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Boxwoods

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BOXWOODS

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Photo by Benoit

A stand of box trees (*Buxus sempervirens* L.)

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BOXWOODS

BY SAMUEL J. RECORD AND GEORGE A. GARRATT

INTRODUCTION

TRUE boxwood, cOlnmonly called Turkish boxwood, is derived from a small group of plants, of which the common evergreen box of our gardens is the type. To this group the famous botanist Linnaeus gave the generic name of *Buxus,* the Latin for box tree. He called the best known menlber of it *Buxus sempervirens,* which is' but another form of Ovid's "buxus perpetuo virens," the evergreen box. For long this was considered the only species, though various forms and varieties came to be recognized, several of which have since been elevated by other botanists to specific rank.

The natural range of the true box embraces southern Europe, part of northern Africa, the coastal regions of Asia Minor, the Caucasus, northern Persia, and from the higher elevations of Afghanistan extends along the Himalayas into China and Japan. This tree has made appeal to peoples of all tinlesand degrees of civilization because of its slow, persistent growth, its long life, its freedom from disease and insect pests, the perennial green of its compact foliage, the ease with which it could be propagated, and also on account of the unique qualities of its wood. The trees, typifying immortality, were planted about shrines and cemeteries, and sprigs of the dainty and durable foliage played a part in religious and festal rites. For these reasons it has been cultivated for centuries, both in the regions of its natural range and beyond.

No other wood is so fine-textured and of such uniform consistency as boxwood; of great density, yet easily shaped and carved; the color a pale yellow throughout. The ancient Egyptians made combs of it (see Plate IV, No. I), a common use in many countries to this day. Box\vood tablets, with their smooth, clean surface, were well adapted for writing purposes, and it was upon such a tablet that the admonitory message of the prophet Isaiah (30: 8) was ordered to be published. The allegorical ship of Tyre *(Ezekiel*

27: 6, Rev. Vers.) had "benches of ivory inlaid in boxwood, from the isles of Kittim."

The early Greeks and Romans found manifold employment for boxwood. The yoke for Priam's steeds was of this material *(Iliad)* 24: 268). Writing tablets, flutes or pipes, spinning tops, combs, jewel cases, carved ornaments and images, inlay and veneers, all made their demands upon this wood,[1] the best of which came from the mountains of Cytorus where the town of Kitros is now situated. So common were these uses that articles, such as tops and flutes, are, through metonymy, frequently referred to as "buxus" or "buxum." From the color of the wood originated the words "buxans," pallor, and "buxeus," sonletimes used in the sense of spurious, an allusion to the paleness of the material. Various legends came to be associated with the tree, as for instance that no serpent could breed in it because of the hardness of the wood. The ease with which the plants could be shaped by pruning gave rise to the art of topiary which filled the Roman and early English gardens with freaks of verdant sculpture.

With the passing of the centuries the earlier uses of boxwood continued and there were added important new ones such as scales, or rules, and xylography, or wood-engraving; for the latter purpose particularly no entirely satisfactory substitute has ever been found. The invention and development of the power loom brought a demand for shuttles of wood of great strength and elasticity and of exceeding fineness and uniformity of texture-qualities in which boxwood is preenlinent. The timber became of great demand, and during the period 1860-1880 the imports into England from the Caucasus, Asia Minor, and Persia averaged about 6000 tons annually.

Then came a sharp decline. The inroads of the substitutes robbed the true boxwood of its former high place in the trade. Such a change was inevitable, but it was hastened by the action of the Russian Government. It is said that they offered to sell to a Liverpool firm all the boxwood in the Caucasus for a lump sum of 10,000,000 rubles, \vith the added stipulation that the purchaser was to make in that region a specified number of versts of military roads, to the satisfaction of the Russian military engineers. Failing the acceptance of this proposal, an export duty of approximately $15 per ton was imposed on all boxwood and walnut shipped from the Caucasus. Stimulated by necessity, the shuttle-makers were not long in dis-

1 References: WRITING TABLETS: *Prop.* 3 (4), 23, 8; *Schol. ad Hor.* S. 1, 6, 74. FLUTES or PIPES: *Ov. M.* 14, 537, and *F.* 6,697. Tops: *Virgo A.* 7, 382; *Pers.* 3, 52. COMBS: *Ov, F.* 6, 229; *Ov. M.* 4J 311; *Juv.* 14, 194. VENEERS: *Pliny,* 16,84.

covering other and cheaper woods for their needs. Apple, pear, and hawthorn were satisfactory, but the supply was limited and uncertain. The flowering dogwood and the persimmon of Virginia were found upon trial to ans\ver the purpose for most textiles and their exploitation on a commercial scale began in 1871,2 The ilnport of boxwood from the Caucasus, Turkey-in-Asia, and Persia subsequently declined to less than a tenth of its former volume.

True boxwood has ceased to be a factor in the shuttle business. The two American woods have largely replaced it for that purpose, but neither of these is suited for fine engraving, mathematical instruments, carving, or other special boxwood purposes, because they do not have the proper color and consistency. In parts of the United States, the name boxvvood has been applied to the dogwood for considerably more than a century and the wood is sometimes sold as American boxwood. Another NorthAmerican tree credited by some of the dictionaries and encyclopedias with contributing to the boxwood supply is the false boxwood of southern Florida, 'but at most, because of the scarcity of the timber, its rôle must have been a very minor one.

It was about the year 1860 that the first trial shipment of the so-called West Indian[3] boxwood was made from Venezuela to Germany, and during the next eight years a regular trade in this commodity developed. The amount exported from Puerto Cabello to Hamburg in 1878 was nearly a million pounds.[4] This material was not a single species, but in all probability a mixture of two or three kinds, eventually reduced to one. The identities of these woods were long in doubt and the confusion resulting from incorrect determination still persists in many standard books of reference. The Maracaibo boxwood or "zapatero" now dominates the boxwood market and is a fairly satisfactory substitute for true boxwood for nearly all purposes except the finest of wood-engravings.

The search for boxwood substitutes extended throughout the British possessions. A series of experiments with native woods for engraving was begun in the School of Arts at Madras in 1858 with a view to improving

2 According to Mr. R. M. Gardner, of Joseph Gardner & Sons; Liverpool, the first shipment of dogwood and persimmon was in 1865, when a parcel of logs from James River, Virginia, was fOTwarded to Liverpool on the sailing ship *Maggie Warren,* plying between Boston and Havre.

3 Venezuelan woods are often referred to in the trade as being of West Indian origin because of their transshipment from Curaçao.

4 ERNST, A.: Botanische notizen aus Venezuela. *Botanisches Centralblatt,* 1: 574, 1880.

the illustration of the literature of India, and the results attracted considerable attention in London, Edinburgh, and Glasgow where specimens of the woods and of the engravings were exhibited.[5] Among the woods tried were the satinwood, sandalwood, wild orange, China orange, and coffee, but none of these met with very distinct success. About this time a reward of 500 rupees was offered by the School of Arts in Calcutta for the boxwood substitute best suited for engraving, and this resulted in bringing to notice the fact that true boxwood was growing in the Northwest Provinces. Scattered stands of this timber were subsequently located in various parts of the Himalayas and a trial shipment of about five tons was made to England in 1881. "The logs comprising the parcel had to be carried on men's backs and partly by carts from the forests to Saharunpur, and thence by rail to Bombay."[6] The difficulties of transportation from the mountains to the seaboard, and the consequent high cost, discouraged further attempts in this direction.

In 1886, a parcel of boxwood logs was shipped to London from South Africa, but it was several years before the trade assumed any importance. Only two woods are now being exported from South Africa and both are classed as boxwood. One, known as Cape, East London, or East African boxwood, is a near relative of the genuine timber, but considered in every way its inferior. The other, the Knysna boxwood or "Kamassi," is a relative of the Venezuelan "amarillo" and, while excellent for shuttles, is of little value for engraving. For a number of years this wood was known in England as West African boxwood, but its true origin was finally revealed. Practically all of the boxwood shuttles now manufactured in England are of the wood of this species.

Although true boxwood grows in parts of China, Japan, and Formosa, the quantity is too limited to meet the Asiatic demand, which is principally for the manufacture of wooden combs. The Japanese derive a portion of their supply from Siam, where a species of *Gardenia,* locally known as "mai put" or "mai phoot," yields small logs of a very compact and fine-textured wood, but the color is white or grayish instead of yellow.

A recent addition to the group of commercial boxwoods is a timber from Santo Domingo, known locally as "baitoa" and on the market as San Domingan boxwood. It belongs to the elm family and its identity was first

[5] HUNTER) ALEXANDER: On the Indian woods that have been tried for engraving. *Transactions 0/ the Botanical Society)* Edinburgh, 6: 3: 358-361, 1860.

[6] Boxwood, Indian. *Report on the progress and conditions 0/ the Royal Gardens at Kew) London)* 1882, p. 25.

established by the senior author in 1918. So far as known there is only a single species, although its range includes Argentina, southern Brazil, the Antilles, Venezuela, Nicaragua, and southern Mexico. One of the curious features of this wood is the presence in the pores of such quantities of lime that the application of hydrochloric acid produces a very noticeable effervescence, thus providing a ready means of identification even though the material may have been "ebonized."

Still more recently some attempt has been made to introduce into the boxwood trade a wood known in Santo Domingo as "caya" ("calla" or "calla blanca"), identified by the senior author as *Sideroxylon* sp. (Sapotaceae). So far the wood has not met with favor from manufacturers.

In addition to the foregoing there are many trees known as box. This is particularly the case in Australia, where conspicuous lack of originality has been shown in naming the native timbers. There many species of *Eucalyptus* are called box, but none yields a boxwood substitute. A few other kinds are mentioned by certain writers as having possibilities in this direction, but they are as yet unknown to the trade.

The search for new boxwoods continues and, while there is little likelihood that any entirely satisfactory all-round substitute for the genuine wood will ever be found, there are still possibilities enough remaining in the poorly explored forests of tropical America to lend interest to the quest.

I. TURKISH BOXWOOD AND OTHERS OF THE FAMILY BUXACEAE

THE FAMILY

THE members of the Box Family, Buxaceae, which some botanists include in the Euphorbiaceae, are evergreen shrubs and small trees growing in the warmer regions of both the Old and the New World. According to Pax,[1] the family is divisible into three sub-families: (1) Buxeae (with the three genera *Sarcococca, Pachysandra,* and *Buxus);* (2) Stylocereae (with the two genera *Notobuxzts* and *Styloceras);* and (3) Simmondsieae (with a single genus *Simmondsia*). The genus *Buxus,* the only one with species yielding timber of commercial importance, is composed of two sections or subgenera: (1) *Eubuxus* Baillon, of which *Buxus semper-*

1 PAX) F.: Buxaceae, in Engler and Prantl's *Pflanzenfamilien, III)* 5, pp. 130-135, 1896.

virens L. is the type, and (2) *Tricera* Swartz, which embraces all of the West Indian species.

Van Tieghem,[2] however, proposes a different classification. He eliminates the genus *Simmondsia*,[3] divides the Buxaceae into two sub-families (the Buxeae and the Pachysandreae), considers *Tricera* of generic rank, and separates the section *Eubuxus* into three genera, namely, (1) *Buxus*, (2) *Buxanthus*, and (3) *Buxella*. The species listed by him under each of the five genera of the Buxeae are: (1) In Europe, *Buxus sempervirens* L. and *B. balearica* Lam.; in Asia, *B. Harlandii* Hance, *B. japonica* Muell.-Arg., *B. longifolia* Boiss., *B. Wallichiana* Baill. (2) In Africa, *Buxanthus Hildebrandtii* (Baill.) Van Tiegh. and *B. pedicellatus* Van Tiegh. (3) In Africa, *Buxella Mac-Owanii* (Oliv.) Van Tiegh. and *B. madagascarica* (Dup.-Th.) Van Tiegh. (4) In Africa, *Notobuxus natalensis* Oliv. (5) In the Antilles, *Tricera acuminata* Gris., *T. citrifolia* Willd., *T. cubana* A. Rich, *T. glomerata* Gris., *T. gonoclada* Wright, *T. leavigata* Swartz, *T. Purdieana* Baill., *T. retusa* Gris., *T. subcolumnaris* Muell.-Arg., *T. Vahlii* Baill., and *T. Wrightii*.

The present authors have found Van Tieghem's classification convenient to use and have accordingly adopted the nomenclature proposed by him. The woods of the various species of *Buxus* (in the restricted sense) are, so far as studied, very similar in structure and are readily separable from that of *Buxella Mac-Owanii*. Moreover, all of the woods of the former group enter the trade without question as genuine boxwood, while that from South Africa is classed as a substitute. The species of *Tricera* are shrubs of no economic importance,[4] and the woods of *Buxanthus* and *Notobuxus* do not enter the market.

1. Buxus (*sens. str.*)

Botanists are not all in agreement as to the classification of the plants belonging to this genus, and species accepted by some authors are by others considered as varieties or forms. *Buxus sempervirens* L., the common box

[2] Van Tieghem, Ph.: Sur les Buxacées. *Annales des Sciences Naturelles* (*Botanique*), ser. 8, 5: 289-338, 1897. See also Solereder, Hans: *Systematic anatomy of the dicotyledons*. Oxford, 1908, pp. 1053-1054.

[3] The wood of *Simmondsia*, unlike that of the other genera mentioned, is of anomalous structure (interxylary bast) and its vessels are spiral and have simple perforations.

[4] Mr. C. H. Pearson informs the writers that at one time very limited quantities of what was considered true boxwood were exported from Cuba. This material was presumably *Tricera* sp.

of Europe, is the best known species, and is sOllletimes credited with a range extending from western Europe to Japan. Rehder and Wilson,[5] whose determination of the Chinese material made necessary a study of most of the species of the subgenus *Eubuxus* (=*Buxus* in the sense used here), improved the opportunity of compiling a short synopsis (in Latin) of all of the species of this subgenus, of which the following is a translation.

SYNOPSIS OF THE SPECIES OF THE SUBGENUS EUBUXUS

Male flowers stalked; rudiment of the ovary one-fourth as long as the sepals. Leaves 1-2.8 in. long.

Leaves with round to emarginate tips, ovate-oblong to oblong, 1.2-1.6 in. long and 0.48-0.8 in. ,vide. Styles erect.

(1) *Buxus balearica* Lamarck.

Leaves with acutish to'obtuse tips.

Leaves 0.28-0.48 in. wide and 1-1.6 in. long, lanceolate to linear-elliptical. ..... (2) *Buxus longi/olia* Boissier.

Leaves 0.6-1 in. wide and 2-2.8 in. long, ovate-Ianceolate to lanceolate. Styles spreading, with recurved stigmas, more than twice the height of ovary, exserted. Basal bracts of the inflorescence ashy-pubescent on the back. Twigs subcylindricaL

(3) Buxus Henryi Mayr.

, Male flowers sessile (not seen in NO.4).

Leaves papillose and bluish-white beneath, narrowly lanceolate, 1.2-2.4 in. long (4) *Buxus papillosa* Schneider.

Leaves not papillose, green to yellowish-green beneath.

Rudiment of the ovary in the male flowers barely half as long as the sepals.

Leaves 1 .2-2.4 in. long.

Leaves lanceolate to linear-lanceolate, 0.24-0.6 in. wide, margin even. Twigs hairy. ..... (5) *Buxus vVallichiana* Baillon.

Leaves ovate-oblong to nearly ovate, 0.6 to 1 in. wide, margin undulate. Twigs nearly glabrous.

(6) Buxus liukiuensis Makino.

Leaves 0.4-1.2 in. long, rarely a little longer.

(7) BUX1tS *sempervirens* Linnaeus.

5 REHDER, ALFRED, and E. H. WILSON: Buxaceae, in *Plantae Wilsonianae, II,p.* 167. Pub. NO.4, Arnold Arboretum, Cambridge, 1916.

Rudiment of the ovary in the male flowers equal or nearly equal in length to the sepals. Leaves mostly small, 0.32-1.2 in., rarely up to 2 in. long.

Leaves roundish to narrowly lanceolate, usually abruptly narrowed at the base. Styles half as long as the ovary.

Leaves 0.16-0.72 in. wide. Rudiment of the ovary decidedly dilated at the apex; stamens twice as long as the sepals.

Twigs glabrous.

Inflorescences mostly all terminal. Leaves oblong-ovate to oblanceolate, 0.16-0.32 in. wide.

(8) *Buxus microphylla* Siebold & Zuccarini.

Inflorescences axillary and terminal. Leaves mostly obovate to oval, 0.32-0.76 in. wide.

var. *japonica* Rehder & Wilson.

Twigs more or less pubescent.

Leaves obovate to ovate-oblong, apex rounded to emarginate, 0.4 to 1.2 in. long. Twigs more or less hairy.

var. *aemulans* Rehder & Wilson.

Leaves 0.12-0.16 in. wide, oblong-lanceolate. Rudiment of the ovary scarcely dilated at the apex. Stamens about half again as long as the sepals. . . . . (9) *Buxus stenophylla* Hance.

Leaves oblanceolate to ovate-oblong, base gradually narrowed, 0.48-0.8 in. long and 0.16-0.24 in. wide. Styles as long as the ovary.

(10) *Buxus Harlandii* Hance.

a. ***Buxus sempervirens*** Linnaeus

Description of the tree.—The common box is a well-known hardy evergreen shrub or small tree, highly esteemed for ornamental planting. Various varieties and forms are recognized, some of them low dwarfs used for edging plants in gardens. The trees are rarely over 15 feet high in Europe, but in portions of the Caucasus heights of 30 to 40 feet and diameters of 10 to 12 inches have frequently been observed. The bark is thin and very smooth on the smaller branches and young stems, becoming rough and grayish on the trunks of old trees. The leaves are opposite, oval, and almost sessile; they are persistent, of a leathery texture, and the upper and lower halves are readily split apart; they are lustrous and their color varies from yellowish to dark green, while some of the horticultural forms are variegated with silver or gold. The plants are monoecious, and the tetandrous flowers are

borne in little tufts in the axils of the leaves; the male flowers contain rudiments of the ovary. The fruit is a small, ovate, 3-horned woody capsule, which splits into three 2-horned parts and liberates the few seeds.

Box is readily propagated by seeds, cuttings, and layers, but the growth is slow, though persistent. It is tolerant of shade and thrives best on well-drained calcareous soils. It is notably free from insect and fungous pests, and it is said that animals will not browse the leaves and twigs. The leaves are ranked high in fertilizing value, and the bitter principle in them and the bark was formerly credited with medicinal virtue.

Distribution.—*Buxus sempervirens* is common throughout southern Europe and in western Asia as far as Persia, and occurs sparingly in northern Africa.

