Ns. 032-001. Material Laboratory, New York Naval Shipyard, Brooklyn, New York.

(29) Normand, Didier.
1950. Atlas des Bois de la Côte D'Ivoire. Vol. I, 148 pp. Centre Technique Forestier Tropical, Nogent-sur-Marne (Seine), France.

(30) Normand, Didier.
1950. Atlas des Bois de la Côte D'Ivoire. Vo. 11, 148 pp. Centre Technique Forestier Tropicale, Nogent-sur-Marne (Seine), France.

(31) Organization for European Economic Co-operation.
1951. Bois Tropicaux Africains, 421 pp. (African Tropical Timber). The Organization for European Economic Co-operation. Paris.

(32) Sallenave, P.
1955. Propriétés Physiques et Mécaniques des Bois Tropicaux de l'union Francaise. 126 pp. Centre Technique Forestier Tropical, Nogent-sur-Marne (Seine)-France.

(33) Scott, M. H.
1949. Weights of Timbers Used in South Africa. South African Forestry Assoc. Jour. No. 17, p. 80, Feb. Pretoria, S. Africa.

(34) Staner, P.
1941. Bois Congolais pour. Traverses de chemin de fer Bulletin Agricole du Congo Belge, Ministere des Colonies. Vol. 32, No. 2, pp. 322-352. Brussels, Belgium.

(35) Uganda Forest Department.
1954. Timber Leaflet No. 12. Standard name--Canarium Utilization Branch, Uganda Forest Department, Kampala, Uganda.

Table 1.--Strength properties of Liberian woods[1]

Species	Specific gravity at 12 percent moisture	Weight	Static bending				Maxim crushing strength[2]	Hardness		Source of date[3]
			Modulus of rupture	Modulus of elasticity	Fiber Stress at proportional limit	Fork to maximum load		Side	End	
		Lb. per cu. ft.	P.s.i.	1,000 p.s.i.	P.s.i.	In.-lb. per cu. in.	P.s.i	Lb.	Lb.	
Afzelia africana	0.80	50	16,616				9,408			2
Afzelia bracteata	.79	49	16,770	2,422	9,080			1,360		1
Albizzia adianthifolia	.56	35	14,336				7,625			2
Albizzia ferruginea	.50	31	9,391				6,010			2
Albizzia lebbek	.66	41	11,525				7,968			2
Albizzia zygia	.50	31	10,045	1,737	5,940		6,030	626	1,013	1
Allanblackia floribunda	.90	56	20,330	2,293	10,900		7,670	2,035	2,140	1
Alstonia congensis	.40	25	8,200	1,280		6.5	5,050	410	690	4
Amphimas pterocarpoides	.80	50	16,070	2,361	9,130		9,290	1,300	1,410	1
Anopyxis klaineana	.98	51	23,860	3,295	13,850		10,950	2,655	2,630	1
Antiaris africana	.66	41	12,400	1,450		9.0	7,620	1,260	1,490	4
Antrocaryon micraster	.52	32	12,758				6,091			2
Beilschmiedia manii	.66	41	14,250	1,968	7,840		7,250	1,160	1,130	1
Berlinia bracteosa	.68	42	15,235				8,406			2
Berlinia grandiflora	.76	47	15,361				8,323			2
Blighia welwitschii	.91	57	16,297				11,683			2
Bombax brevicuspe	.64	40					4,730	1,020	1,180	1
Bridelia micrantha	.56	35	13,984				6,432			2
Bussea occidentalis	.99	62	22,670	2,970	11,550		10,420	3,255		1
Calpocalyx brevibracteatus	.88	55	19,630	2,416	12,900		8,600	2,555		1
Calpocalyx sp.[4]	(0.37)	Green	7,200	1,230	4,170	6.1	3,500	550	610	5
Canarium schweinfurthii	.50	31	10,570	1,670	10,570		6,160	630	740	1
Carapa procera	.86	54	18,430	2,411	10,120			2,215	2,460	1
Cassipoovea firestoneana	.86	54	21,000	2,606	10,970		10,490	2,210	2,470	1
Ceiba centranda	.33	21	5,757				2,837			2
Chlorophora excelsa	.66	41	12,400	1,450		9.0	7,620	1,260	1,490	4
Do	.68	42	13,746				7,747			2
Chlorophora regia	.71	44	11,368				8,111			2
Chrysobalanus sp.	.98	61						3,440		1
Chrysophyllum africanum	.56	35	11,300				5,837			2
Chrysophyllum perpulchrum	.82	51	20,796				10,046			2
Cleistopholis patens	.30	19	4,170	881	2,531			270	400	1
Coelocaryon oxycarpum	.51	32	10,420	1,707	6,270		5,270	670	1,050	1
Coelocaryon preussii	.65	41	13,138				6,475			2
Cola acuminata	.59	37	9,220	1,482	7,160		6,560	1,070	1,310	1
Cola buntingii	.83	52						2,135		1
Cola lateritia	.59	37	10,725	1,468	6,490		7,320	895	950	1
Combretodendron macrocarpum	.81	51	16,117				8,419			2
Conopharyngia durissima	.64	40	11,520	1,547	6,100		7,050	1,300	1,380	1
Copaifera salikounda	.78	49	20,881				10,358			2

Table 1.--Strength properties of Liberian woods[1]--Continued

Species	Specific gravity at 12 percent moisture	Weight	Static bending				Maximum crushing strength[2]	Hardness		Source of data[3]
			Modulus of rupture	Modulus of elasticity	Fiber stress at proportional limit	Work to maximum load		Side	End	
		Lb. per cu. ft.	P.s.i.	1,000 p.s.i.	P.s.i.	In.-lb. per cu.-in.	P.s.i.	Lb.	Lb.	
Coula edulis	1.06	66	25,010	3,209	18,100			2,610		1
Cylicodiscus gabunensis	.93	58	19,300	2,490		12.9	11,920	2,770	3,090	4
Cynometra ananta	.91	57	18,300	2,588	14,175		10,850	2,632	2,910	1
Dacryodes klaineana	.81	51	16,036				8,102			2
Daniellia ogea	.51	32	11,200	1,410		10.0	5,810	710	970	4
Daniellia thurifera	.66	41						1,250	1,540	1
Do	.52	32	8,213				4,670			2
Detarium senegalense	.82	51	17,210	2,211	9,140		9,140	1,850	2,100	1
Diospyros kamerunensis	.99	62	24,520	2,265	13,450			3,340		1
Diospyros sanza-minika	.86	54	21,980	2,305	12,380		10,510	2,440		1
Discoglypremna caloneura	.42	26	9,302				5,017			2
Distemonanthus benthamianus	.67	42	14,900	1,760		12.8	8,000	1,230	1,650	4
Drypetes aubrevillei	.96	60	26,080	2,880	14,510		11,020	3,645		1
Enantia polycarpa	.58	36	14,180	1,796	9,360		6,830	1,040	1,810	1
Entandrophragma angolense	.56	35	10,426				6,490			2
Entandrophragma candollei	.74	46	12,179				7,205			2
Entandrophragma cylindricum	.69	43	15,391				8,200			2
Entandrophragma utile	.51	38	12,065				7,310			2
Erythrophleum ivorense	.85	53	17,720	2,913	9,230		9,500	2,025		1
Erythrophleum sp.[4]	(0.52)	Green	12,270	1,930	8,350	9.0	6,870	1,240	1,300	5
Erythroxylum mannii	.65	41	13,875				8,213			2
Eugenia whytei	.99	62						3,320		1
Fagara leprieurii	.50	31	12,530	1,732	7,430			860	940	1
Fagara macrophylla	.99	62	28,690				14,015			2
Funtumia africana	.45	28	7,280	1,118	4,490		3,660	295	480	1
Garcinia epunctata	.98	61	25,450	3,323	13,520			2,655		1
Gilbertidendron ivorense	.75	47	17,900	2,059	12,300	20.8		1,303		3
Gluema ivorensis	1.11	69								5
Guarea cedrata	.59	37	12,722				7,558			2
Guarea thompsonii	.62	39	14,700	1,680		12.1	8,360	1,100	1,370	4
Haplormosia monophylla	.95	59								5
Irvingia gabonensis	.94	59	22,985				10,181			2
Kaoue stapfiana	.75	47	14,240	2,377	7,540		8,510	1,720	2,040	1
Khaya anthotheca	.51	32	11,400	1,400		9.8	6,190	860	1,240	4
Khaya ivorensis	.50	31	10,336				5,717			2
Klainedoxa gabonensis	1.14	71	27,630	3,728	16,070		13,370			1
Lannea welwitschii	.50	31	11,094				6,216			2
Lophira alata	1.12	70	22,990	2,839	14,090	23.6		2,246		3
Lovoa trichilioides	.52	32	11,428				6,686			2
Maba sp.	.91	57	20,510	2,155	11,365		8,380	2,675		1