England.—The tree has been growing so long in an apparently wild state in southern England, particularly on Box Hill, that many writers, especially Ray, Lambarde, and Evelyn, consider it a native; others, however, believe that it is one of the many introductions owed to the Romans. In favor of the latter opinion is the fact that the plant is not wild on the Channel Islands, while in the north of France, Holland, and Belgium it is found only in hedgerows and near cultivation. Loudon[6] sums up the available evidence as follows: "At present the only habitat of this tree in England is Box Hill; and though this circumstance cannot be considered as a proof that it is not indigenous, yet, as it is known that it does not ripen its seeds freely in this country, and seldom sows itself, either on Box Hill or anywhere else, when in a neglected state, we may fairly be allowed, when these circumstances are taken into consideration and conjoined with its Roman name, to doubt whether it be a native. It is so beautiful a tree, that its branches, like those of the bay, were probably in early use both in civic festivals and religious ceremonies; and it appears likely that it was not only introduced, but was cultivated, at an early period. At the same time, it must not be forgotten, that, in estimating the probability of a tree or plant being indigenous to a country, we must add to the other considerations

[6] LOUDON, J. C.: *Arboretum et fruticetum Britannicum, I.* 2d ed., London, 1844, pp. 25-26.

See also: EVELYN, JOHN: *Silva, or a discourse of forest trees and the propagation of timber in his Majesty's Dominions, as it was delivered in the Royal Society the XVth of October, MDCLXII, upon occasion of certain quaeries propounded to that illustrious assembly, by the Honourable the Principal Officers and Commissioners of the Navy.* 4th ed., London, 1706, pp. 177-179.

JOHNS, C. A.: *The forest trees of Britain.* 10th ed., London, 1912, pp. 70-81.

mentioned that of its native habitat. Now the native site of the box is in woods of deciduous trees, where it is well known a plant may propagate itself by seeds, which would not do so on naked exposed situations. Taking this view of the subject, the box may yet be a native."

The stands of box trees in England have furnished a limited amount of material for local uses for a long time. "During the World War there was urgent need for boxwood in the manufacture of artillery shells and the remaining stands were heavily cut for that purpose. *Timber News*[7] records a sale in May, 1924, of a small quantity of yew, box, and holly on an estate on the London boundary. "Both yew and holly are more frequently offered than box. Ten tons of yew recently sold for 4S. 6d. per cu. ft. Box is much more expensive, that of only fair size realizing £10 per ton."

Portugal and Spain.-Regarding the distribution of box in Portugal, Willkomm[8] says that among the middle European plants which have their western limits in the peninsula, special attention should be called to *Buxus sempervirens,* which advances froin the Pyrenees out through northern Spain to southern Galicia, through the mountains of the central tablelands to Portugal (Coimbra, Bussaco, etc.), and from Catalonia out through the Valencian and Murcian mountains to Cazorla in the Province Jaën. The boundary line is too irregular to be definitely determined. Else\vhere *(Zoe. cit.,* p. 3°5) he states that box undergrowth is particularly abundant in Galicia and along the little streams between Figueira and Thomar in Estrenladura, Portugal.

France.-Box is common in parts of France, and Mouillefert[9] says there are pure stands frequently covering large areas in the Jura, the Dauphine, the Haute-Province, the Languedoc, the Pyrenees, and Corsica. Willkomm *(loc. cit.,* pp. 106-107) states that box is a characteristic shrub of the whole Pyrenees region. The earliest known fossil forms of *Buxus* have been found in the Pliocene deposits of France.

The trade in boxwood from the Pyrenees has been of very little importance during the past IS years. The sticks now available are small, rough, and inclined to split badly in drying.

Switzerland.—In the Jura Mountains of Switzerland there are areas of bushland composed of *Buxus sempervirens,* to which Baumberger has given

7 *Timber News,* London, June 7, 1924, p. 18.

8 WILLKOMM, MORITZ: *Die vegetation der erde, I. Grundzüge der pflanzenverbreitung auf der Iberischen Halbinsel.* Leipzig, 1896, p. 221.

9 MOUILLEFERT, P.: *Traité des arbres et arbrisseaux, II.* Paris, 1892-1898, p. 811.

the name "fell heath."[10] A grove of trees of about one-eighth acre in extent, located in Bemish Seeland near the village of Pieterlen (Perles), was described by Benoit[11] in 1898. Its location beside a churchyard suggests that the original trees were planted, though it had much the appearance of a natural stand and was reproducing well. (See frontispiece.) The total number of trees, to a minimum diameter of two inches, was 325; the largest tree was a little over seven inches in diameter, breast high. The average age of the stand was found to be 140 years, and the mean annual increment was computed to be 1.58 cubic meters per hectare. The growth was best where the box grew under the partial shade of some old ash trees. The writer concluded that under proper conditions, namely, limestone soil and mild climate, the cultivation of box could be made financially successful.

Germany.—According to Grisebach,[12] *Buxus sempervirens* occurs in the Moselle Valley and is sporadic in Thüringia, the northern limit being 510. Lorey[13] mentions its occurrence in mountainous places in the Moselle Valley and near Grenzach in Baden, where there is a natural underwood of about 80 hectares. Loudon[14] says that it is almost the only evergreen, exclusive of the Coniferae, that will stand in the open air, without protection, in the gardens of Berlin.

Balkans.—In the Balkans, according to Adamovic,[15] *Buxus sempervirens* is very well distributed in a continuous belt through Albania, old Serbia) Macedonia, and North Pirus, from the mixed forest region to the Lower Alps. The highest elevation of a box stand observed by him was on the Ljubitrn (Sar Planima), nearly 4000 feet above sea level. Grisebach[16] says that in the oak forests along the Drin in northern Albania, low dense growths of box were found in a few places. It extends into the mountains to an elevation of 3000 feet. Limited quantities of boxwood are exported from Saloniki, mostly small sticks ¾ to 1½ inches in diameter and 4 feet long, sold in bundles. The wood is used for small articles of turnery.

10 WARMING, EUG.} and MARTIN VAHL: *Oecology 0/ plants.* Oxford, 1909, p. 291.

11 BENOIT, *A.:* Das buchsbaumwaldchen in Pieterlen. (Petite forêt de buis aux environs de Perles.) *Schweizerische Zeitschrift für Forstwesen}* 49: 5 : 151-153, May, 1898.

12 GRISEBACH, A. : *Die vegetation der erde} I.* Leipzig, 1884, p. 513.

13 LOREY, T. : *Handbuch der forstwissenschaft, I.* Tubingen, 1913, pp. 493-494.

14 LOUDON, J. *C.* : *An encyclopædia of trees and shrubs.* London, 1842, p. 704.

15 ADAMOVIC, LUJo: *Die vegetation der erde} XI. Die vegetationsverhiiltnisse der Balkenländer.* Leipzig, 1909, p. 153.

16 GRISEBACH, *A.: Reise durch Rumelien und nach Brussa im Jahre 1839, II.* Gottingen, 1841, p. 332.

Africa.—Buxus sempervirens is, according to Engler,[17] native to Madeira Island, but not to the Canaries, and is also found in North Africa, especially in Algeria in the Province of Constantine on the Dschebel Azighza.

Asia Minor.—Box grows all along the coastal regions of the Black Sea and to a more limited extent on portions of the Mediterranean coast and on Cyprus. Cytorus, in old Paphlagonia, was famed for its box trees in the time of Virgil,[18] and the same region still supples boxwood for export, though only in small sizes and limited quantities. According to Consul General G. B. Ravndal, of Constantinople, the principal sources of supply are from the Black Sea provinces of Castamouni and Zoungouldak, particularly from the villages of Devrek, Bartin, Djide, Zafran, and Bolou. The area covered is about 25,000 acres. This wood, according to Mr. R. M. Gardner, is often known in the market as Anatolian boxwood. There are some stands of small trees, rarely as much as three inches in diameter, in northwestern Trebizond. There are occasional shipments of Bartin wood, but the sticks are rarely as large as four inches in diameter.

Georgia.—Box is at its best in the Black Sea region of the Caucasus. According to Gamrekel,[19] in the northern part of the latter region, where the range approaches the coast, the range of the species extends inland for about 20 miles, while farther south the distance is about 40 miles. In the midst of the inner mountainous region there is the Kutais circle, which is rich in box. The author differentiates the true coast region and the stream valleys, as well as the Bsyb Mountain range with the basin of the Bsyb and Bsytach rivers.

The stretch of land extending from the sea to an elevation of about 2000 feet is characterized by a growth of maritime pine, hornbeam, sumach, box, and other species. The box trees are common everywhere, the largest being in the valleys of the Jejerty, Chipsti, Showe, Gagrypsch, and Absty rivers. In portions of the basin of the Absty, the trees are frequently 10 inches or more in diameter. Toward the north, box is found only at the lower elevations, and its distribution is limited to the triangle formed by the Bsyb and Mtschysch rivers and the Black Sea. It is common near the Pigundi Monastery, owing to the old custom, still more or

[17] ENGLER, A.: *Die vegetation der erde, IX. Die pflanzenwelt Afrikas, III, 2.* Leipzig, 1921, p. 169.

[18] Et juvat undantem buxo spectare Cytorum. *Georg.* ii.

[19] GAMREKEL, A. S.: Der buchsbaum. *Forst Journal der k. Forst-Gesellschaft zu St. Petersburg, 2*: 1-32; 3: 33-36, 1891. (Abstract by V. Herder in *Beihefte zum Botanischen Centralblatt, III,* 1893, pp. 155-157.)

less observed, of planting box, or so-called Caucasian palm (Kavkazskaja palma), about monasteries, churches, shrines, and cemeteries.

On the Bsyb Mountains, at elevations between 2000 and 2500 feet above the coastal zone, the principal growth is oak with hornbeam and ash, and occasional box trees. 1'he basin of the Bsyb River is in part covered with fir and spruce and in part with beech and oak,box trees occurring in the undergrowth, particularly in·thebroadleaf forest. In the narrow valleys of the tributary streams on both sides of the Bsyb River,.there are many box trees from 8 to 10 inches in diameter.

Radde[20] speaks of *Buxus sempervirens* growing abundantly in the Kador Valley. In the Kolchiche region the species is generally distributed up to an elevation of 4000 feet above the sea. Trees 30 to 40 feet high, with diameters up to 12 inches, were noted in the stands of the coastal zone of Abchasia (Abassia) and northwest to SotschL The trees prefer decidedly calcareous soil, and grow either in clumps or scattered in the broadleaf forest.

Pesozky[21] states that boxwood (Hsamsheet") attains a maximum height of 50 feet and a diameter of 18 inches in the Caucasus, where it occurs scatteringly or occasionally in clumps. The age of a tree a foot in diameter is estimated to be between 200 and 300 years.

According to a writer in the *Lesnoj-Journal* (1900),[22] the stands of boxwood rernaining in the Caucasus are in remote, hardly accessible ravines, and their ownership is partly individual, partly communal, and partly governmental. Owing to the uncertainty of property·boundaries the purchasers of timber are likely to become involved in controversies over title: The cutting season is from September to February, and the worklnen live in tents or rude shelters in the forest. Trails are cut through the undergrowth of *Ilex, Laurocerasus, Rhododendron,* and *Smilax,* the trees are felled and cut into prescribed lengths (usually one meter), after which the logs are brushed free of moss and lichens, placed in piles and covered with turf to prevent checking. Later the wood is transferred to better shelters, which must be well ventilated so that the timber can season without staining. Sticks with cross grain, rotten places, and other defects, and the tops and branches too small to be utilized are left in the woods and comprise from 30 to 40 per cent of the whole. The commercial timber is di-

20 RADDE} GUSTAV: *Die vegetation der erde, III. Grundzüge der pflanzenverbreitung in den Kaukasusländern.* Leipzig, 1899, p. 145.

21 PESOZKY) N. : *Lesopilnoje diclo.* Petrograd, 1915, p. 32.

22 See GUSE: Der handel mit kaukasischenbuchsbaum. *Zeitschrift f. Forst- und Jagdwesen,* 34: 3 : 181-183, March, 1902.

vided into four grades on a basis of size, color, and defects. The most highly prized are the clear yellow sound pieces, 9 to 10 inches thick, for engravers' blocks. For cogwheels, wooden screws, rules, etc., sections one meter long and 6½ centimeters in diameter are taken. The logs are transported overland to the seaport during the month of February. Box\vood is used locally to a limited extent for shuttles for hand looms, and for spoons, scales, candlesticks, combs, joiners' tools, etc. In Russia, it is used for woodcuts in printing on cotton and for sundry small utensils. The shuttles used in the Russian cotton mills are manufactured abroad.

The following is from an article in the *Russian Information and Review:*[23] "Box *(Buxus sempervirens)* : At present this species occurs in considerable quantities chiefly in Abkasia. Thirty years ago boxwood areas covered no less than about 7,000 acres, but owing to the high value of the wood and the unrestricted exploitation, the area is now much reduced. Caucasian boxwood always commanded a ready market in European markets. During the half century before the war, one firm alone exported at least 5,000,000 poods, while only about 40,000 poods were sold to Russia for the domestic market."

The trade in Caucasian boxwood was interrupted by the World War and has only recently been resumed. The logs on the market in 1924 were mostly of poor quality, badly stained and otherwise defective.

Azerbaijan.-Buxus sempervirens is of limited. occurrence in Talish. Radde *(loc. cit.)*, referring to the care that both Mohammedan and Christian people give to the tree, especially in places where it is rare, says that in Talish there are little boxwood groves which remain inviolable and the trees are bedecked with all sorts of ribbons and bits of cloth. The people use the twigs occasionally in their religious ceremonies, but otherwise do not injure the living trees, any wood removed being from dead and down timber.

Persia.-Gamrekel (loc. cit.) mentions the occurrence of boxwood in Gilanin northeastern Persia, and according to Oberforstmeister Guse's[24] abstract of an article from the *Lesnoj-Journal* (1900, IV), there are commercial stands of the timber over large areas of the Provinces of Mazandaran and Gilan, though their wood is of poor quality. Another writer[25]

23 See: Caucasian timber resources. *Timber News}* London, Dec. 6, 1924, p. 13.

24 GUSE: Der handel mit kaukasischen buchsbaum. *Zeitschri/t für Forst- und Jagdwesen,* 34: 3 : 181, March, 1902.

25 See: Boxwood. *Journal of Forestry and Estates Management* (London), 1: 811-812, 1878.

stated in 1878 that boxwood was to be found in abundance in parts of Persia, particularly in the district of Tenekaboun, in the Province of Mazandaran, but that the timber had already become very scarce in Gilan. Persian boxwood is shipped by rail from Baku to Batum for export, and is used for the same purposes as the Caucasian, though considered somewhat inferior to it.

History.—Loudon[26] says: "The box tree appears to have been first mentioned by Theophrastus, who ranks the wood with that of ebony, on account of the closeness of its grain. Pliny described it as being as hard to burn as iron, as producing no flame, and as being totally unfit for charcoal. He distinguishes three kinds, which he calls the larger, the smaller, and the Italian box; and speaks of the use of the tree for topiary work, and of the wood for musical instruments. Vitruvius also recommends the box for topiary work; and it appears to have been much employed in verdant sculpture, and close-clipped hedges, in the gardens of Roman villas in the Augustan age. Pliny describes his Tusculan villa as having a lawn adorned with figures of animals cut out in box trees, answering alternately to one another. This lawn was again surrounded by a walk enclosed with evergreen shrubs, sheared into a variety of forms. Beyond this was a place of exercise, of a circular form, ornamented in the middle with box trees, sheared, as before, into numerous different figures; and the whole fenced in by a sloping bank, covered with box rising in steps to the top. In another part of the grounds of the same villa, the box is mentioned as being cut into a variety of shapes and letters; some expressing the name of the master, and others that of the artificer, &c. (*Plin. Epist.*, book v, letter vi.) The same practice is followed in several Roman gardens at the present day; and, in that of the Vatican, the name of the pope, the date of his election, &c., may be read from the windows of the palace in letters of box. Virgil calls it

> 'Smooth-grain'd, and proper for the turner's trade,
> Which curious hands may carve, and steel with ease invade.'
>
> DRYDEN'S *Virgil.*

Both Virgil and Ovid allude to the use of this wood for musical instruments, and employ the word box as if synonymous with that of flute. In more modern times, in Britain, it is mentioned by Turner, Gerard, Parkinson, and other writers on gardening and rural affairs; and, previously to

[26] LOUDON, J. C.: *Aboretum et fruticetum Britannicum, III.* 2d ed., London, 1844, pp. 1334-1335.

the eighteenth century, was in great repute for gardens in the geometric style, from the facility with which it could be made to assume whatever form the gardener wished; it was also highly valuable when there were but few evergreens grown in England, from its hardy habit, and the liveliness of its hue. The wood of the tree has been in use for turnery from the earliest ages, and for wood engraving since the fifteenth century."

Uses of the wood.—As shown elsewhere, boxwood has long been highly prized, particularly for carving and turning. Cabinetmakers have used it for inlaying and ornamentation, such as fillets and borders, and for dentals; on cornices of Sheraton furniture in combination with mahogany or rosewood; in the Jacobean period, for the cnlde geometrical designs with Indian and Persian motives; for box-lines in combination with ebony for marquetry during the Queen Anne and William and Mary periods; for the fanlous seaweed marquetry design, and the fish-scale pattern, in which the boxwood was shaded by scorching the separate units in hot sand. Boxwood does not lend itself to dyeing in different colors as does the wood of the holly.

Various substitutes, particularly the West Indian boxwood, or "zapatero," have been found which are more or less completely meeting the requirements of true, or so-called Turkish boxwood, in cabinetwork, marquetry and inlay, carving, mathematical instruments, shuttles, flax bosses, small utensils, etc., but it still holds undisputed possession of the field of wood-engraving, or xylography.[27]

"An important extension of wood-engraving was due to the invention of compound blocks by Charles\\Tells about the year 1860. Formerly a woodcut was limited to the dimensions of a block of box,voodcut across the grain, except in the primitive condition of the art, when COlumoner woods \vere used in the direction of the grain; but by this invention many small blocks were fitted together so as to form a single large one, sometimes of great size. They could be separated or joined together again at will, and it was this facility \vhich rendered possible the rapid production

[27] For information regarding experiments with various substitutes for boxwood in wood-engraving, see the following:

HUNTER, ALEXANDER: On the Indian woods that have been tried for engraving. *Trans. Bot. Soc.* (Edinburgh), 6: 3: 358-361, 1860.

Boxwood substitutes. *Report on the progress and condition of the Royal Gardens at Kew during the year* 1882. London, 1884, pp. 35-36.