Table 1.- Strength Properties of Liberian woods[1]---Continued

Species	Specific gravity at 12 percent moisture	weight	Static bending				Maximum crushing strength[2]	Hardness		Source of data[3]
			Modulus of rupture	Modulus of elasticity	Fiber stress at proportional limit	Work to maximum load		Side	End	
		Lb. per cu. ft.	P.s.i.	1,000 p.s.i	P.s.i.	In.-lb. per cu. in.	P.s.i.	Lb.	Lb.	
Macaranga sp.	0.36	22	7,095	1,161	4,290		4,535	430	610	1
Mammea africana	.72	45	15,247				8,251			2
Manilkara lacera	.95	59	20,829				11,750			2
Mimusops heckelii	.61	38	13,950	1,570		10.7	7,440	1,110		4
Mitragyna sp.	.54	34	11,500	1,440		9.8	6,490	780	1,160	4
Morus mesozygia	.88	55	22,339				12,106			2
Musanga cecropioides	.24	15					2,320	165	330	1
Myrianthus liberious	.50	31	8,240	1,478	4,720			790	940	1
Nesogordonia papaverifera	.75	47	19,850				8,669			2
Octoknema borealis	.80	50	13,480	2,426	12,020			1,350		1
Oldfieldia africana	.99	62	25,480	3,304	13,820		12,150	3,020		1
Omphalocarpum elatum	.64	40						1,315	1,530	1
Ongonea gore	.90	56	18,131				9,403			2
Oxystigma manii	.51	32	11,008				6,884			2
Pachypodanthum staudtii	.76	47	20,170	2,850	12,090		8,680	2,035		1
Do.[4]	(0.60)	Green	9,120	2,040	6,000	4.1	5,780	790	1,080	5
Parinari excelsa	.76	47	17,000	2,080		12.2	9,160	1,720	2,190	4
Do.	.80	50	10,345	1,906	7,340		6,110	1,997	1,850	1
Parinari kerstingii	.98	61	23,740				12,950			2
Parinari robusta	1.00	62	26,657				12,883			2
Parinari sp.[4]	(0.72)	Green	13,710	2,320	8,220	8.9	6,650	1,230	1,490	5
Parkia bicplor	.46	29	5,120	1,382	3,210		4,940	555	680	1
Parkia sp.[4]	(0.40)	Green	5,450	940	3,300	3.2	2,620	310	550	5
Pausinytalia lane-poolei	.72	45	13,510	2,012	8,940		9,380	1,470	2,700	1
Pentaclethra macrophylla	.98	61	21,584				11,026			2
Pentadesma butyracea	.85	53	20,050	2,767	13,840		8,140	1,800		1
Phyllanthus discoideus	.74	46	10,870	2,036	6,030			1,695	1,840	1
Piptadeniastrum africanum	.75	47	12,660	1,980	7,670		8,680	1,540	1,820	1
Do.[4]	(0.62)	Green	10,860	1,720	6,130	9.7	5,460	1,070	1,170	5
Do.	.67	42	13,167				7,747			2
Placodiscus pseudostipularis	.99	62	19,540	2,540	11,110		10,340	3,995		1
Protemegabaria stapfiana	.70	44					7,710	1,520	1,700	1
Pycnathus angolensis	.53	33	8,910	1,754	5,640		5,510	745	690	1
Rhizophora racemosa	1.07	67	23,798				10,795			2
Saccoglottis gabonensis	.91	57	16,490	2,690	8,480		10,510	2,475	2,810	1
Sarcocephalus diderrichii	.75	47	16,500	2,070		11.7	10,020	1,630	2,060	4
Scottellia coriacea	.70	44	17,810	2,138	10,320			1,682	1,825	1
Scytopetalum tieghemia	.71	48	17,820	1,953	9,070		7,940	1,645	1,780	1
Spondianthus preussii	.75	47	15,910	1,880	8,780		7,530	1,720	2,120	1
Sterculia oblonga	.77	48	16,990	2,110		15.0	9,390	1,120		4

Table 1.--Strength properties of Liberian woods[1]--Continued

Species	Specific gravity at 12 percent moisture	Weight	Static bending: Modulus of rupture	Static bending: Modulus of elasticity	Static bending: Fiber stress at Proportional limit	Static bending: Work to maximum load	Maximum crushing strength[2]	Hardness: Side	Hardness: End	Source of date[3]
		Lb. per cu. ft.	P.s.i.	1,000 p.s.i.	P.s.i.	In.-lb. per cu. in.	P.s.i	Lb.	Lb.	
Strephonema pseudocola	.78	49	17,480	2,143	8,940		7,780	1,680	1,720	1
Strombosia glaucescens var. lucida	1.02	64	21,170	2,472	9,740			3,215		1
Do	.88	55	20,990				10,550			2
Symphonia globulifera	.53	33	11,870	1,803	6,970		6,120	990	1,250	1
Tarrietia utilis	.69	43	15,650	1,715		15.7				3
DO	.56	35	12,370	1,470		9.9	7,220	1,100		4
DO	.69	43	14,777				7,814			2
Terminalia ivorensis	.54	34	11,500	1,440		7.9	6,670	840	1,310	4
Terminalia superba	.54	34	11,861				6,504			2
Tetraberlinia tubmaniana	.62	39	16,500	1,995		8.0				5
Tetrapleura tetraptera	.60	37	13,110				6,830			2
Tetrorchidium didymostemon	.51	32	10,890	1,722	8,100		6,580	805	1,120	1
Trichelia heudelotii	.51	32	9,140	1,330	6,020		5,790	635	960	1
Trichoscypha arbores	.85	53	24,880	2,347	17,500			2,010		1
Triplochiton scleroxylon	.37	23	7,500	850		6.9	3,940	430	690	4
Turraeanthus africanus	.57	36	13,738				6,605			2
Uapaca guineensis	.75	47	16,280	2,025	8,360			1,740	1,860	1
Uapaca heudelotii	.68	42	14,568				7,742			2
Uapaca paludosa	.76	47	19,318				7,867			2
Vitex micrantha	.52	32	13,599				6,610			2
Vitex oxycuspis	.58	36	13,270	1,556	9,440		7,220	1,110	1,260	1
Xylopia aethiopica	.42	26	9,790	1,727	6,430		5,040	460	740	1
Xylopia quintasii	.96	60	26,240	3,320	15,290		10,780	3,075		1
Xylopia stauatii	.50	31	11,560	1,714	6,550		6,710	700	880	1

[1] All values shown are for standard 2- by 2-inch specimens or converted from the metric 2-centimeter tests to this standard. Moisture content at test was 12 percent unless otherwise indicated.

[2] Measured in compression parallel to the grain.

[3] (1) Yale University School of Forestry, New Haven, Conn. (14).
(2) Centre Technique Forestier Tropical, France (32).
(3) Material Laboratory, New York Naval Shipyard, Brooklyn, N.Y.
(4) British Forest Products Research Laboratory, England (2, 5).
(5) U.S. Forest Products Laboratory, Madison, Wis.

[4] All values shown are for tests on green material (moisture content above fiber saturation). Specific gravity based on volume of green wood and its weight when ovendry.

Table 2.--Shrinkage values for Liberian woods[1]