JACKSON, JOHN R.: Boxwood and its substitutes. *Journ. Soc. Arts* (London), 33: 1690: 566-569, Apr. 10, 1885; 33: 1691 : 600-602, Apr. 17. 1885.

of large cuts for the newspapers, many cutters on the same subject at once, each taking his own *section."-Encyclopcedia Britannica.*

The process of manufacture of box\vood blocks for woodcuts is as follows: The best Abassian logs are preferred, straight-grained, free of knots and other defects, and of a bright yellow color. These are sawn into discs, 1 1/8 inches thick in direction of the grain, and the ends smoothed to show the quality of the wood. The discs are then marked off into squares and rectangles, sawn accordingly, the different pieces graded for quality and placed on racks in a room for thorough seasoning. When thoroughly air-dry, the blocks are trued up and glued together edgewise into strips and squares. Formerly splines were used to reinforce the joints, but they are no longer considered necessary. Small defects are bored out and the holes plugged tightly \vith boxwood pegs. (See Plate III.) During the war, when box\vood was very scarce, the experiment \vas tried of gluing an end-grain veneer of choice wood to a backing of maple or low grade boxwood, and it proved so successful that the practice continues. These veneers are cut to a thickness of about 3/16 inch, but there is a loss of about 1/16 inch in polishing. The best veneered blocks have built-up end-grain boxwood backing, and are less likely to \varp than if t\VO kinds of wood are used which respond differently to atmospheric changes. There are five grades of blocks manufactured, the prices (1924) ranging from 4 to 16 cents per square inch; before the \var the prices were from 2 to 6 cents for blocks of same grade, but of solid wood.

The demand for woodcuts is on the decrease. They are still used in printing mail-order catalogues, since they give good impressions on cheap paper" but this field is becoming more and more restricted. The center for wood-engravers is Chicago, but there are less than 100 there now and nearly all of them are over 45 years of age. Unless some unexpected stimulus serves to recruit the thinning ranks, this interesting trade seems destined to lose all its forluer importance in America with the passing of the present generation of engravers.

COMMON NAMES

Box, boxwood, Turkish boxwood (General); Abassian, Anatolian, Circassian, Corsican, English, French, Parthenian, Persian, and Turkish boxwood (Trade); buis, buis commun, buis béni, buis toujours vert (French); buchs, buchsbaum; echte, gemeine, kaukasische, levantinische, and orientalische buchsbaum; buchsholz, buchsbaumholz (German); nordische or abendHindischeebenholz (Ancient German); bus, busboom, boksboom,

boksboomhout (Dutch); buhs, buhsboum (O.H.G., M.A.G.); bux, buxbom, boksboom, buksboom (Danish); bux, buxbom, buxbomsträ (Swedish); buxo, madeira do buxo (Portuguese); boj, madera de boj, buje (Spanish); bosso, bosso comun, bosso verde, bossolo, bossolo di Constantinopoli, busso (Italian); bus (Illyrian); boschtom (Calmuk); bsa (Georgian); Kavkazskaja palma (Caucasian palm), samsheet (Russian); buxus (Latin); puxos, puxari (Greek); teasshur (Hebrew); box (M.E.); box, bux (Anglo-Saxon).

Description of the Wood

Macroscopic Features

General properties.—Wood hard, heavy, and very compact; sp. gr. (air-dry) 0.85 to 1.13; weight 53 to 72 lbs. per cu. ft.; free of grit, very easily turned and carved, but difficult to split. Load required to imbed a 0.444-inch ball to one-half its diameter in end surface, 3900 to 4350 lbs. Grain nearly straight to very irregular; wood often knotty; texture extremely fine and uniform.

Color light yellow; little difference between sapwood and heart. Some specimens show prominent areas of "rotholz" or compression wood, known in the trade as red boxwood; it is very brittle and unsuited for fine engravings.

Odor not distinct; taste slightly bitter. Aqueous solution practically colorless.

Growth rings.—Fairly distinct to unaided eye; closely spaced; mostly regular; due mainly to narrow, denser zones which are deficient in pores and darker than rest of wood; terminated by thin layer of flattened fibers, which frequently appears under the lens, especially on moist sections, as an indistinct line of parenchyma.

Parenchyma.—Present, but not visible without compound microscope.

Pores.—Just visible with lens, the smaller ones often appearing as light dots; minute; numerous; well distributed, except in narrow zones which terminate growth rings; mostly solitary; rounded; open.

Vessel lines.—Barely discernible with lens; extremely fine.

Rays.—Very numerous; uniform; narrow; visible without lens, but usually not very distinct on cross section; invisible on tangential surface; low and of about same color as background on radial surface, but readily visible.

Minute Anatomy

(See Plate V, No. I.)

Vessels.-Diameter of pores 0.016 to 0.049 mm. (av. 0.032 mm.) tangentially by 0.017 to 0.057 mm. (av. 0.035 mm.) radially. Thickness of walls, 0.002 to 0.006 Ulm. Length of vessel segments, 0.329 to 0.814 mm. (av. 0.587 mill.), including overlapping tips, which usually are less than 0.120 mm. (max. 0.277 mm.). Perforations decidedly oblique, exclusively scalariform, \vith 5 to 15 (mostly. IO to 12) bars which are more than half as wide as the intervening spaces. (Fig. I, NO.2.) Intervascular pits are minute (about 0.003mm.) and not commonly met with because the vessels are so rarely in contact \vith one another; the borders are circular and not very distinct; the apertures are narrow-lenticular or slit-like. Vessel-ray pits are similar in size and appearance (radial section) to the others.

Wood fibers.-The ground mass of the wood is composed of fiber-tracheids, usually arranged in fairly definite radial rows and distinctly flattened at periphery of growth rings. The walls are thick (0.004 to b.OIO mm.), some with an indistinct gelatinous layer, and the cavities are very narrow. Length of fibers, 0.537 to 1.160mm. (av. 0.817 mm.); diameter of median portion, 0.014 to 0.026 mm. (av. 0.020 mm.). The fiber tips are often sharply bent, at times scalloped or even bifurcated. The irregularity of the fibers is particularly noticeable on radial section where the tips appear interwoven and at times bent practically at right angles along the margins of the rays. (Fig. 2, No.8.) The pits, which are well distributed in both radial and tangential walls, are minute (0.003 mm.), with indistinct circular borders and narrow-lenticular or slit-like apertures. (Fig. I, No. Sa; Fig. 2, Nos. 3, 4.)

Wood parenchyma.-In short, irregular, mostly uniseriate, tangential lines, also sparingly diffuse and paratracheal. The cells are very thin-walled and are of about the same size as the wood fibers. The strands vary in length from 0.312 to 0.745 mm. (av. 0.581 film.) and are composed of 2 to 8 (mostly 4) cells which are conjugate when in contact with other parenchYlna cells or with ray cells. The spaces between the tubular processes of these conjugate cells are filled with middle lamella, giving the appearance of thickened \valls in unstained sections. There are usually several small pits in the ends of the processes and on radial sections these appear clustered, often in a ring, in light-colored spots. Sections across the

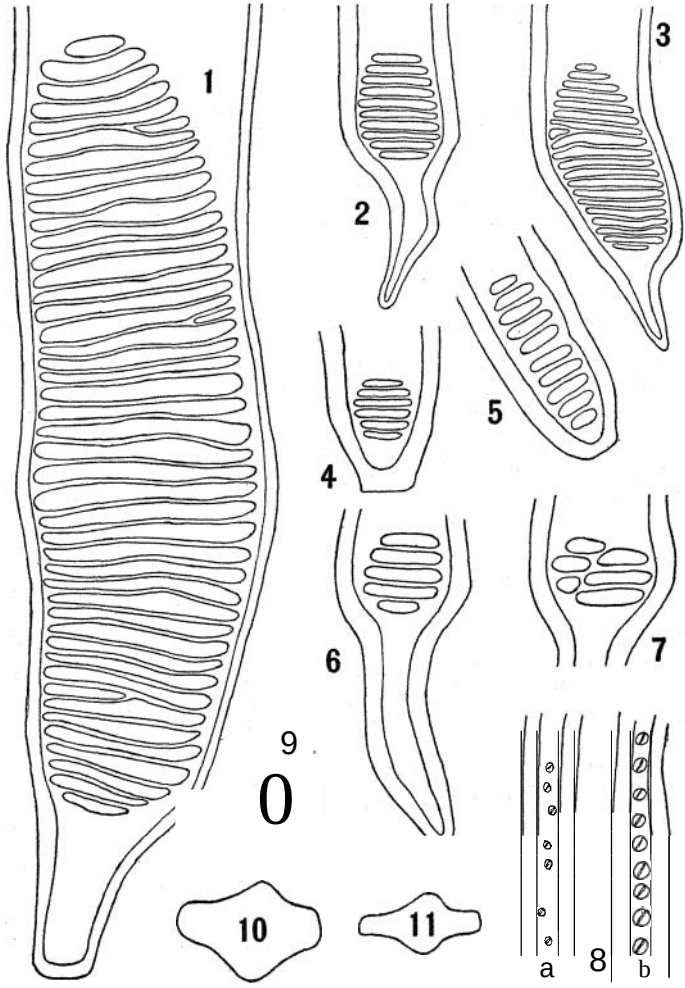

Fig. 1. Vessel perforations and other structural details of the woods of *Cornus*, *Buxus*, and *Buxella*.

FIG. I. EXPLANATION OF DRAWINGS

No. I.-End of vessel segment of dog\vood (*Cornus floridaL.),* showing scalariform perforation with 42 bars, three of which are branched. X 400.

No. 2.-End of vessel segment of rrurkish boxwood *(Buxus sempervirens* L.), showing pointed tip and scalariform perforation with 9 narrow bars. X 400.

No. 3.-End of vessel segment of East Indian boxwood (*Buxus vVallichiana* Baill.), showing scalariform perforation with 18 narrow bars. X 400.

No. 4.-End of vessel segment of Turkish boxwood (*Buxus sempervirens* L.), with blunt tip and with only 5 narrow bars in the perforation. X 400.

No. 5.-Endof vessel segment of Cape boxwood *(Buxella Mac-Owanii* Van Tiegh.), with rounded tip and with 9 coarse and widely spaced bars in the perforation. X 400.

No. 6.-End of vessel segment of Cape boxwood *(Buxella Mac-Owanii* Van Tiegh.), with long pointed tip and with 4 narrow, but widely spaced, bars in the perforation. X 400.

No. 7.-Malformed scalariform perforation in vessel segment of Cape boxwood *(Bttxella Mac-Owanii* Van Tiegh.). X 400.

No. 8.-a. Portion of wood fiber (fiber-tracheid) of Turkish boxwood (*Buxus sempervirens* L.), showing the very small bordered pits characteristic of the true boxwoods. X 400.

b. Portion of \vood fiber (fiber-tracheid) of Cape boxwood *(Buxella Mac..Owanii* Van Tiegh.), showing much larger and more conspicuous pits characteristic of the species. X 400.

No. 9.-0utline of the pith of Cape box\vood (*Buxella Mac-Owanii* Van Tiegh.). X 12½.

No. Io.-Outline of the pith of the Balearic boxwood (*Buxus balearica* Lam.). X 12½.

No. I I.-Outline of the pith of Turkish boxwood *(Buxus sempervirens* L.). X 12½.

processes show a vertical series of small rounded cells within a rather indistinct border corresponding to the normal portion of the cell from which they extend, a "cells-within-a-cell" appearance, illustrated in *Gardenia*. (Fig. 3, Nos. 2, 3, 4, 6.)

Rays.—The rays are heterogeneous; uniseriate or more often biseriate, at least in the median portion; occasionally there are portions 3 cells wide. The uniseriate are 1 to 8 cells high, measuring 0.017 to 0.195 mm. (av. 0.079 mm.), and 0.009 to 0.019 mm. (av. 0.014 mm.) wide. The others are 4 to 36 cells high, measuring 0.052 to 0.588 mm. (av. 0.268 mm.), and 0.013 to 0.034 mm. (av. 0.021 mm.) wide. As seen on radial sections, the cells in the wider portions are distinctly procumbent, varying in length from 0.034 to 0.129 mm. (av. 0.086 mm.), and in height from 0.009 to 0.020 mm. (av. 0.013 mm.). The cells of the uniseriate rays and unseriate portions of the others are frequently very irregular in shape and usually distinctly upright, at least in the marginal rows. They vary in width from 0.020 to 0.063 mm. (av. 0.037 mm.) and in height from 0.017 to 0.086 mm. (av. 0.036 mm.). The upright rights are conjugate and the processes, which are confined to the vertical or end walls, are much longer than those of the conjugate wood parenchyma cells, being up to 0.023 mm. in length. This conjugate condition may give the rays the appearance (on cross section) of being composed of unconnected cells, but if the sections are not too thin the connecting processes can be brought into view by changing the depth of focus of the microscope. (Fig. 1, No. 5.) The ray-fiber pits are indistinctly half-bordered and of about the same size as the inter-fiber pits. Between adjacent ray cells the pits are minute, fairly numerous, and irregularly disposed, while between ray cells and wood parenchyma the group pitting peculiar to conjugate cells is usually present.

Material.—Yale Nos. 4480 (engraver's block); 4481 (grown in Royal Botanic Gardens, Kew); 5937 (Caucasus); miscellaneous trade samples from C. H. Pearson & Son Hardwood Co., New York, Sandberg Manufacturing Company, Chicago, and Hadji Zadé Messoud Fils, Constantinople.

b. *Buxus balearica* Lamarck

Buxus balearica Lamarck,[28] the Balearic box, is apparently limited in its distribution to the Balearic Islands, Spain, and Sardinia, although some

[28] *B. sempervirens*, var. *gigantea* N. Duhamel.

writers[29] extend the range into Turkey, and credit the species with supplying large quantities of boxwood of commerce. It is closely related to the Palestine box.[30] Its occurrence in Spain is not extensive, being principally between Nerja and Salobrena. The tree was introduced into France, at Trianon, by Antonie Richard about 1730, but is unable to endure the winter climate of Paris.[31] It was first grown in England about 50 years later and reaches a height there of 15 to 20 feet, with a straight trunk, and leaves three times the size of those of *B. sempervirens,* according to Loudon (*loc. cit.*). In its native habitat it is said by the same author to reach a height of 80 feet and to yield a wood of brighter yellow and coarser texture than the common box.

Common Names

Balearic box, Minorca box (English); buis des Baléares, buis de Mahon, buis de Minorque (French); balearische buchsbaum (German); bossolo gentile (Italian).

Description of the Wood

Macroscopic Features

The wood is practically identical with that of *B. sempervirens*. The only available specimen is, however, of a rather distinct greenish-yellow color, especially in the sapwood.

Minute Anatomy

Vessels.—Diameter, 0.020 to 0.048 mm. (av. 0.031 mm.) tangentially by 0.020 to 0.054 mm. (av. 0.035 mm.) radially. Length of segments, 0.272 to 0.782 mm. (av. 0.493 mm.). Perforations exclusively scalariform, with 6 to 13 (mostly 8 to 11) bars.

Rays.—Uniseriate rays 1 to 5 cells high, measuring 0.020 to 0.113 mm. (av. 0.067 mm.); biseriate, or occasionally triseriate, 3 to 22 cells high, 0.054 to 0.375 mm. (av. 0.183 mm.), including the uniseriate margins which are usually present.

[29] Loudon, J. C.: *An encyclopædia of trees and shrubs*. London, 1842, pp. 704-705.

Encyclopædia Britannica, 11th ed., p. 352.

[30] *Buxus longifolia* Boissier. This species seems to occur only in a restricted region in Syria, in the mountains south of Antioch, and is so rare that its wood is probably never exported.

[31] Mouillefert, P.: *Traité des arbres et arbrisseaux, II*. Paris, 1892-1898, p. 811.

Remarks.-The minute anatomy is essentially the same in other respects as that of *B. sempervirens*.

Material.-Yale No. 7446, from tree grown in Royal Botanic Gardens, Kew, England.

c. *Indian Species of Buxus*

In the Himalayan region of India there are two species of *Buxus*, namely, *B. papillosa* Schneider and *B. Wallichiana* Baillon, though they are both often referred to as *B. sempervirens* L. The timber has only local importance, as the stands are too limited and inaccessible to supply material for export. Knowledge of the species in India is largely due to the detailed reports which were made by Hearle,[32] Ribbentrop;[33] and Bryant;[34] and published in the *Indian Forester* some 40 years ago.

Buxus papillosa is, according to Troup,[35] a large evergreen shrub or small tree with a crooked stem, supplying wood for fuel only. The leaves are from 1½ to 3 inches long, dull green above, \vhitish papillose beneath. "The species grows on dry and arid slopes of the outer Himalaya from the Jhelum westwards at 2000 to 4000 feet, the Salt Range, trans-Indus, the Kalachitta and Margalla forests of the Ralwalpindi district, and the Garamthun reserve in Hazara. It is found usually on dry limestone hills; in the Shahpur Salt Range it occurs on sandstone. It is cultivated at Lahore."

Buxus Wallichiana Baillon, according to Troup *(loc. cit.)* pp. 834-836), has leaves which are shiny above and pale green beneath, and are from 1 to 2, occasionally 3, inches long. The bark is yellowish-gray, corky, soft, and cut into numerous small rectangular plates on old stems. The range extends from Western Himalaya eastward to Nepal, at elevations of 4000 to 9000 feet; the species also occurs in Bhutan. It gro\vs gregariously or in mixed stands and is found in Bashahr on shale and gneiss, in Chamba on mica schist, and in the Jumna Valley on gneiss and mica schist. The essential

[32] HEARLE, N. : Notes on box, alpine birch, and *Quercus semecarpifolia* forests of the western Himalayas. *Indian Forester,* 9: 4: 196-198, April, 1883.

[33] RIBBENTROP, BERTH. : Report on the boxwood supply of the Punjab. *Idem,* 11 : 1 : 25-28, Jan., 1885.

[34] BRYANT) F. B.: The boxwood forests of Kumaun and British GarhawL *Idem,* 11 : 6 : 283-285, June, 1885.

[35] TROUP"R. S.: *The silviculture o/Indian trees, Ill.* Oxford, 1921, p. 836.

conditions are moisture and shelter, the tree being at its best in moist, sheltered ravines, along banks of streams, or on northerly and northwesterly slopes, avoiding hot aspects.

The trees sometimes attain large diameters, though they are never very tall. Hearle *(loc. cit.)* p. 197) found one tree in the Western Himalayas that was 21 inches in diameter, though the trunk was very knotty, and counted over 4,000 stems that were six inches and more in thickness. Regarding the size attained in the forests of Jumaun and British Garhwal, Bryant *(loc. cit.)* p. 284) says: "The size to which the box will grow under favorable conditions has been generally understated. Mr. Brandis gives '15 to 16 feet in height \vith a girth of 20 to 30 inches.' I measured one tree with a girth of 86 inches at 5 feet from the ground, and trees of 5 feet in girth,\vith a trunk 25 feet to the first branch and a total height of 40 to 50 feet are often to be found. Unfortunately, however, many of the bigger trees are unsound, and the best size to cut will probably be found to be from 2 to 4 feet in girth." In Bashahr, especially on the Neogli River, the trees are said by Ribbentrop *(Zoe. cit.)* p. 30) to attain a girth of 4 feet and a height of 30 feet, with clear lengths of 10 to IS feet. Countings of the annual rings of a number of box trees growing in various locations in the Punjab Province gave the following results: "An average of 18 rings per inch radius in Bashahr, against 28 rings in Chamba, 30 in KuIu, and from 30 to 40 in Rawalpindi. According to these figures, it would take 72 years in Bashahr, 112 in Chamba, 120 in Kulu, and 120 to 140 years in Rawalpindi, to grow a first class workable tree of 24 inches girth."