Species	Shrinkage, green to ovendry condition		
	Radial	Tangential	Volumetric
	Percent	Percent	Percent
Afzelia africana	.....	.....	8.5
Albizzia adianthifolia	2.3	6.5	9.9
Albizzia ferruginea	3.4	4.9	8.6
Albizzia lebbek	3.1	5.7	9.0
Allanblackia floribunda	.....	.....	17.2
Alstonia congensis	3.4	5.1	10.3
Amphimas pterocarpoides	.....	.....	15.5
Anopyxis klaineana	6.6	10.0	15.6
Antiaris africana	4.4	7.2	12.0
Antrocaryon micraster	4.8	7.4	13.0
Berlinia grandiflora	5.7	7.8	13.0
Blighia welwitschii	6.5	10.3	18.0
Bridelia micrantha	3.8	6.1	10.4
Canarium schweinfurthii	.....	.....	14.8
Ceiba pentandra	2.9	4.3	10.9
Chlorophora excelsa	3.1	4.7	9.6
Chrysophyllum africanum	.....	.....	11.0
Chrysophyllum perpulchrum	5.9	9.7	14.7
Coelocaryon preussii	.....	.....	11.8
Combretodendron macrocarpum	5.5	9.4	16.3
Copaifera salikounda	5.1	8.4	11.3
Coula edulis	4.8	9.1	11.8
Cylicodiscus gabunensis	4.9	8.5	13.6
Cynometra ananta	.....	.....	13.6
Dacryodes klaineana	7.4	8.3	14.4
Daniellia thurifera	2.6	5.6	12.9
Detarium senegalense	.....	.....	11.8
Diospyros sanzaminika	.....	.....	14.7
Distemonanthus benthiamianus	.....	.....	11.4
Entandrophragma angolense	4.8	6.5	12.0
Entandrophragma candollei	.....	.....	11.7
Entandrophragma utile	.....	.....	10.9
Erythrophleum guineense	.....	.....	12.6
Erythrophleum micranthum	4.6	7.3	12.2
Fagara macrophylla	.....	.....	11.5
Gilbertiodendron Sp*	3.5	8.7	12.1
Guarea thompsonii	5.2	6.5	10.9
Irvingia gabonensis	6.5	10.2	16.4
Khaya anthothcca	.....	.....	10.6
Khaya ivorensis	.....	.....	10.0
Klainedoxa gabonensis	7.9	10.3	16.0
Lophira alata	5.7	10.0	15.3
Lovoa trichilioides	3.4	5.6	9.6

Table 2.-- Shrinkage values for liberian woods[1] (continued)

Species	Shrinkage, green to ovendry condition		
	Radial	Tangential	Volumetric
	Percent	Percent	Percent
Mammea africana	6.1	8.7	13.6
Manilkara lacera	.....	.....	14.3
Mimusops heckelii	.....	.....	11.0
Mitragyna ciliata	.....	.....	11.3
Mitragyna stipulosa	.....	.....	11.7
Morus mesozygia	.....	.....	10.0
Musanga cecropioides	.....	.....	12.5
Nesogordonia papaverifera	5.3	6.5	12.9
Ongokea gore	4.5	11.2	13.8
Parinari spp.	8.3	10.7	16.3
Pentaclethra macrophylla	.....	.....	11.3
Pentadesma butyracea	4.5	8.0	12.2
Piptadeniastrum africanum	2.5	8.0	12.1
Pycnanthus angolensis	3.9	7.8	12.5
Rhizophora racemosa	.....	.....	16.9
Sacoglottis gabonensis	.....	.....	12.4
Santiriopsis balsamifera	.....	.....	12.9
Sarcocephalus diderriehii	4.8	7.4	12.4
Scytopetalum tieghemii	.....	.....	18.2
Strephonema pseudocola	5.7	11.1	13.8
Strombosia glaucescens var. lucida	7.6	7.9	14.3
Symphonia globulifera	.....	.....	12.0
Tarrietia utilis	2.9	5.9	11.7
Terminalia ivorensis	3.1	4.9	9.6
Terminalia superba	4.4	5.4	10.3
Tetraberlinia tubmania*	4.5	7.7	12.1
Tetrapleura tetraptera	.....	.....	9.3
Triplochiton scleroxylon	3.3	5.3	8.9
Uapaca guineensis	.....	.....	14.4
Uapaca heudelotii	.....	.....	17.2
Uapaca paludosa	5.9	11.3	16.2
Vitex micrantha	2.7	5.8	10.4

[1] Shrinkage values from P. Sallenave, "Propriétés Physiques et Mécaniques des Bois Tropicaux de l 'Union Française," Reference No. 32 in the list of references, except those marked with an asterisk (*) are tests made by the U.S. Naval Shipyards.