Common Names

Box, boxwood (English); buis de Wallich (French); papri, papar, paprang, shamshad, sansád, shumaj (Punjab); chikri (Kashmir); shanda laghune (Afghanistan).

DESCRIPTION OF THE WOOD

Macroscopic Features

The wood of *Buxus Wallichiana* Baillon is very similar to that *ofB. sempervirens* L., though in the only available specimen the color is somewhat deeper, being rather distinctly bro\vnish-yellow, and the grain is decidedly straight. Sp. gr. 0.82 ; weight about 51 lbs. per cu. £t.

Minute Anatomy

Vessels.—The pores are apparently more numerous, thinner-walled (0.003 to 0.004 mm.), and somewhat more irregular in outline than those of *B. sempervirens* L. Diameter, 0.017 to 0.045 mm. (av. 0.035 mm.) tangentially by 0.017 to 0.051 mm. (av. 0.040 mm.) radially. Length of vessel segments, 0.374 to 0.748 mm. (av. 0.583 mm.), including the overlapping tips, which may be up to 0.323 mm. in length, but are usually much shorter. The scalariform perforations have 12 to 20, mostly 15 or more, closely and uniformly spaced bars. The intervascular and vessel-ray pits are about 0.003 mm. in horizontal diameter.

Wood fibers.—The fibers appear to be somewhat more irregular in section than those of *B. sempervirens* L. No mucilaginous thickenings were observed. Length 0.595 to 1.173 mm. (av. 0.875 mm.); diameter 0.017 to 0.028 mm. (av. 0.023 mm.); thickness of walls 0.006 to 0.010 mm. (av. 0.008 mm.). The indistinctly bordered pits are about 0.003 mm. in diameter.

Wood parenchyma.—Seems to be somewhat more abundant than in *B. sempervirens,* especially in contact with the pores. The longitudinal strands are composed mostly of 4 cells, and are 0.272 to 0.714 mm. (av. 0.548 mm.) long, and 0.011 to 0.025 mm. (av. 0.018 mm.) wide.

Rays.—In tangential view the rays, especially the wider ones, appear to be somewhat lower than those in *B. sempervirens* L. The uniseriate are 1 to 7 cells high, 0.023 to 0.141 mm. (av. 0.077 mm.), and 0.008 to 0.017 mm. (av. 0.012 mm.) wide, while the biseriate, or occasionally partly triseriate, are 5 to 27 cells high, 0.085 to 0.386 mm. (av. 0.116 mm.), and 0.014 to 0.031 mm. (av. 0.021 mm.) wide. Heights given for the wider rays include uniseriate portions which are frequently present and which may be up to 7 cells (0.133 mm.) high. On radial section the distinctly procumbent cells are 0.039 to 0.141 mm. (av. 0.081 mm.) long, and 0.011 to 0.021 mm. (av. 0.016 mm.) high, while the cells in the uniseriate rays and on the margins of the wider rays are 0.023 to 0.068 mm. (av. 0.043 mm.) long, and 0.023 to 0.065 mm. (av. 0.039 mm.) high. The processes of the conjugate cells are up to 0.020 mm. in length.

Material.—Yale No. 7447; Indian Forest Service No. 617.

d. *Chinese and Japanese Species of Buxus*

In China, according to Rehder and Wilson (*Plantae Wilsonianae, II,* 165-169), there are five native species and varieties of *Buxus,* namely,

B. microphylla S. & Z., var. *sinica* R. & W.; *B. microphylla,* var. *aemulans* R. & W.; *B. Henryi* Mayr; *B. stenophylla* Hance; and *B. Harlandii* Hance.

The first of these is a shrub, 3 to 10 feet high, reported from western Hupeh, Yunnan, Shensi, Kiangsi, Shantung, and Hongkong, and also from Takow, Formosa, and cultivated in Seoul, Korea. The authors say *(loc. cit.)* : "This box is found in many parts of China and is common in rocky places in the woods and thickets of western Hupeh and in Szech'uan. It is also a favorite garden shrub with the Chinese. This variety is really the typical *Buxus* of eastern continental Asia and the variation in foliage, habit, etc., is similar to what occurs in the European *B. sempervirens* Linnaeus, which is distinguished by the minute gynophore to the rudimentary ovary in the male flower. From *B. microphylla* Siebold & Zuccarini, which under the rules of priority must be kept as the type of the species, this Chinese variety is well distinguished by the pubescent branches and larger leaves. It is nearest to *B. microphylla,* var. *japonica* Rehder & Wilson, which is easily recognized by its glabrous shoots. In western Hupeh this plant is colloquially known as 'Huang-yang.' "

B. microphylla, var. *aemulans* Rehder & Wilson is a shrub 3 to 6 feet high in ,vestem Hupeh. In foliage and general appearance it is said to strongly resemble *B. Wallichiana* Bailloo. *B. Henryi* Mayr is reported only from Ichang and immediate neighborhood, in western Hupeh. *B. stenophylla* Hance occurs in Fokien where it is known as "an-koe." "Probably not specifically distinct from *B. microphylla* Siebold & Zuccarini." *B. Harlandii* Hance is a fluviatile shrub in western Hupeh, Fokien, and Hongkong. Rehder and Wilson *(Zoe. cit.)* p. 166) say of it: "This curious species is abundant in the gorges and ravines near Ichang growing in rock-crevices and among stones in the bed and banks of streams where during summer floods it is submerged. It is found only at low altitudes ,vhere the winters are very mild and would not be hardy in northern temperate regions."

Shaw[36] refers to the Chinese box as *B. sempervirens* L., and gives the vernacular name of "huang yang" (yellow poplar). "Unknown in N. China (David), box grows in Fukien, Chekiang, Kweichow, and in Szechwan, where two varieties are found. It is grown as an ornamental shrub throughout Szechwan, but exists as a timber-tree on the upper waters of the Ya, where it is specially cultivated for its wood, which is the source of all the combs made in the province. It is valued at TI.04 per catty. In Fukien combs, seals, and printing blocks are made of it, and for the last purpose

36 SHAW, NORMAN: *Chinese forest trees and timber supply.* London, 1914, p. 212.

it is very highly valued. The average diameter of the trees obtainable is only 4 inches."

The principal species of *Buxus* in Japan are *B. microphylla* Siebold & Zuccarini and *B. microphylla,* var. *japonica* Rehder & Wilson (=*B. japonica* Muell.-Arg. =*B. sempervirens,* var. *japonica* Makino). The latter is said to be a very hardy variety of box, and its yellowish-green leaves are larger and broader than those of the type. It occurs in the warmer portions of Japan, notably Shikoku, Kiushu, and southern islands, is partial to limestone soils, and attains a maximum height of 30 feet and a diameter of 12 inches. The species found in the Liukiu Islands is *B. liukiuensis* Makino, a small tree called "okinawa-tsuge";[37] that of northern Formosa is *B. microphylla,* var. *sinica* Rehder & Wilson, according to Kanehira,[38] who says that it is a small tree upwards of one foot in diameter, and that it is becoming rare.

Boxwood is used in Japan for engravings, combs, abacus beads, handles of small tools, and for small articles of turnery. The wooden combs are of many different sizes and patterns, some of them with long handles and in fancy shapes for ornamental effect. The teeth are cut parallel to the grain of the wood.[39] Much of the boxwood consumed in Japan is imported.

Common Names

Huang-yang, huang-young-mu, an-koe (China); tsuge, asamatsuge, benten-tsuge, hon-tsuge, kara-tsuge, ko-tsuge, okinawa-tsuge, detchiki, ojo (Japan). In Chosen (Korea), where box occurs apparently only in cultivation, the name is "fang-guyan-gmok."

Description of the Woods

Macroscopic Features

The woods of (1) *Buxus microphylla,* var. *japonica* and (2) var. *sinica* are very similar to that of *B. sempervirens.* In (1) the wood parenchyma is somewhat more distinct, appearing under the lens on cross section as numerous, exceedingly fine, and irregularly tangential lines.

[37] Makino, T.: Mr. H. Kuroiwa's collections of Liukiu plants. *Tokyo Botanical Magazine,* 9:102:229, Aug. 20, 1895.

[38] Kanehira, Ryoso: *Anatomical characters and identifications of Formosan woods.* Taihoku, 1921, pp. 192-193.

[39] For information as to method of manufacture see Mochizuki, H.: *Technical utilization of Japanese woods,* pp. 847-848. (In Japanese.)

Minute Anatomy

Vessels.—(1) Tangential diameter of pores 0.024 to 0.052 mm. (av. 0.036 mm.); radial, 0.024 to 0.052 mm. (av. 0.037 mm.). Vessel perforations with 9 to 24, mostly 14 to 21, bars. The vessel-ray pits in the upright ray cells are sometimes slightly elongated horizontally, rarely tending to scalariform.

(2) Tangential diameter of pores 0.18 to 0.40 mm. (av. 0.031 mm.); radial, 0.022 to 0.055 mm. (av. 0.038 mm.). Vessel perforation with 8 to 20, mostly 14 to 19, bars.

Wood parenchyma.—(1) On cross section the tangential lines appear somewhat longer than in *B. sempervirens,* especially in the poreless zone terminating the growth ring; very little paratracheal parenchyma. The strands (longitudinal sections) are composed of 2 to 6, mostly 4, cells.

(2) Same as preceding on cross section. The strands are composed of 2 to 4, mostly 4, cells; yellowish-brown deposits common.

Rays.—(1) Rays uniseriate or more commonly biseriate, wholly or in part. The latter are noticeably lower than in *B. sempervirens,* being 5 to 15 cells high, 0.105 to 0.385 mm. (av. 0.219 mm.), including the uniseriate margins which may be up to 5 cells high (0.210 mm.). The uniseriate rays are 1 to 8 cells high, 0.031 to 0.220 mm. (av. 0.117 mm.).

(2) Rays mostly between 1 and 3 cells wide, occasionally wider; maximum, 7 cells in median portion. The larger rays are 4 to 31 cells high, 0.142 to 0.692 mm. (av. 0.306 mm.), including the uniseriate margins, which are rarely over 2 cells high, though in one instance a maximum height of 6 cells (0.109 mm.) was noted. The uniseriate rays are mostly lower than in *B. sempervirens,* being 1 to 5 cells high, 0.025 to 0.193 mm. (av. 0.306 mm.).

Material.—(1) Yale No. 7473; (2) Yale No. 7474; both supplied by Mr. Ryozo Kanehira, Director of Forest Experiment Station, Taihoku, Formosa, Japan.

2. Other Members of the Buxaceae

a. *Buxella Mac-Owanii* (Oliver) Van Tieghem

The genus *Buxella* (see page 12) is comprised of two known species, namely *Buxella Mac-Owanii* Van Tieghem (=*Buxus Mac-Owanii* Oliver) and *Buxella madagascarica* Van Tieghem (=*Buxus madagascarica* Dup.-

Th.). The latter is a sn1all tree, of no commercial importance, only known to occur in Madagascar.

This species supplies the wood commonly known on European and American markets as Cape boxwood or East London boxwood. According to Sim,[40] it is a small tree with a clean stem and bushy crown, often growing in pure dense stands. The leaves are leathery, deep green, glabrous, ovate or ovate-oblong, entire, and almost sessile. They are of much the same size on a single tree, but vary on different specimens from 0.75 to 1.25 inches long and 0.33 to 0.75 inch wide at the middle, tapering at both ends. The male flowers are axillary, sessile, clustered, or on undeveloped spikes; the female flowers are usually single, or central between two male flowers, and either sessile or on bracted peduncles. The capsule is globular, about 0.33 inch in diameter. The seeds, which are black and lustrous, ripen sometime between February and June.

The tree inhabits the forests within 20 miles of the sea from Alexandria to West Pondoland. It is scarce or absent east of Port St. Johns, where the shale recedes from the coast and is replaced by carboniferous sandstone; also scarce or absent west of Port Elizabeth. It is gregarious, often forming forests in some places, as at East London; it is not common on sand dunes, but is abundant in the warm dry valleys a few miles inland, growing alike over the ridges and bottoms and on the slopes of all aspects. Its distribution is local, as it is partial to the shale, slate, and limestone formations; it frequently grows where there is but little soil. It does not coppice, but reproduces well from seed. Seedlings two or three years old are easily transplanted, even from the forest.

The diameter of the stem is usually between 6 and 9 inches (occasionally, in Alexandria forests, 12 inches), the length from Iota 20 feet. In the Grey Forest, with an area of 1100 acres, a survey made in 1888 showed a stand of 15,950 trees not less than 6 inches in diameter, an average of 14·5 mature trees, containing 55 cubic feet, per acre. East London specimens examined have about 25 rings per inch, requiring a rotation of about 40 years with a minimum felling diameter of 6 inches. The bark of the stem is of two layers, the outer about one-fourth inch thick, light gray on the surface, irregularly fissured; the inner layer darker and firmer.

Cape box escaped attention of foresters until about 1883, when it was placed on the Reserved List and its commercial value ascertained. The wood was first exported in 1886. According to Sim *(loc. cit.)* p. 323), the

[40] SIM, THOMAS R. : *The forests and forest flora of the Colony of the Cape of Good Hope*. Aberdeen, Scotland, 1907, pp. 321-324.

total export of true Cape boxwood from Alexandria and East London up to the end of 1899 was 135,260 cubic feet, of the declared value of about £9135. During the first 11 months of the year 1923, according to the commerce reports, the total shipments of this wood from the Union of South Africa (Port Elizabeth and East London) were 1,349,363 lbs., valued at £3472. The destinations of those shipments were as follows: United Kingdom, 1,219,245 lbs., Japan 56,468 Ibs., Italy 33,600 lbs., Germany 20,025 lbs., Holland 20,0251bs.

COMMON NAMES

Cape, East London, African, East African, South African, or Colonial boxwood (Trade) ; gala-gala[41] (Kafir) ; buig-mij-niet, buig-my-nie (Dutch, in Alexandria) ; buis du Cap (French).

DESCRIPTION OF THE WOOD

Macroscopic Features

General properties..-Wood hard and heavy; Spa gr. (air-dry) 1.18; weight 74 lbs. per cu. ft.; easily turned and carved. Grain fairly straight to rather irregular; texture very fine and uniform.

Color light yellow; dark-bro\vn, oily, vertical streaks suggesting pith flecks common in some of the specimens; little or no difference between heartwood and sapwood. In one specimen (Yale No. 4504A) the surface of the wood next the bark is marked with narro\v grooves, which in some places are deep and include the bark.

Odor and taste not distinctive. Aqueous solution practically colorless.

Growth rings.-F'airly distinct to unaided eye; very closely and uniformly spaced; due mostly to slightly darker lines ,vhich, under lens, are found to be narrow zones with fewer and smaller pores.

Parenchyma.-Invisible without compound microscope.

Pores.-Barely discernible\vith lens; nlinute ; numerous; well distributed, except for narrow zones at termination of late wood; mostly single., rarely in groups of 2 or 3 ; open.

41 SIM *(loc. cit.,* p. 324) says that in East Pondoland, where the Cape box does not grow, the name "gala-gala" is applied to *Notobuxus,* and that a shrub, *Diplospora* (Rubiaceae), with *Buxus*-like foliage, is also known as Cape box there. See, also, MILLER, O. B. : *A list 0/ some native names of trees, shrubs, etc., in use in the Transkeian TerTitories.* Bul. No.8, Forest Dept., Union of South Africa, Pretoria, 1923.

Vessel lines.—Visible with lens, but not distinct.

Rays.—Very numerous; narrow; visible in part with unaided eye on cross section; invisible on tangential; on radial surface same color as background and low, but visible without lens.

Minute Anatomy

(See Plate V, No. 2.)

Vessels.—Size of pores, 0.008 to 0.037 mm. (av. 0.026 mm.) tangentially by 0.014 to 0.049 mm. (av. 0.033 mm.) radially. Thickness of walls, 0.002 to 0.006 mm. Length of vessel segments, 0.260 to 0.745 mm. (av. 0.495 mm.), including the usual tongue-like tips, which may attain a length of 0.190 mm. Perforations decidedly oblique, exclusively scalariform, with 2 to 10 (mostly 4 to 8) bars, which are commonly less than half the width of the intervening spaces. Intervascular pits minute (0.003 mm.), with distinct circular borders and dot-like or narrow-lenticular apertures. Vessel-ray pits similar in size and appearance (radial section) to the others.

Wood fibers.—The ground mass of the wood is composed of fiber-tracheids, arranged in fairly definite radial rows and slightly flattened at the periphery of the growth rings. In differentially stained sections of specimen No. 4504 chemical growth rings were noted, in which the fibers in zones of variable width at the termination of the late wood were noticeably less deeply stained than elsewhere. Fiber walls thick (0.003 to 0.007 mm.) and double, the outer layer thin, the inner one thicker and gelatinous. Length of fibers, 0.329 to 0.849 mm. (av. 0.593 mm.); width of median portion, 0.013 to 0.023 mm. (av. 0.018 mm.); shape libriform, the tips commonly scalloped or bent. Pits small (0.004 to 0.006 mm.), with distinct borders and oblique to nearly vertical slit-like apertures; distribution irregular in both radial and tangential walls.

Wood parenchyma.—Sparingly diffuse and in short and irregular tangential lines which are uniseriate or occasionally biseriate when in contact with the pores. Strands 0.208 to 0.554 mm. (av. 0.362 mm.) long and composed of 2 to 4 cells which are 0.007 to 0.020 mm. (av. 0.015 mm.) wide. The cells are conjugate, with short processes.

Rays.—Heterogeneous, and 1 or 2, rarely 3, cells wide. The uniseriate rays predominate and are 1 to 8 (mostly 1 to 4) cells high, measuring 0.019 to 0.261 mm. (av. 0.099 mm.), and 0.007 to 0.017 mm. (av. 0.013 mm.) in width. The others are 4 to 16 cells high, 0.060 to 0.319 mm. (av. 0.163

mm.), and 0.013 to 0.035 mm. (av. 0.020 mm.) wide. As seen on radial section, the interior cells of the wider rays are decidedly procumbent, while those of theuniseriate margins and throughout the entirely uniseriate rays are square or upright and conjugate.

Material.-Yale Nos. 868 (So. Afr. For. Service No. 465) ; 4503, 4504, 4504A (trade samples from J. H. Monteath Co., N. Y.); miscellaneous trade samples.

b. ***Notobuxus natalensis*** Oliver

The single species of the genus *JVotobuxus* is a small tree occurring only in South Africa, \vhere it is known as boxwattle, "luxwezo," and "gala-gala." According to Sim *(loc. cit.,* p. 321), it is "usually only of wattle size, but occasionally up to 30 feet in height and one foot in diameter. It is abundant along the coast from Kei to Natal; not seen beyond 1000 feet altitude, though in Natal it is stated to extend to 2000 feet. Mr. Carlson, District Forest Officer, Butterworth, writes: 'Luxwezo, which only grows along the coast, produces our best wattle for straightness, strength, and resistance against insect borers.'

"Probably it has a much higher value as an engravers' wood, and it might be reserved in the Transkei and Pondoland until that is ascertained, as exploitation for wattles is most ruinous to the succeeding crop and in the case of a slo\v-growing tree may affect it for a century. The wood is like Cape box in colour and texture, very close-grained. As the general appearance of this is not similar to *Buxus,* though it is closely related botanically, it is notable that the same native name is applied to it in the Egossa where *Buxus* is absent as is given to *Buxus* elsewhere."

DESCRIPTION OF THE WOOD

Macroscopic Features

General properties.-Wood very hard and heavy; sp. gr. (air-dry) 1.12; weight 70 lbs. per cu. ft. Texture very fine and uniform. Grain fairly straight. Available specimen split very badly in drying.

Color uniform light clear yellow. Odor not distinctive. Taste slightly bitter. Aqueous solution nearly colorless.

Growth rings.-Fairly distinct without lens; closely and fairly uniformly spaced; result of slight differences in porosity.

Parenchyma.-Not visible without compound microscope.

Pores.-Visible with lens as white dots; nunlerous, but not crowded; well distributed; solitary; open.

Vessel lines.-Exceedingly fine; barely visible.

Rays.-Very numerous; uniform; visible in part \vithout lens on cross section; invisible on tangential; fairly distinct on radial surface, where they are of slightly lighter color than the background.

AIinute Anatomy

VesseIs.-Size of pores, 0.017 to 0.046 mm. (av. 0.030 mm.) tangentially by 0.024 to 0.060 mm. (av. 0.040 mm.) radially. The vessel segments usually have overlapping tips of varying length. The perforations are steeply oblique, exclusively scalariform, with I to 40 (mostly 20 to 35) bars, often anastomizing. Intervascular pits, which usually are found only in the overlapping tips, o\ving to the fact that the vessels are isolated, have circular borders and very narrow horizontal apertures. The vessel-ray pits (radial section) are similar in appearance to the others, but are slightly larger.

Wood fibers.-The ground mass of the wood is composed of fiber-tracheids, arranged in fairly definite radial rows and tending to flatten slightly at the periphery of the growth ring. The walls are thick, sometimes with indistinct gelatinous layer, and the cavities are very small. The pits have distinct borders and slit-like oblique orifices.

Wood parenchym.a.-Diffuse, sparingly paratracheal, and at times in short tangential lines. The strands are composed of 4 to 8 (mostly 4) cells, commonly conjugate.

Rays.-Heterogeneous; uniseriate or more often biseriate, at least in median portion; rarely loca.lly triseriate. The uniseriate rays are I to 7 cells high, measuring 0.035 to 0.403 mm. (av. 0.I6Imm.), while the wider ones are 6 to 23 cells in height, 0.140 to 0.665 mm. (av. 0.390 mm.), including the uniseriate margins. The cells in the uniseriate rays or portions are upright and conjugate. The interior cells of the \vider rays are procumbent.

Material.-Yale No. 7477, collected by Mr. Ernest J. Neethling, South African Forest Department.

II. \VEST INDIAN BOXWOOD OF THE FAMILY FLACOURTIACEAE

THE FAMILY

This tropical family (extended to include to the Samydaceae) embraces about 70 genera with a total of several hundred species, mostly shrubs and small trees of little or no economic importance. One of the most famous members is a tree of the Far East whose seeds yield the chaulmoogra oil used in the treatment of leprosy. Only one wood, the "zapatero," or West Indian boxwood, is known to enter the world's markets, though a few others supply good material for local use. It is the product of a species of *Casearia*.

Casearia praecox Grisebach

There are approximately 200 described species of the' genus *Casearia*, mostly shrubs or small trees, occurring in practically every tropical region of the world. So far as determined, the only one of importance is *Casearia praecox* Grisebach, first discovered in Cuba and described as a shrub from 6 to 10 feet high. In the region of Lake Maracaibo in Venezuela the species attains tree size, and while not very tall the diameter of its trunk is' occasionally as much as 20 inches; the usual commercial sizes of logs are be-: tween 6 and TO inches thick.

The leaves are alternate, punctate with inconspicuous pellucid dots, and the midrib is hairy on the underside. The flowers are small, apetalous, have 4-6 sepals and 6-12 stamens, and are borne in fascicles on stalked cups in the axils of the leaves. The bark of the twigs and branches is smooth and ash-colored, ,vhile that 'of the older trunk is finely fissured and varying in color from gray to reddish-brown, often mottled, due to irregular scars from the bark flakes. One of the most characteristic features of the bark is the .presence of secretory canals, whose oily or gummy contents exude and stain the ends of the freshly cut logs.

The date of the entrance of this Venezuelan boxwood into the trade has not been determined. Sprague and Boodle,42 who were the first to refer it to *Casearia praecox,* state: "The samples of wood from the Maracaibo district appear to be identical with several specimens of West Indian boxwood

42 SPRAGUE, T. A., and L. A. BOODLE :-West Indian boxwood *(Casearia praecox* Griseb.). *Bulletin of Miscellaneous Information,* Royal Botanic Gardens, Kew, 6: 214-219, 1914.

in the Museum at Kew. Two of these are pieces prepared for \vood-engraving and presented by Mr. R. J. Scott, of 8 Whitefriars, E. C., one in 1867, the other in 1880. The latter bears a note that the donor reported on this wood: 'It is the only likely successor to boxwood I have yet seen.' "

The first available description of this wood is that by Moeller[43] published in 1880. He was under the erroneous impression that he was describing the wood of *Aspidosperma Vargasii* DC. and claimed to have found in the structure of the pits of the wood fibers a definite relationship to the white quebracho *(Aspidosperma Quebracho-blanco* Schl.), but his description fits *Casearia* and not *Aspidosperma.* (In this connection see page 54.)

The situation was further confused by the mis-labeling of some of the earlier specimens in the Kew Museum as *Tecoma pentaphylZa* Benth. & Hook. f. The wood was briefly described under this name hy Jackson[44] in 1885. About twenty years later an article[45] in the Kew Bulletin contained the statement that a specimen of "zapatero" had been found to agree closely with a wood known in commerce as West Indian boxwood, and that "upon further comparison of these two woods with that of *Tabebuia pentaphylla,* they were found to be identical, thus proving that the 'zapatero' wood and the West Indian boxwood of English commerce are both produced by the plant just mentioned." This mistake has found its way into most of the reference books on wood and still persists in spite of the findings of Sprague and Boodle *(loc. cit.)* to the contrary.

The work of the latter authors is based upon specimens of branches with leaves and flowers, together with pieces of the wood supplied by Mr. Schroder, the British Vice-Consul of Maracaibo. (See Plate I.) "As the twigs which bore the leaves and flowers were separate from the samples of wood, it was thought advisable to compare the microscopic structure of the twigs with that of the WOOd-specimens, in case there should have been any mistake on the part of the collector. The result of the comparison is quite satisfactory as regards agreement in structure, and proves that the twigs and wood belong to the same species, or to two closely related species. Under the circumstances they may be accepted as belonging to the same species.

43 MOELLER) J.,: Ueber das westindische buchsholz. *Di,tgler's Polytechnischen Journal,* 238 : 59-62, 1880.

44 JACKSON, JOHN R.: Boxwood and its substitutes. *Journal of the Society of Arts* (London), 33: 1691 : 601, April 17, 1885.

45 Zapatero, or West Indian boxwood *(Tabebuia [Tec01na] pentaphylla* Bth. and Hook. f.). *Bulletin of Miscellaneous Information,* Royal Botanic Gardens, Kew, 1904, No. 1, pp. 11-12.

"The abundant supply of flowering and leafy twigs has enabled the Maracaibo boxwood tree to be identified as *Casearia praecox* Griseb., a species hitherto recorded only from Cuba. C. *praecox* has been collected, however, in the District of Santa Marta, Colombia, by Mr. H. H. Smith, No. 789, distributed as '*Casearia ramiflora*' Vahl (?)."

The identification of "zapatero" by Sprague and Boodle is confirmed by Pittier,[46] who states that it is one of the principal woods exported from Maracaibo.

USES OF THE WOOD

This species is by far the most important box\vood of commerce and has very largely replaced Turkish box"vood for all purposes except the finest of wood-engravings. The logs are well formed, smooth and round, with comparatively little taper; they are mostly from 8 to 10 (rarely 11 or 12) feet long and from 6 to 12 inches in diameter, as opposed to the short, knotty, and small sticks of *Buxus*. The annual consumption of the timber in the United States is between 2000 and 2500 tons. There are from 8 to 11 logs per ton, average 10.

Pearson[47] says: "Perhaps the largest consumption of boxwood in the United States is for the manufacture of rules. Other uses are veneers for furniture and marquetry, blocks for wood-engraving, objects of turnery, combs, spoons, shuttles and spindles, mill supplies, and jewelers' burnishing wheels. The sawdust is used for polishing jewelry. Sometimes the wood is dyed black to imitate ebony. Turkish boxwood is best for wood-engravings, but for all other purposes the West Indian gives eminent satisfaction."

The various stages in the manufacture of box\vood ,rules were observed by the senior author at the plant of the Eugene Dietzgen Company, 954 Fullerton Avenue, Chicago. The logs are bought in the round and are sawed into planks, 1⅜ to 2 inches thick, carefully piled under cover and allowed to season for a period of 1 to 3 years. When thoroughly dry, the planks are sawed into rule blanks (triangles and flats), care being exercised that the wood is used to the best advantage. Many careful operations and special machines are required in the processes of shaping, sanding, gradu-

48 PITTIER, H.: *Esbozo de las formaciones vegetales de Venezuela.* Caracas, 1920, p. 24. Also in his: *Exploraciones y otras en la cuenca de Maracaibo.* Caracas, 1923, pp. 25-27.

47 C. H. PEARSON & SON HARDWOOD Co., INC.: *Tropical woods.* New York, 1924, p. 7.

ating, finishing, and sorting. rrhe quality of West Indian boxwood preferred for rules is straight-grained, free of all defects, and of a bright, clear butter-color. All-wood precision rules are made exclusively of the "zapatero," but for cheaper grades hard maple and a few other woods are used. Slide rules are often made of mahogany faced with celluloid strips for the graduations.

West Indian boxwood is often dyed black in imitation of ebony and used for handles of cutlery and other utensils, for piano keys, keyboards of musical instruments, inlay, and other purposes. In this it follows another precedent of the true box\vood. Jackson[48] says: "The Italian receipt books are well provided with receipts for producing black, which suggests that most of the ebony used in inlay was factitious. A 15th century MS. says: 'Take boxwood and lay it in oil with sulphur for a night, then let it stew for an hour, and it will become as black as coal.' Evidently this iswhatVasaril calls oil of sulphur, *aqua fortis.* Others are founded upon the application of a solution of logwood, followed by one of iron." It is interesting to note in this connection that the ancient Gerlnan name for boxwood is "ebenholz."
(See p. 23.)

A modern process of ebonizing box\vood is as follows: 'I'he logs are sawn into planks, usually two inches thick, and carefully kiln-dried, after which they are cut up into small blocks and placed in burlap bags. These bags are put into a \vire cage and lowered into an upright impregnation cylinder provided with a steam jacket and fitted with a heavy lid, or door, provided with an air-gauge and pop-valve. After charging the cylinder, a vacuum is maintained for three hours. \Vithout breaking this vacuum, log\vood solution (8° Baume) is admitted in sufficient quantity to cover the charge, but leaving an air space in the dOlne of the lid. Air pressure of 85 Ibs. gauge and a temperature of 200° :F. (thermostatically controlled) are maintained for 8 or 10 hours, after which the solution is drawn off and the charge washed with\vater. The bags of blocks are allowed to air-dry for 48 hours and are then kiln-dried and returned to the cylinder. The second treatment duplicates the first except that the solution is acetate of iron (6° Baume) and is not heated. It is more difficult to secure uniform penetration with the acetate than with the logwood solution and it is customary to split a number of blocks to determine the thoroughness of the treatment. If the results are unsatisfactory the charge is subjected to further treatment in the cylinder. After washing and drying, as before, the \veod is ready for use.

48 JACKSON, F. HAMILTON: *Intarsia and marquetry.* London, 1903, p. 138.

COMMON NAI\1ES

Zapatero,[49] sapatero, naranjillo?, lima?, limoncillo? (Venezuela) ; West Indian, Venezuelan, or Maracaibo boxwood Cfrade, gen.); India boxwood (Eu. Trade) ; buis des Antilles, buis d'Amerique (France); westindische buchsbaum (Germany).

DESCRIPTION OF THE WOOD

Macroscopic Features

Generalproperties.-Wood hard, heavy, and compact; easy to carve and turn; takes a high natural polish; splits more readily than true boxwood; not durable in contact with ground; sp. gr. (air-dry) 0.80 to 0.90; weight 50 to 56 lbs. per cu. ft. Grain mostly straight; texture extremely fine and uniform.

Color light clear yello\v or nearly white; mostly uniform; little or no difference between heartwood and sapwood. Blue stain common in improperly seasoned wood.[50]

Odor and taste not distinctive; aqueous solution colorless.

Growth rings.-Fairly distinct to unaided eye; mostly rather close; due to fine, concentric, light-colored lines which have the appearance of terminal parenchyma, frequently emphasized by difference in color of early and late wood; under compound microscope found to be caused by a flattened condition of the libriform fibers.

Parenchyma.-Very rare; not visible except under compound microscope.

Pores.-Individually distinct only with hand lens; minute; very numerous; mostly in radial rows of 2 to 4, or at times as many as 10; open.

Vessel lines.—Fine and indistinct.

[49] In Trinidad and parts of Venezuela the name "zapatero" is applied to purpleheart *(Peltogyne* sp.).

[50] "As to the color of 'zapatero,, we find that if the wood is shipped in the period from January to early March and provided it is stowed in a vessel 'where it is free from dampness and where there is ample ventilation, the color is butter-yello·w. On the other hand, if the wood is put in the bottom of a ship's hold, with hundreds of tons of cargo stowed on top of it and kept in such a place for six or eight weeks, it is apt to lose its bloom and freshness and become very light buff or, in bad cases, brownish. If this woodis immersed in water for even twenty-four hours it will be ruined. In such cases it turns a bluish black color and decays very quickly."—Mr. R. M. Gardner, of Joseph Gardner & Sons, Liverpool, in letter of Dec. 20, 1924.

Rays.-Numerous; very narrow and low; fairly distinct to unaided eye on cross section; invisible even with lens on tangential; distinct in proper light on radial surface where they are of about the same color as, or slightly lighter than, background.

Minute Anatomy

(See Plate VII, NO.1.)

Vessels.-Solitary pores irregularly oval, the long axis radial. Interior pores of the radial groups usually little flattened; terminal ones elongated radially. Size, 0.014 to 0.048 mm. (av. 0.034 mm.) tangentially by 0.011 to 0.068 mm. (av. 0.036) radially. Thickness of walls, 0.0025 to 0.005 mm. Length of vessel segments, 0.258 to 0.859 mm. (av. 0.579 mm.), including tips, which may attain a length of 0.189 mm., rarely longer. Perforations mostly oval, oblique, exclusively simple. Intervascular pits minute (maximum 0.003 mm.), often crovded, with slit-like apertures tending to coalesce into spirals. Vessel-ray pits of same size and general appearance (radial section) as the others.

Wood fibers.-Ground mass composed of libriform fibers, with thick walls (av. 0.0056 mm.), often with gelatinous layer, rather irregular in outline, arranged in fairly regular radial rows. At intervals there are narrow zones in which the fibers are more or less radially flattened, giving rise to growth rings which are, however, usually more distinct under the lens than under the compound microscope. Length of fibers, 0.289 to 1.207 mm. (av. 0.843mm.), diameter, 0.013 to 0.028 mm. (av. 0.019 mm.). Pits simple, slit-like or narrowly lenticular, vertical, 0.0025 to 0.0057 mm. long, and largely confined to the radial walls. Fibers often falsely septate, due to resin plates.

Wood parenchyma.-Very rare. Only occasional isolated cells observed on cross section.

Rays.—Heterogeneous, 1 to 4 cells wide, the wider ones predominating. The uniseriate are 1 to 23 cells high, measuring 0.042 to 0.850 mm. (av. 0.352 mm.), and 0.007 to 0.017 mm. (av. 0.012 mm.) in breadth. The larger rays; which are mostly 3-seriate (occasionally 4-seriate) in median portion,are 8 to 77 cells high, n1easuring 0.119 to 1.462 mm. (av. 0.574 mm.), including the uniseriate lnargins, which may be from fe\v to 14 cells in height. As seen on radial section, the interior cells of the polyseriate rays are procumbent, while those of the uniseriate rays and margins vary in

shape from square to palisade. The upright cells are conjugate. Irregular rhombohedral crystals are common in both procumbent and upright cells.

Remarks.-In specimen No. 4424 the cells, particularly the fibers and pores, were much distorted in places, especially near the margins of the growth rings, sometimes giving the appearance (cross section) of an intricate jig-saw puzzle.

Material.-Yale Nos. 2663, 2675, 2735, 2759, 4424, 4425, 4426, 5884, 7158 (Venezuela).

III. KNYSNA BOXWOOD AND OTHERS OF THE FAMILY APOCYNACEAE

THE FAMILY

Within the family Apocynaceae are about 130 genera, with a total of considerably more than a thousand species of perennial herbs, shrubs, vines, and trees. Though widely distributed they are most numerous in tropical regions. Only a few species are important sources of timber. There are only two, namely, *Gonioma Kamassi* E. Mey. and *Aspidosperma Vargasii* DC., whose woods are classed as boxwood, but others may prove to be of importance as boxwood substitutes.

1. *Gonioma Kamassi* E. Meyer

This species, the only one of the genus, is the source of the Kamassi wood or Knysna boxwood of South Africa. It is an evergreen tree with a small compact crown and a clear straight bole rarely over 12 or 14 inches in diameter. The leaves, which are opposite or in whorls of three, are from two to three inches long and about half an inch wide at the middle, tapering toward tip and base; they are smooth and lustrous, deep green above and paler beneath. The small, yellowish-white, scented flowers are borne in few-flowered terminal cymes. The fruit is a pod upwards of two inches long and half an inch in diameter, splitting along the upper surface and liberating numerous flat and somewhat winged seeds; the pods are borne in widely divergent pairs.

According to Sim,[51] this species is "abundant in the lower forests of

[51] SIM, THOMAS R.: *The forests and forest flora of the Colony of the Cape of Good Hope*. Aberdeen, Scotland, 1907, p. 272.

the Midland Conservancy, and extending sparingly near the coast as far east as East London; reserved in all the Conservancies, except the Trans.. keian, where"it is not known to occur. Timber yellowish, dense, hard, close-grained, 58 Ibs. weight per cu. ft.; easily worked or turned, and formerly used for fencing poles, but now too valuable for that. Very considerable quantities of this have been sent to Europe under the name boxwood. . . . Though present at East London there is no commercial stock in the forests of the Eastern Conservancy. The juice of this tree is watery and bitter."