Table 3.--Kiln Schedule A (6)[1]

Moisture content (percent) of the wettest timber on the air-inlet side at which changes are to be made	Temperature (Dry bulb)		Temperature (Wet bulb)		Relative humidity (approx.)
	°F.	°C.	°F.	°C.	Percent
Green	95	35	87	30.5	70
60	95	35	83	28.5	60
40	100	38	84	29	50
30	110	43.5	88	31.5	40
20	120	48.5	92	34	35
15	140	60	105	40.5	30

[1]Suitable for timbers which must not darken in drying and for those which have a pronounced tendency to warp but are not particularly liable to check.

Table 4.--Kiln Schedule B (6)[1]

Moisture content (percent) of the wettest timber on the air-inlet side at which changes are to be made	Temperature (Dry bulb)		Temperature (Wet bulb)		Relative humidity (approx.)
	°F.	°C.	°F.	°C.	Percent
Green	105	40.5	101	38	85
40	105	40.5	99	37.5	80
30	110	43.5	102	39	75
25	115	46	105	40.5	70
20	130	54.5	115	46	60
15	140	60	118	47.5	50

[1]Suitable for timbers that are very prone to check.

Table 5.--Kiln Schedule C (6)

Moisture content (percent) of the wettest timber on the air-inlet side at which changes are to be made	Temperature (Dry bulb)		Temperature (Wet bulb)		Relative humidity (Approx.)
	°F.	°C.	°F.	°C.	Percent
Green	105	40.5	101	38	85
60	105	40.5	99	37.5	80
40	110	43.5	102	39	75
35	110	43.5	100	38	70
30	115	46	103	39.5	65
25	125	51.5	109	43	60
20	140	60	118	47.5	50
15	150	65.5	121	49	40

Table 6.--Kiln Schedule E (6)

Moisture content (percent) of the wettest timber on the air-inlet side at which changes are to be made	Temperature (Dry bulb)		Temperature (Wet bulb)		Relative humidity (Approx.)
	°F.	C.	°F.	°C.	Percent
Green	120	48.5	115	46	85
60	120	48.5	113	45	80
40	125	51.5	116	46.5	75
30	130	54.5	117	47	65
25	140	60	120	49	55
20	155	68	127	53	45
15	170	76.5	136	58	40

Table 7.--Kiln Schedule F (6)

Moisture content (percent) of the wettest timber on the air-inlet side at which changes are to be made	Temperature (Dry bulb)		Temperature (Wet bulb)		Relative humidity (approx.)
	°F.	°C.	°F.	°C.	Percent
Green	120	48.5	111	44	75
60	120	48.5	109	43	70
40	125	51.5	109	43	60
30	130	54.5	109	43	50
25	140	60	115	46	45
20	155	68	124	51	40
15	170	76.5	136	58	40

Table 8.--Kiln Schedule H (6)

Moisture content (percent) of the wettest timber on the air-inlet side at which changes are to be made	Temperature (Dry bulb)		Temperature (Wet bulb)		Relative humidity (approx.)
	°F.	°C.	°F.	°C.	Percent
Green	135	57	127	53	80
50	135	57	126	52	75
40	140	60	126	52	65
30	150	65.5	129	54	55
20	170	76.5	136	58	40

Table 9.--Kiln Schedule J (6)

Moisture content (percent) of the wettest timber on the air-inlet side at which changes are to be made	Temperature (Dry bulb)		Temperature (Wet bulb)		Relative humidity (approx.)
	°F.	°C.	°F.	°C.	Percent
Green	135	57	123	50.5	70
50	135	57	119	48	60
40	140	60	118	47.5	50
30	150	65.5	121	49	40
20	170	76.5	127	53	30

Table 10.--Kiln Schedule K (6)

Moisture content (percent) of the wettest timber on the air-inlet side at which changes are to be made	Temperature (Dry bulb)		Temperature (Wet bulb)		Relative humidity (approx.)
	°F.	°C	°F.	°C.	Percent
Green	160	71	151	66	80
50	170	76.5	156	68.5	70
30	180	82	159	70.5	60
20	190	88	153	67.5	40

Table 11.--Kiln Schedule L (6)

Moisture content (percent) of the wettest timber on the air-inlet side at which changes are to be made	Temperature (Dry bulb)		Temperature (Wet bulb)		Relative humidity (approx.)
	°F.	°C.	°F.	°C.	Percent
Green	180	82	165	74	70
40	200	93.5	162	72	40