The wood of *Gonioma* is often confused in the trade with that of the Cape boxwood *(Buxella Mac-Owanii* Oliv.), but the ports of shipment usually give the clue to the kind of \vood, since the commercial ranges of the two woods do not overlap. Sim *(loe. cit.)* p, 323) says: "The Knysna export under the name of boxwood \vas all, or mostly, Kamassi-\vood with.. out any boxwood, and that still continues to be sent from there under the name of boxwood, a lively industry in it having arisen since 1895, including the export of yearly increasing quantities in manufactured condition, at least in so far as to be dressed in billets clear of waste."

The "afrikanisches buchsholz" described by Wiesner[52] is *Gonioma.*

USES OF THE WOOD

Knysna boxwood, or West African boxwood, as it was first called, began to be used for shuttle manufacture in England about 1886, sparingly and intermittently at the start, but later (about 1902) in considerable quantity. It is still in demand in Europe for this purpose, particularly for shuttles in silk mills, but now enters the markets of the United States in only very limited amounts. The logs are very irregular in outline, and the commercial sizes are from 4 to 8 inches in diameter and 8 to 14 feet long. Sim *(loc. cit.)* p. 323) says that the total export from South l\frica up to the end of 1899 amounted to 128,812 cubic feet, of a declared value of £10,574. According to the commerce reports, the amount exported during the first 11 months of the year 1923 was 1,47°,569 pounds, valued at £6285. The destinations \vere as follows: United Kingdom, 582,162 lbs.; France, 496,830 lbs.; Germany, 242,779Ibs.; Holland, 52,960 lbs.; Italy, 50,081 lbs.; United States, 45,125 lbs.; Japan, 722 Ibs.

The wood is reputed to be injurious to some of the \vorkmen \vho handle it in the shuttle factories, and this was made the subject of an investigation

[52] WIESNER} JULIUS: *Die rohstoffe des pflanzenreiches,* fl. Leipzig, 1903, pp. 1001-1002.

in 1905 by members of staff of the University of Liverpool.[53] Dr. A. W. Titherly obtained an alkaloid, or mixture of alkaloids, from the sawdust, and Miss S. C. M. Sowton conducted a series of six experiments to determine the physiological effect of this alkaloid on the mammalian heart as evidenced by sphygmographic records. "The net result of all these experiments is to show that the alkaloid present in the 'West African boxwood' is a cardiac poison, inducing a gradual slowing of the heart-beat and diminution of vigor in the contractile tissue of the heart; that its effect is cumulative, finally producing a cessation of the beat under long exposure to its influence." There is no evidence that there is even the slightest danger in the ordinary handling and using of the wood, and, so far as the present writers are able to ascertain, no trouble is experienced in manufacturing plants where provision is made for the efficient removal of the dust.

Knysna boxwood is not a satisfactory substitute for Turkish boxwood in engraving, nor can it be "ebonized" in the manner described on page 44 for West Indian boxwood. A mixed lot of blocks of the same size and given the same treatment were examined by the writers, who found that the Knysna blocks had been fairly well impregnated with the logwood solution, but only superficially with the acetate of iron, consequently were black only on the surface, The West Indian boxwood *(Casearia)* blocks in the same lot were jet black throughout, and those of the San Domingan *(Phyllostylon)* closely approximated that condition.

COMMON NAMES

Knysna or Kamassi boxwood (Trade, general); South African, West African, East London, or Cape boxwood (Trade); Kamassi, Kamassihout (Dutch in So. Afr.).

DESCRIPTION OF THE WOOD

Macroscopic Features

General properties.-Wood hard and heavy; sp. gr. (air-dry) 0.93; weight 58 lbs. per cu. ft. (Sim); easy to carve and to turn. Texture very fine and uniform; grain straight or fairly so.

Color variable; mostly deep yellow with rather pronounced greenish or

53 HARVEY-GIBSON] R. J.: The physiological properties of West African boxwood. *Bio-Chemical Journal,* 1: 39-44, 1906.

HARVEY-GIBSON] R. J.: Note on the synonymy and histological characters of East London boxwood *(Gonioma Kamassi* E. Mey.). *Bio-Chemical Journal}* 6: 127-129, 1912.

slight orange tinge; at times light brown to nearly white; in some specimens with irregular darker streaks or patches; sap\vood of slightly lighter color.

Odor not distinctive; taste bitter. Aqueous solution has pronounced greenish-yellow tinge.

Growth rings.-Mostly distinct to unaided eye, due to regular, closely spaced, narrow zones, usually darker than background, in which there are few pores and parenchyma cells.

Parertchyma.-Visible with lens as very numerous, fine, closely spaced, irregular, tangential lines; also barely visible about pores; rare in poreless zones.

Pores.-Visible only \vith lens; fairly nUlnerous; minute; mostly single; slightly oval; well distributed, except in narrow poreless zones which terminate growth rings.

Vessel contents.-Many of the pores, especially in darker specimens, partially filled with reddish brown to black deposits.

Vessellines.-Visible only \vith lens; fine; straight.

Rays.-Numerous; narrow; low; fairly distinct to unaided eye on cross section; barely visible with lens on tangential; on radial surface are of about same color as background, but distinct to naked eye.

Minute Anatomy

(See Plate VI, No. I.)

Vessels.-Pores solitary and rather thin-walled; size, 0.025 to 0.070 mm. (av. 0.048 mm.) tangentially by 0.034 to 0.085 mm. (av. 0.060 mm.) radially; cavities open or containing yellow deposits. Vessel segments vary in length from 0.510 to 0.918 mm. (av. 0.787 mm.), including the overlapping tips, which may be up to 0.306 mm. long; perforations round to oval, slightly oblique, exclusively simple. Intervascular pits minute (0.003 mm.), fairly numerous, alternate, the mouths dot-like or slightly elongated. Vessel-ray pits of similar appearance.

Wood fibers.-Ground mass of the wood composed of thick-walled fiber-tracheids, some of which exhibit an indistinct gelatinous layer. Length of fibers, 0.646 to 1.547 mm. (av. r.08I mm.); median diameter, 0.020 to 0.037 mm.(avo 0.027 mm.). Pits small (0.0056 to 0.0085 mm.), distinctly bordered, well distributed. (Fig. 2, Nos. 1,6, 7.)

Wood parenchyma.-Well distributed, except in a narrow *zone* terminating the growth ring, being diffuse, sparingly paratracheal, and in irregular tangential lines, mostly uniseriate, but sometimes 2 or 3 cells wide. Strands composed of 2 to 8 (mostly 4) cells; often rather indistinctly conjugate, both with adjacent parenchyma cells and marginal ray cells.

Rays.-The rays are 1 to 6 cells wide and heterogeneous. (Fig. 2, Nos. 2, 5, 6, 7.) The uniseriate rays are composed of 1 to 9 cells, the highest varying from 0.028 to 0.423 mm. (av. 0.202 mm.) ; the others are mostly 3 to 4 cells wide and from 3 to 50, though rarely over 35, cells high and measure 0.051 to 0.952 mm. (av. 0.440 mm.). The polyseriate rays have uniseriate margins, sometimes 9 cells high (0.374 mm.). The interior cells, as viewed in radial section, are usually low and procumbent, the marginal ones square to palisade and more or less conjugate. The minute pits between ray cells are usually disposed in two rows near the top and bottom of the cells; those between ray cells and fibers are similar in appearance to those between fibers;

Marginal *ray tracheids* were observed in a few instances, the most conspicuous example being shown in Fig. 2, No. 1. It is not an unusual thing in dense woods for the tips of wood fibers to penetrate the rays or run along their margins (see Fig. 2, No.8), and it is likely that this explains the condition noted in tangential section in certain instances. Such structures are readily detected on radial sections, for even if only a portion of a distorted vertical element is present, the slanting cut through the \valls or some other feature \vill disclose the true nature of the element. Thus, in the ray tracheids shown in Fig. 2, No. 1, the walls are clearly defined and the pits are considerably smaller than those of the wood fibers. Ray tracheids in dicotyledonous woods are apparently of very rare occurrence. They have been noted by the senior author[54] in *Quercus alba*, and Janssonius[55] states that he observed radially running libriform fibers in some of the medullary rays of *Neesia altissima* Blume. The libriform fibers he refers to are really fiber-tracheids, since they have bordered pits.

Material.-Yale Nos. 4501 (Museum, Royal Bot. Gardens, Kew) ; 450IA (So. Afr. For. Service, No. 16) ; 5938 (C. H. Pearson & Son Hardwood Co., N. Y.) ; misc. trade samples.

[54] RECORD, SAMUEL J.: Ray tracheids in *Quercus alba*. *Botanical Gazette*, 64: 5: 437, November, 1917.

[55] MOLL, J. W., und H. H. JANSSONIUS: *Mikrographie des holzes der auf Java vorkommenden baumarten, I*. Leiden, 1906, p. 411.

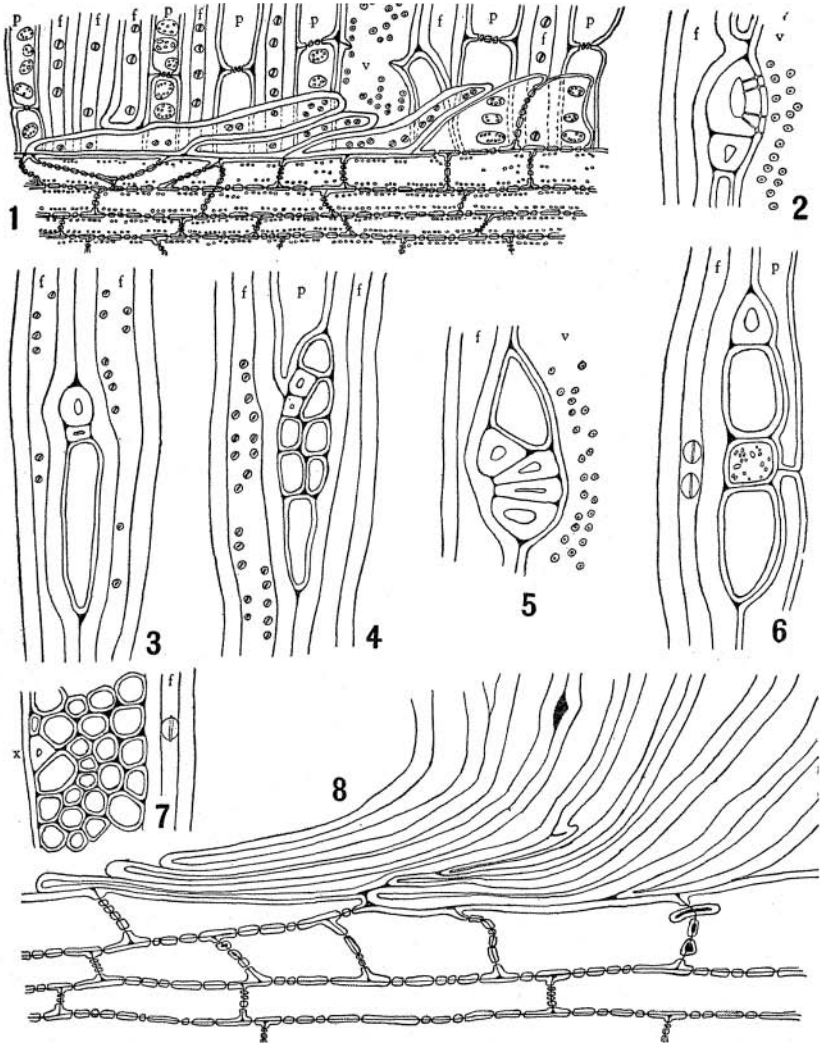

Fig. 2. Structural details of the rays of *Gonioma* and *Buxus*.

FIG. 2. EXPLANATION OF DRAWINGS

No. I.-Radial section of Knysna boxwood (*Gonioma Kamassi* E. Mey.), showing portion of a ray with 3 nlarginal ray tracheids, 2 upright parenchymatous cells, and 3 rows of procumbent cells. Note the nature of the pitting in the ray cells, the wood parenchYlna (p), the wood fibers (f), and the vessels (v); the groups of small pits are characteristic of conjugate parenchyma. X 200.

No. 2.-Tangential section showing portion of a uniseriate ray of Knysna boxwood *(Gonioma Kamassi* E. Mey.), with two marginal tracheids. Note intervascular pits in vessel (v) and sections of 4 pits between upper ray tracheid and vesseL X 400.

No. 3.-Tangential section of a uniseriateray of Turkish boxwood *(Buxus sempervirens* L.), showing (at the top) tips of 2 wood fibers bent along the ray, and appearing as part of it. Note characteristic pitting of the wood fibers (f). X 400.

No. 4.-Tangential section of a biseriate ray of Turkish boxwood (*Buxus sempervirens* L.), showing tips of 2 wood fibers in upper left-hand portion. X 400.

No. s.-Tangential section of a uniseriate ray of Knysna boxwood *(Goni-omaKalnassi* E. Mey.), with 4 tracheids (at the bottom). X 400.

No. 6.-Tangential section of a uniseriate ray of Knysna boxwood *(Gonioma K amassi* E. Mey.), with one tracheid (at the top). The small ray parenchyma cell shows nature of pitting in end \valls. Note characteristic pits of the \vood fiber (f) and compare with intervascular pits of the sanle species shown in Nos. 2, 5 (v) and with the pits of the wood fibers of *Buxus sempervirens* L. in Nos. 3, 4 (f). X 400.

No. 7.-Tangential section of a portion of a multiseriate ray of Knysna box\vood *(Gonio1na Kamassi* E. Mey.), sho\ving ray tracheid or tip of wood fiber at left (x). X 400.

No. 8.-Radial sectIon of Turkish boxwood (*Buxus sempervirens* L.), showing tips of wood fibers bent along the margin of a ray. On tangential section these ,vould appear as part of the ray, as shown in Nos. 3, 4. Two of the Inarginal ray cells (at the right) are slightly conjugate. X 400.

2. Aspidosperma Vargasii De Candol1e

The genus *Aspidosperma,* with more than 60 known species, mostly Brazilian, includes some of the most valuable timber trees of South America. The \yoods are separable into three more or less well·defined groups of which the types are: (I) "quebracho blanco" of Argentina, (2) the "peroba rosa" of southern Brazil, and (3) woods of the boxwood class in Venezuela and BraziL[5][6]

A Brazilian \vood of the last group is *Aspidosperma eburneum* Fr. Allemão, known as "pequia marfim" and "páo setim," although these names are also applied to certain of the Rutaceae. This tree, which has a bole length of 20 to 25 feet and a maximum diameter of 30 inches in northern São Paulo and Victoria, is said to be of so rare occurrence that its valuable wood is available only in very limited quantities. Some of the woods known as "guatambu," *A. tomentosum* Mart. and probably other species, approach the boxwood class, though others are luore like the "peroba rosa," *A. polyneuron* Muell.-Arg. So far as kno\vn, these woods have not entered the boxwood trade, but some of them are deserving of consideration.

Aspidosperma Vargasii De Candolle[57] is a small tree of the coastal region of Venezuela. Its leaves are more or less elliptical, being about an inch wide and 2 or 3 inches long, exclusive of the petiole which is about an inch long; the under side is pale. The t\vigs are glabrous and stiff. The fruit, according to Ernst,58 is "an ovate, unequal-sided follicle, 2½ inches long, 1½ broad, grayish, covered with numerous \vhitespots. Its contains from 6 to 8 seeds; these are ovate, 1½ inches long and 1 inch broad. The follicle looks like a ham in miniature."

This species is reputed to have supplied the first of the woods known as West Indian boxwood. The authority for this is Dr. Ernst,59 who wrote from Caracas under date of May 17, 1880, that the Venezuelan boxwood exported from Puerto Cabello to Hamburg was of this species, locally known as "amarilla yema de huevo" *(i.e.,* "yolk yello,v"). This statement was long accepted as applying to all of the boxwood exported from that country, though t\VO or three different kinds were recognized in the trade

[56] For information about the woods of the first two groups see: RECORD} SAMUEL J., and CLAYTON D. MELL: *Timbers of Tropical America.* New Haven, 1924, pp. 505-515.

[57] DE CANDOLLE, A. P.: *Prodromus systematis naturalis regni vegetalis, VIII.* Paris, 1824-1873, p. 399·

[58] ERNST} A.: Jottings from a botanical note book. *Journal of Botany,* 8: 375, 1870.

[59] *Botanisches Centralblatt}* 1 : 574, 1880.

under the names of "naranjillo," "atata," etc. In 1880, Dr. Moeller[60] published a description of the wood, under this name, but his description clearly indicates *Casearia praecox* Griseb. and not *Aspidosperma*. Wiesner[61] falls into the same error, as does Laris[62] also, though in the latter case the information is obviously taken from the work of Moeller.

Pittier[63] says that the wood of this species, which grows chiefly in the dry and monsoon forests along the coast, where it is kno\vn as "amarillo" and probably also as "naranjilIa" and "limoncillo," was exported to Europe in considerable quantity during the last decades of the nineteenth century, but that there is now little demand for it. In a conversation with the senior author, Dr. Pittier recently expressed the opinion that this wood had lost its importance because of the exhaustion of easily available supplies and had been superseded by the "zapatero" *(Casearia)* of Maracaibo because the latter timber could be had in quantity.

Whatever may have been the standing of "amarillo" in the past, it seems no longer an important factor in the boxwood trade. The wood is of excellent quality and it is not unlikely that limited quantities will enter the market from time to time.

COMMON NAMES

Amarillo, amarillo boj, amarilla yema de huevo, naranjillo, limoncillo (Venez.); West Indian box"\vood, India boxwood (Eng.); westindische buchsholz (Germ.).

DESCRIPTION OF THE WOOD

Macroscopic Features

General properties.-Wood hard and heavy; easy to carve and turn; takes a high polish; sp. gr. (air-dry) 0.94; weight 59 lbs. per cu. ft. Texture exceedingly fine and uniform; grain straight to decidedly irregular.

Color somewhat variable in different specimens; mostly pale yello\v, at

60 MOELLER, J.: Ueber das westindische buchsholz. *Dingler's Polytechnische Journal,* .238 : 59-62, 1880.

61 WIESNER, JULIUS: *Die rohstoffe des pflanzenreiches, II.* Leipzig, 1903, pp. 999-1000.

62 LARIS,EUGEN: *Nutholz liefernde holzarten.* Wien and Leipzig, 1910, pp. 149-150.

63 PITTIER, H.: *Esbozo de las formaciones vegetales de Venezuela.* Caracas, 1920, p. 24.

times with slight greenish tinge; sapwood slightly lighter in color or nearly white. In two specimens (Yale Nos. 6796 and 6897) supplied by the Museo Comercial de Venezuela, the color is distinctly darker, having a fairly pronounced bro\vnish tinge.

Odor not distinctive; taste slightly astringent. Aqueous solution has slight greenish tinge.

Growth rings.-Faitly distinct to unaided eye; rather closely spaced; under lens found to be due to very narrow denser zones, deficient in pores; usually marked by a fine line, resembling wood parenchyma.

Parenchyma.-Not visible without compound microscope.

Pores.-Minute; indistinct without lens; numerous; well distributed except that they are usually much fewer in extreme outer part of growth rings; mostly solitary, though frequently in groups of 2 or 3; open.

Vessel lines.-Indistinct without lens; fine; straight.

Rays.-Very numerous; narrow; low; barely visible to unaided eye on cross section; not visible even with lens on tangential; about same color as background on radial surface and not very distinct without hand lens.

Minute Anatomy

(See Plate VII, No.2.)

Vessels.-Mostly solitary, occasionally in groups of 2 or 3, thin-walled, rather irregular in outline; size, 0.023 to 0.090 mm. (av. 0.060 mm.) tangentially by 0.020 to 0.107 mm. (av. 0.068 mm.) radially; thickness of walls, 0.002 to 0.005 mm. (mostly 0.003 mm.). Length of vessel segments, 0.442 to 1.190 mm. (av. 0.834 mm.) ; overlapping tips variable in length up to 0.374 mm. Perforations circular to oval, slightly oblique, exclusively simple. Intervascular pits very small (0.004 mm.), numerous but not cro\vded, alternate, with slit-like apertures often extending beyond the borders and apparently coalescent. Vessel-ray pits of same size, but arranged in rows, the apertures forming distinct horizontal lines.

Wood fibers.-Ground nlass of wood composed of fiber-tracheids, irregular in cross section and in arrangement; terminal fibers (I to several ro\vs) noticeably flattened. The walls are thick (0.0056 to 0.0085 mm.) and \vithout gelatinous layer; cavities constricted. Length of fibers, 0.697 to 1.935 mm. (av. 1.378 mm.) ; median diameter, 0.014 to 0.030 mm. (av. 0.022 mm.). Pits distinctly bordered, irregularly distributed in both radial

and tangential walls; size, 0.004 to 0.0056 mm.; apertures slit-like and vertical.

Wood parenchyma.-Diffuse and in more or less interrupted, usually uniseriate, tangential lines, more abundant infirst formed portion of growth ring. Length of strands, 0.306 to 1.004 mm. (av. 0.708 mm.); diameter, 0.014 to 0.028 mlD. (av. 0.020 mm.) ; number of cells, 2 to 6, mostly 4; cells often conjugate, the processes in rare instances being 0.022 mm. long; number of pits in end of processes, 2 to 4.

Rays.—Mostly uniseriate, occasionally biseriate, 1 to 25 cells high, measuring 0.020 to 0.378 mm. (av. 0.160 mm.). They are normally homogeneous, though the marginal cells may be somewhat higher than the others and in rare cases are upright; no conjugate ray cells observed.

Material.-Yale Nos. 267°,4423, 6780, 6796, 6897 (Venez.).

IV. SIAMESE BOXWOOD OF THE FAMILY RUBIACEAE

THE FAMILY

THE family Rubiaceae includes about 3So genera and 600 species of trees, shrubs, and herbaceous plants, most of which are tropicaL The best known members are the *Cinchona,* the source of cinchona bark and qUinine; the tree whose berries are the coffee of commerce; the madder, a dye-yielding plant of the Himalayas; and the common decorative plant, *Gardenia.* Very few are important sources of timber. One of these is the degame of Cuba, whose hard and strong wood serves the same purposes as lancewood; in Central America the same kind of wood is used for making combs, which is also one of the oldest uses of box\vood in the region of its growth. The only tree known to yield a boxwood of the trade is a species of *Gardenia* growing in Siam, though Indian species of *Randia* are said to be in the same class. The family seems a likely one in which to find boxwood substitutes.

Gardenia sp.

Nearly all of the 60 or more species of this genus are shrubs, a few being small trees. Their natural range is confined to the Old World, particularly Africa and the Far East, but a few are \videly cultivated for orna-

mental purposes. There are about 11 species in India, and Gamble[64] says: "Like the species of *Randia)* those of *Gardenia* have the characters of boxwood, and deserve attention as possible substitutes for the cheaper rougher work of engraving, toolhandles, etc."

l'heboxwoodexported from the kingdom of Siam is produced by an unidentified species of *Gardenia.* Mr. W. :F. Lloyd, Chief Conservator of Forests of Siam, wrote to the senior author from Bangkok in January, 1924, that botanical specimens submitted to the Royal Botanic Gardens, Kew, England, were not complete enough to permit of specific determination and it is thought possible that it lnay prove to be a new species. "Box\vood in Siam," he says, "is known in the vernacular as 'mai phoot.' There are several other species called 'mai phoot' which have been identified as follows: (1) *Ervatamia coronaria* Stap., (2) *Zizyph'ys Jujuba* Lam., (3) *Limonia acidissima* Linn., (4) *Hibiscus mutabilis* Linn., (5) *Gardenia obtusifolia* Roxb., (6) *Jasminum auriculatum* Vahl, and (7) *Holarrhena similis* Craib. Whether any of them could be classed as box\vood like the *Gardenia* sp. exported from here, I am unable to say, as I have not yet come across any of the wood of those trees."

rfhe available literature on Siamese box\vood is very meager. Carter[65] says: "Turning to the woods of the peninsular districts we find along the coasts of Petchaburi and Champawn a kind of boxwood (mai put), much sought after by Japanese traders, who export it for use in wood carving." Picharn[66] lists *Gardenia* sp., vernacular name "poo'd-mai," with six other species of *Gardenia,* but gives no other data concerning it.

The authors have no definite information as to the time when the Siamese boxwood was first introduced into the market, but Professor Mitsunaga Fujioka, of the Kyushu Imperial University at Fukuoka, Japan, stated in 1921 that the wood was first imported into Japan about seven or eight years previously. He said that it was inferior in quality to the true boxwood, but had the advantage of being considerably cheaper. It could be readily distinguished from *Buxus* through its lighter color and the absence of bitter taste. There is no evidence of the wood having entered the European or American markets.

The following information regarding Siamese boxwood is contained in

[64] GAMBLE,]. S.: *A manual oj Indian ti1nbers.* 2d ed., London, 1922, P.41 5.

[65] CARTER, A. CECIL: *The Kingdom of Siam.* N. Y. & London, 1904, p. 180.

[66] PICHARN, PHYA VANPRUK: *List of C01nmon trees, shrubs, etc.) in Siam.* Bangkok, 19 2 3.

a letter of June 27, 1923, from Mr. Maurice P. Dunlap, American Consul at Bangkok, who cites the Chief Conservator of Forests as his authority: "There is a limited quantity of boxwood exported from Siam to Japan every year. The demand is rather irregular and at present there is no enquiry froni Japan, although some dealers in Chaugwad. Petchaburi and Prachuab Kirikhan (districts of Siam) have a fairly large stock for disposal. Boxwood timber is procured from a species of *Gardenia,* a moderate-sized tree of Rajburi Circle, and is of a very close-grained, ivory-like consistency. People here say that it is used in Japanfor making combs and high class cabinet work. The supply of this timber is very limited, say not more than 50 tons a year, as it is rare. The wholesale price from the forest is from Tcs. 2 to Tcs. 3 perpicul, or say Tcs. 2 per 100 pounds or Tical one per cubic foot. (A tical is equivalent to about $0.44 bank-buying rate.) The size of the timber averages only 16 to 20 inches in girth."

DESCRIPTION OF THE WOOD

Macroscopic Features

General properties.-Wood hard and heavy; sp. gr. (air-dry) 0.95; \veight 59 lbs. per cu. ft.; easy to carve and turn. Grain mostly straight; texture fine and even.

Color whitish, with faint bro\vn tinge; not yellow; little or no difference between heart\vood and sapwood.

Odor and taste not distinctive. Aqueous solution practically colorless.

Growth rings.-Mostly distinct to unaided eye; fairly regular and closely spaced; due to narrow, denser zones, which often appear darker than remainder of wood and in which pores are smaller and less numerous; flattened fibers at outside of late wood emphasize the rings and sometimes appear under lens as rather indistinct lines of parenchyma.

Parenchyma.-Present, but invisible \vithout compound microscope.

Pores.-Barely visible with lens; minute; numerous; mostly solitary; oval; decreasing in size and number toward outside of growth rings; open.

Vessel lines.-Visible with lens, but not very distinct; extremely fine; straight.

Rays.-Numerous; just visible in part to unaided eye on cross section; invisible on tangential; same color as background on radial surface, but fairly distinct without lens.

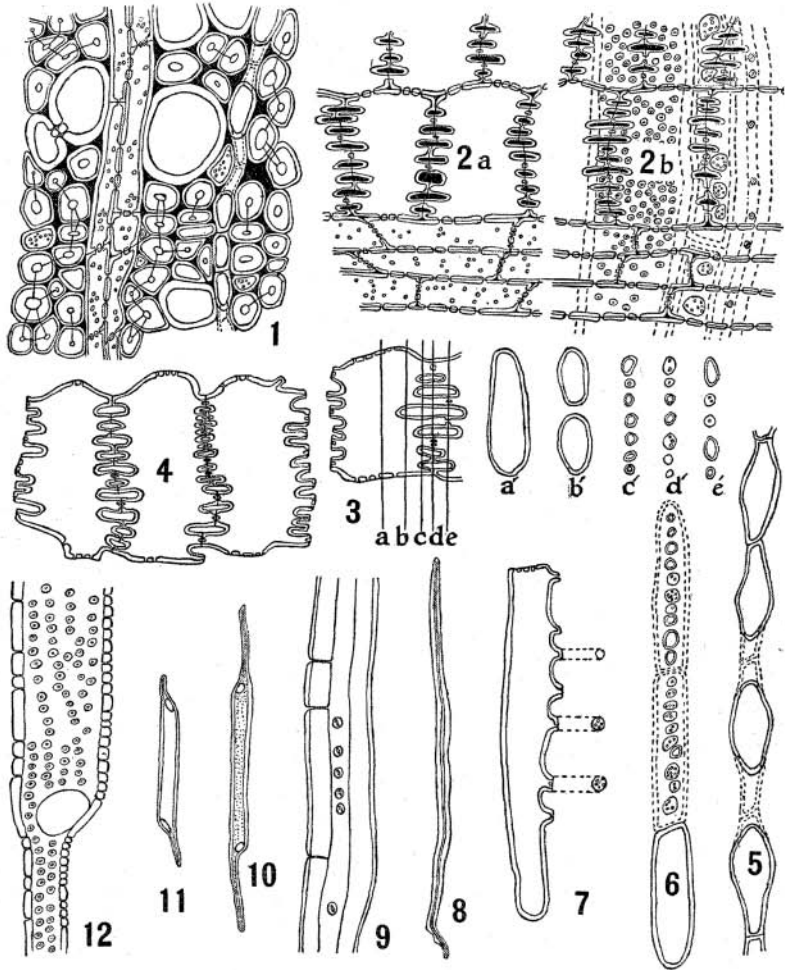

Fig. 3. Structural details of the wood of *Gardenia* sp. from Siam.

:FIG. 3. EXPLANATION OF DRAWINGS

(Siamese boxwood, *Gardenia* sp.)

No. I.-Cross section showing usual appearance of the cells at the junction of two gro\vth rings. Note the ,vood fibers with thick inner mucilaginous layers, a biseriate ray, conjugate cells of a uniseriate ray, a few wood parenchyma cells (3 with pits in end walls), and the thickened middle lamella at the corners of all ,cells. X 300.

No. 2.-a. Radial section of portion of a ray showing conjugate upright cells, and the pits between adjacent ray cells. X 400.

b. Another portion of the same ray, showing the nature of the pitting between the ray cells and the vessels, wood fibers and wood parenchyma. In the latter case, the pits are grouped in the manner characteristic of conjugate cells. X 400.

No. 3.-At the left a conjugate ray cell (and portion of another) as seen on radial section. The five drawings (a' to e') to the right are intended to show how successive sections, first through the body of the cell at a, and then through the processes at b, c, d, and e, would appear in tangential view. X 400.

No. 4.-Radial view of 3 conjugate ray cells from macerated material, showing processes with the thickened middle lamella removed by Shultz's solution. X 400.

No. s.-Uniseriate ray (or uniseriate margin of a ray) as it appears on cross section. Note constrictions of the conjugate cells where the plane of section is through the processes, as well as the isolated appearance of one cell (second from bottom) where the section passes between the processes. The dotted lines indicate the processes which, if.the section is not too thin, may be brought into view by changing the depth of focus of the microscope. X 400.

No. 6.-Tangential section of a uniseriate ray, showing one cell (at bottom) cut through the middle, the other two through the processes and presenting a "cells-within-a-cell" appearance. In several instances the pits in the ends of the processes are sho\vn. X 400.

No. 7.—Terminal conjugate cell of a wood parenchyma strand from macerated material, sho,ving short tubular processes, some of \vhich are projected to show the shape and arrangement of the pits. X 400.

No. 8.-Wood fiber from macerated material. X 50.

No. 9.-Portion of same fiber enlarged to show thick inner mucilaginous wall and the nature of the pitting. X 400.

Nos. 10, 11.-Vessel segments from macerated material, showing simple perforations and the nature of the tips. X 50.

No. 12.—Portion of vessel segment shown in No. 11, enlarged to show details of perforation, pitting, and constricted end. X 400.

BOXWOODS

Minute 'Anato1ny

(See Plate VI, No.2.)

Vessels.-Size of pores, 0.014 to 0.048 mm. (av. 0.032 lum.) tangentially by 0.020 to 0.057 mm. (av. 0.039 mm.) radially. Thickness of walls, 0.002 to 0.006 mm. Length of vessel segments, 0.094 to 0.763 mm. (av. 0.542 mm.), including the tips, which may be up to 0.254 mm. in length. Perforations circular or oval, horizontal to somewhat oblique, exclusively simple. (Fig. 3, Nos. 10, I I, 12.) Intervascular pits minute (max. 0.003mm.), numerous, not crowded, usually in I to 4 vertical rows, borders sub-circular, apertures dot-like or elongated horizontally. (Fig. 3, No. 12.) Vessel-ray pits similar in appearance (radial section), but more or less alternate. (Fig. 3, No. 2b.)

W oodfibers,-Ground mass composed of fiber-tracheids, rounded-polygonal except in one or two rows terminating growth rings, in which case they are flattened-rectangular; usually irregularly disposed; walls 0.004 to 0.010 mm. (av. 0.007 mm.) thick, with distinct gelatinous layer; cavities very small; middle lamella very thick at the corners of the cells, especially in the early wood. (Fig. 3, No. I.) Length of fibers, 0.220 to 1.288 mm. (av. 0.864 mm.); median diameter, 0.013 to 0.025 mm. (av. 0.019 mm.). Pits minute (0.003 to 0.004 mIn.), with distinct borders and slit-like orifices, fairly numerous in both radial and tangential walls and disposed,in rather definite vertical rows usually throughout the entire length of the cells. (Fig. 3, Nos. 8, 9.)

Wood parenchyma.-Diffuse and in interrupted tangential lines, sometimes rather abundant in the narrow and denser late wood, but not terminal. Cells of the same size as the fiber-tracheids, but very thin-walled. (Fig. 3, No. I.) The strands are 0.254 to 0.678 mm. (av. 0.479 mm.) long, compound of 2 to 5, usually 4, long, narrow cells which often are conjugate. (Fig. 1, NO.7.)

Rays.-Decidedly heterogeneous and 1 or 2 cells wide. The uniseriate rays are 1 to 10 cells high, measuring 0.052 to 0.931 mm. (av. 0.241 mm.), and 0.006 to 0.016 mm. (av. 0.012 mm.) wide. The biseriate rays, commonly with uniseriate margins, are 4 to 18 cells high, measuring 0.078 to 0.621 mm.(av. 0.322 mm.), and 0.017 to 0.172 mm. (av. 0.083 mm.) ,vide. The marginal cells are upright and very distinctly conjugate. (Fig. 3, Nos. 2, 3, 4, 6.) In unstained radial sections the conjugate condition suggests irregular thickenings of the vertical "valls, ,vhile differential stains

give these apparent thickenings a resemblance to scalariform bordered pits with the middle lamella appearing as the pit mouth.

Material.-Yale No. 6338 (supplied by Conservator of Forests of Siam); 6338A (trade sample from Japan, supplied by C. H. Pearson & Son Hardwood Co., New York City).

V. SAN DOMINGAN BOXWOOD OF THE FAMILY ULMACEAE

THE FAMILY

THE family Ulmaceae includes about 13 genera and 150 species of trees and shrubs having extensive distribution in both temperate and tropical regions of the world. The best known representatives of the family in the United States are the elms (*Ulmus)* and the hackberry (*Celtis).* The woods of some genera are of much finer texture than these, but only *Phyllostylon,* of tropical America, supplies a minor boxwood of commerce, and it has so far met with little success in the trade.

Phyllostylon brasiliensis Capanema[67]

This is the only species, although its range is known to include portions of Argentina, southern Brazil, Cuba, Hispaniola, Venezuela, Nicaragua, and southern Mexico. (See Plate II.) It is a medium-sized tree, with fine and stiff twigs, small to rather small sparingly toothed leaves, and winged fruits resembling those of maple, except that one of the wings of the pair is aborted.

The wood is one of recent introduction to the trade, first in 1918 coming to the notice of the senior author, who provisionally identified it through comparison with specimens of "palo lanza" from Argentina. This identification was confirmed by a study of twigs from herbarium material in the New York Botanical Garden, collected by Dr. N. L. Britton near Guantanamo, Cuba.

The timber on the market comes from the Dominican Republic where it is called "baitoa," and it appears that the first lot of logs was secured by the J. H. Monteath Company, 202 Lewis Street, New York. The tree is said to be common in the valleys of the Yaque del Norte and the Yaque

67 Synonyms: *Phyllostylon rhamnoides* Taubert and *Samaroceltis rhamnoides* Poisson.

del Sur and also on the low dry foothills and lower mountain slopes, where it attains a height of from 50 to 70 feet and a diameter of from 20 to 24 inches. The trunks are usually irregular and fluted.

In Haiti, where it is known as "bois blanc," it is one of the most common trees in the dry calcareous regions in the western and northern portions of the country and is abundant in the flat and arid regions south of Gonaives. It grows gregariously in open stands, where the trees are of poor timber form, and also in mixture with other trees, where the growth is denser and the trees are taller and of better form. Under these conditions occasional specimens may be seen with trunks 18 inches in diameter, breast high, and clear of limbs for 30 feet. A characteristic feature of the trees, regardless of their associates and the nature of the site, is the abundance of epiphytic plants they support, apparently to their detriment. The timber is not esteemed very highly by the natives and their use of it seems to be limited to the smaller sizes for fence posts and squared timbers for buildings.[68]

Following the publication of the senior author's paper on the *Boxwoods of Commerce*,[69] Mr. G. C. Bucher, of Santiago, Cuba, wrote as follows regarding the occurrence of *Phyllostylon* in his province: "The 'jatia,' as it is called here, occurs on the south coast in this province, growing in almost solid stands on the coastal plains. The largest stand that I have observed is around the mouth of the Guantanamo River. There is another large one at the head of the bay, and another in the lower Yateras Valley. It is very rarely seen in the interior of the island, that is, after passing the first range of hills from the coast. Its principal use here is for firewood for the sugar mills near the coast, and it is not even considered a very good wood for charcoal."

The first intimation to the senior author of the occurrence of this tree in Mexico was supplied by Mr. C. H. Pearson, importer of tropical hardwoods, 29 Broadway, New York, who, in July, 1922, submitted for identification a specimen of "seron" supplied by Mr. Arturo M. Garcia, Monterey, Mexico. Later Mr. Garcia obtained herbarium material, wood samples, and a photograph of the tree, and wrote as follows: "The 'seron' is found in the southern part of Tamaulipas, close to the boundary with the State of San Luis Potosi. Owing to the similarity in climate and soils in the portions of those two states and of Hidalgo which form what is commonly called La Huesteca, I presume the tree is pretty widely distributed in all three states, excepting, of

[68] From information supplied by Mr. C. D. Mell.

[69] RECORD, SAMUEL J.: Boxwoods of commerce. *Bulletin of the Torrey Botanical Club*, 48: 297-306, January 19, 1922.

course, the higher regions in the Central Plateau." A wood specimen of the same species was obtained in 1923 by Mr. C. D. Mell near Tampico, the name being spelled "cerón." In the U. S. National Herbariu|11 at Washingtoll,D. C., there are fruiting spechnens collected at Las Palmas, altitude 300 feet, in July, 1896, by Pringle (No. 7290). The label states that they were taken from a tree, but gives no further data.

Early in the year 1925 Mr. Mell discovered a group of trees of this species near the edge of Lake Managua, Nicaragua, a short distance from Buqueron Station on the railway between Granada and Corinto. He states that he was able to recognize the trees at a distance because of their close resemblance to those previously seen in Mexico and Haiti. Leaf specimens were collected and photographs taken. (See Plate II.)

The existence of *Phyllostylon* in Venezuela was established by the senior author in 1923 from a \voodspecimen (Yale No. 6773) forwarded by Dr. H. Pittier from the collections of the Museo Comercial de Venezuela at Caracas. The structure of the wood of this genus is so characteristic that there is no occasion for a mistake in its identification. The name on the Venezuelan specimen is "membrillo." This discovery has since been confirmed by Pittier.[70]

The species occurs in Argentina in Misiones, Formosa, Chaco, Santa Fé, Salta, Jujuy, and Tucuman, according to Venturi and Lillo.[71] These authors state that it is a tall tree with a straight trunk about I8 inches in diameter, yielding a yellowish, hard, and very elastic wood used in house construction. The tree sheds its leaves during the dry season in Embarcacion and during the winter in Santa Fé. Attention is called to the variations in the appearance of different specimens and these are attributed to differences in climate and soil, but from the fact that some of the Argentine woods in the Yale collections are incorrectly labeled *Phyllostylon,* the present authors are of the opinion that there is a confusion of this tree and certain of the Borraginaceae. SpegazzinF2 says that the tree is about 50 feet high and 30 inches in diameter, the bark wrinkled and showing little fissures of a dark ashy-gray color. The wood, which is noted for its durability, is considered excellent for agricultural implements and for furniture.

70 PITTIER, H.: Les richesses forestieres du Vénézuela et leur exploration. *La Revue Inaustrielledu Bois,* Paris, July J5, 1924, p. 106.

71 VENTURI, SANTIAGO, Y MIGUEL LILLO: *Contribución al Conocimiento de los arboles de la Argentina.* Buenos Aires, 1910, p. 103.

72 SPEGAZZINI, CARLOS: *Maderas.* Exposicion Internacional de Agricultura de 1910, p. 344.

The logs enteringthe New York market are 8 to 12 feet long and mostly 6 to 8 inches in diameter; 12 to 15 logs to the ton. The wood is used to a limited extent for shuttles, rules, knife handles, etc.

COMMON NAMES

San Domingan boxwood,West Indian boxwood (Trade) ;baitoa, bois blanc (Santo Domingo); bois blanc (Haiti); jatia (Cuba); seron, ceron (Mexico) ; membrillo (Venezuela); páo branco (Brazil) ; palo lanza, palo lanza negro?, palo blanco, palo amarillo, ibirá-catú, tala grande?, yvá-si-y guazu? (Argentina).

DESCRIPTION OF THE WOOD

Macroscopic Features

General properties.-Wood hard, heavy, and compact; sp. gr. (air-dry) 0.95; weight about 59 lbs. per cu. ft.; easy to carve and to turn; takes a high polish. Texture fine and uniform; grain straight or fairly so, at times slightly curly or \vavy.

Color deep clear yellow, or in some specimens with pale brownish tinge; sometimes with dark streaks; sapwood thin, pale yellow to whitish.

Odor and taste not distinctive. Aqueous solution is nearly colorless.

Growth rings.-Sometimes fairly distinct to unaided eye as a result of fine lines of terminal parenchyma, or occasionally (especially in No. 971) due to very narrow poreless zones; not infrequently, however, the arrangement of elements is such as to make rings indistinct even with hand lens.

Parenchyma.-Barely visible to unaided eye, but usually fairly distinct under lens, especially on moist cross section; about pores and pore groups and usually connecting them in irregular tangential lines ; also in fine, uniform lines at termination of growth rings.

Pores.—Indistinct without lens, except when filled with whitish deposits, in which cases they appear as minute dots; very numerous; mostly solitary and circular in outline, although frequently in radial groups of 2 to 4, or rarely more.

Vessel lines.-Inconspicuous, except those containing white deposits, which are distinct; very fine ; mostly straight.

Minute Anatomy

Vessels.-Size of isolated pores, 0.017 to 0.065 illm. (av. 0.043 rom.) tangentially and 0.017 to 0.085 mm. (av. 0.048 mm.) radially; ,valls 0.003 to 0.005 moo. thick; deposits of calcium oxalate abundant in certain areas; pitted tyloses present in one specimen (No. 782). Length of vessel segments, 0.102 to 0.238 moo. (av. 0.167 mm.); without overlapping tips. Perforations nearly circular, horizontal or slightly oblique, exclusively simple. Segments are of the same length as the parenchyma strands and lower rays, and are in horizontal seriation with them (tangential section). Intervascular pits are numerous, often crowded, rather large (0.0056 to 0.010 mm.), \vith narrow lenticular apertures tending to coalesce into spirals. Vessel-ray pits simple to indistinctly half-bordered, opposite, of same size as the others.

Wood fibers.-Ground mass coruposed of libriform fibers, in radial rows, the walls thick (0.004 to 0.007 mm.) and composed of a thin outer layer and a thicker gelatinous layer inside. Length of fibers 0.306 to 1.275 moo. (av. 0.815 mm.); diameter 0.010 to 0.018 mm. (av. 0.013 mm.).The pits are simple, slit-like, Obliquely inclined, mostly confined to the median portion of the radial \valls, likely to be obscured by yellowish granular deposits in the heartwood.

Wood parenchyma.-Abundantly developed. Mostly in terminal and numerous metatracheal lines 1 or 2 cells wide, enlarging at the pores. Paratracheal parenchyma is rather sparjngly developed, except in connection with the tangential bands, but in one specimen (No. 971) it forms distinct rings about the pores. In this specimen, also, terminal parenchyma is absent, the growth rings being formed by narrow zones nearly free of pores and parenchyma. Cells thin-\val1ed, slightly wider than the wood fibers. Strands 0.140 to 0.240 moo. (av.o.I80 mm.) long, composed of 2, rarely 3 or 4, cells; strands in horizontal seriation (tangential section), the cells of the different strands usually in secondary seriation, and often conjugate. Substitute, or intermediate, fibers occasionally found.

Rays.-Therays are more or less heterogeneous and vary in width from 1 to 4 cells, mostly 2 or 3. The uniseriate are few, 1 to 10 cells high,measuringo.o28 to 0.186 mm. (av.o.o95 moo.), while the wider ones are 4 to 45 cells high, .0.065 to 0.663 moo. (av. 0.272 mm.). The latter only occasionalIyhave uniseriate margins, varying in heights up to 9 cells (0.164 mm.). As seen on radial sections, most of the cells are procumbent,but in

the margins and sometimes interspersed and occasionally throughout low rays are square or somewhat upright cells, the latter more or lessconjugate. Small rhombohedral crystals are common, usually in fairly distinct vertical rows.

Material.-Yale Nos. 782 (Cuba); 971,1048, 1690,6237 (Argentina); 4456, 4457, 4458, 4458A (Santo Domingo trade samples, J. H. Monteath Co.), 5023 (Santo Domingo, Mr. Durland) ; 5404 (So. Tamaulipas, Mexico, Mr. Garcia), 6994 (Tampico, Mexico, Mr. C. D. Mell) ; 6773 (Venezuela, Messrs. O. Stelling and C. D. Mell).

VI. A VENEZUELAN BOXWOOD OF THE FAMILY RUTACEAE

THE FAMILY

COMPRISING the citrus family are about 110 genera and over a thousand species of trees, shrubs, and a few herbaceous plants, widely distributed throughout the warm and temperate regions of both hemispheres. The most valuable genus is *Citrus,* which includes the orange, lemon, grapefruit, lime, etc. The \voods of the family, of which the orangewood and the East Indian and West Indian satin\voods are the best kno\vn, vary in density from moderately light and soft to very hard, heavy, and fine-textured. The color ranges from white to different shades of yellow and brown. No menlber of this family supplies an important substitute for boxwood, although various woods have been tried with more or less success. A species of *Esenbeckia* of Venezuela was one of the first of the so-called West Indian box\voods, but it has apparently disappeared from the trade. The "páo amarillo," or Brazilian satinwood, *Euxylophora paraënsis* Huber, is sometimes known in the New York market as Brazilian boxwood, but the wood can scarcely be classed as a boxwood substitute.[73]

Esenbeckia Atata Pittier

There are about 25 species of the genus *Esenbeckia* in tropical America, all presumably small or medium-sized trees of little present value for their timber. *Esenbeckia febrifuga* Mart., a Brazilian species, produces a yellow wood suitable for carving and used locally for turnery and for the manufacture of wooden spoons and various domestic utensils.

[73] For description of this wood see RECORD & MELL'S *Timbers of Tropical America.* New Haven, 1924, pp. 323-325.

Esenbeckia Atata Pittier, locally known as "atata' ("ata-ata"), is a medium-sized tree of the dry coastal forests of Venezuela. According to Pittier,[74] it is from 30 to 50 feet in height, with an erect trunk having a maximum diameter of 16 inches. Unlike many of the thorny trees and shrubs with which it is associated, it is unarmed. The leaves are alternate and 3-foliate, the middle leaflet varying in length from 1.4 to 2.4 inches and in breadth from 0.6 to 1.2 inches, the lateral ones being somewhat smaller.

The tree was noted for the first time by Dr. Ernst[75] who referred it to the genus *T'icorea* (Rubiaceae), near *T. nitida.* Pittier *(loc. cit.)* says this \vas evidently a mistake and that there is no doubt as to this plant being a species of *Esenbeckia* of the section Hymenopetalae Engler, and related very closely to *E. febrituga* A. Juss., of eastern Brazil. Ernst states that the tree grows well on coast lands, and that the ha.rd" heavy, fine-textured \vood, of a clear yellow color, is one of the best for fine furniture and inlaid work. Pittier[76] says that the logs were formerly exported to Germany and on a small scale to New York, and could be substituted advantageously for the "zapatero" and "amarillo," were it not so scarce. Dr. Moeller[77] in 1880 listed "atata" as one of the kinds of boxwood regularly exported from Puerto Cabello to Hamburg, being considered next to the "naranjillo" ill quality. The tree grows in association with *Aspidosperma Vargasii* DC., which was evidently one of the first of the Venezuelan boxwoods of commerce, hence it is likely that both these species were included in early shipments. The available published descriptions of West Indian boxwood, however, apply to *Casearia* and not to *Aspidosperma* or to *Esenbeckia.*

DESCRIPTION OF THE WOOD

Macroscopic Features

General properties.-Wood hard and heavy; sp. gr. (air-dry) 1.12; weight 70 lbs. per cu. it.; easy to \vork. Grain mostly rather irregular; texture very fine and uniform.

74 PITTIER, H.: *Contribuciones para la flora de Venezuela, I. Arboles y arbustos de Venezuela.* Caracas, 1921, pp. 7-8.

75 ERNST, A.: *La Exposieion Nacional de Venezuela en I883.* No. 43.

76 PITTIER, H.: *Esbozo de las formaciones vegetales de Venezuela.* Caracas, 1920, p. 24.

77 MOELLER, J.: Ueber das westindische buchsholz. *Dingler's Polyteehnisches Journal,* 238: 59: 62, 1880.

See also LARTS, EUGEN: *Nutzholz liejernde holzarten.* Wien& Leipzig, 1910, p. 149.

Color clear light yellow; uniform.

Odor and taste not distinctive. Aqueous solution practically colorless.

Growth rings.-Distinct to unaided eye; rather irregular; often extremely close; due to fine lines of terminal parenchYlna.

Parenchyma.-Readily visible without lens at termination of growth rings; also faintly about some of the pores and pore groups.

Pores.-Nat visible without lens; minute; numerous; distributed throughout growth rings; solitary or more often in small radial groups of 2 to 4, or occasionally more; apparently all open.

Vessel lines.-Faintlyvisible under lens; very fine; of lighter color than background, due to parenchyma sheaths.

Rays.-Numerous; extremely narrow; invisible without lens on cross section; jlist visible with lens on tangential; very low and scarcely visible on radial surface, being of the same color as the background.

lJlinute Anatomy

Vessels.-Solitary pores sub-circular, those in the interior of the radial groups, square or rectangular, but not much flattened; size, 0.020 to 0.051 mm. (av. 0.034 mm.) tangentially by 0.020 to 0.065 mm. (av. 0.037 mm.) radially; walls 0.002 to 0.006 mm. in thickness. Vessel segments 0.119 to 0.408 mm. (av. 0.280 mm.) long, frequently with short overlapping tips sometimes 0.102 mm. in length. Perforations circular to decidedly oval, horizontal to very oblique, exclusively simple. Intervascular pits minute (about 0.003 mm.), very numerous but not crowded, with narrow-lenticular apertures exceeding the borders and giving a spiral appearance. Vessel-ray pits similar in size and appearance to the others.

Wood fibers.-Ground mass of the wood composed of libriform fibers, irregular in shape and arrangement, with small cavities, thick walls (av. 0.005 mm.), some with rather indistinct gelatinous layer. Pits simple, slit-like, very oblique, indistinct, confined to the enlarged portions of the cells and more numerous in the radial than in the tangential walls. Length of fibers, 0.306 to 1.1bS mm. (av. 0.726 mm.); median diameter, 0.010 to 0.018 mm. (av. 0.014 mm.).

W oodparenchyma.-Sparingly diffuse, irregularly paratracheal, and in terminal lines which are uniseriate except where in contact ,vith pores, in which case they may be 5 cells wide; cells thin-walled, of same size as the

wood fibers. Strands 0.187 to 0.442 mm. (av. 0.302 mm.) long, composed of 2 to 4 (mostly 2) cells each, or chambered and containing numerous small irregular crystals. Cells sometimes indistinctly conjugate. Substitute, or intermediate fibers, occasionally found.

Rays.-Heterogeneous in part, 1 or 2 cells wide. Uniseriate rays 1 to 8 cells high, measuring 0.017 to 0.144 mm. (av. 0.07Imm.), and 0.0056 to 0.014 mm. (av. 0.010 mm.) wide; biseriate, 4 to 9 cells high, 0.076 to 0.211 mm. (av. 0.124 mm.), and 0.014 to 0.025 mm. (av. 0.018 mm.) wide. As seen on radial section, the interior cells of the higher rays are procumbent to square, while the marginal ones and those composing the low rays are more or less upright. The indistinctly upright cells may be some\vhat conjugate.

Material.—Yale No. 443 (Venezuela).

VIT. DOGWOOD, A BOXWOOD SUBSTITUTE OF THE FAMILY CORNACEAE

THE FAMILY

THE family Cornaceae, in the sense used by Sargent,78 consists of ten genera of trees and shrubs of wide distribution, but more numerous in temperate than in tropical regions. The only genus of importance in connection with boxwood is *Cornus*.

Cornus florida Linnaeus

The genus *Cornus*, with nearly 50 species, is widely distributed through the continents of the northern hemisphere, and south of the equator is represented by a single species, a native of Peru. It is said that there isa species in Asia Minor with \vood of exceptional quality, an excellent substitute for boxwood, but not available in sufficient quantity to be of commercial importance. There are 16 or 17 species in the United States, four of which attain the dimensions of trees. The western dogwood, C. *Nuttallii* Aud., attains much larger dimensions than the eastern species, but the wood is practically unknown to the trade.

Cornus florida L., the flowering dog,vood, is a bushy tree, rarely 40 feet

78 SARGENT, CHARLES S.: *Manual of the trees of North America (exclusive of Mexico)*, Boston and New York, 1922, p. 680.

high and 12 to 15 inches in diameter, with rather large opposite leaves and conspicuous \vhite or pink flowers. It is often cultivated or protected in \voodlands for decorative purposes. It grows scatteringly in the forest in the shade of many other kinds of trees throughout most of the eastern half of the United States, and extends into the mountains of northern Mexico; it is at its best, however, in the southern Appalachian region.

This species is associated with boxwood both in use and in name. As stated in the introduction, it has proved to be one of the most satisfactory substitutes for Turkish boxwood in the manufacture of shuttles. It is known in the American trade as dogwood and in England as cornel, although the name American boxwood is sometimes applied to it. In certain parts of the United States the tree has borne the name boxwood, along with that of dog\vood, for more than a century. This name is recorded by Shecut[79] in 1806, and by F. A. Michaux[80] (as applicable in Connecticut) in 1813, while Eaton[81] refers to the tree as fals'e boxwood, placing this name first. Torrey,[82] writing in 1843, says: "The wood, on account of its close grain and hardness, is extremely useful. It is often employed as a substitute for *box,* and is susceptible of a fine polish." According to Boulger,[83] *Cornus florida* is known commercially as cornel and also as boxwood and carnelian wood.

USES OF THE WOOD

Dogwood has many uses, but by far the most important is for weavers' shuttles. (See Plate I'T, NO.2.) Owing to the small size of the trees it is difficult to get material suitable for the largest sizes of shuttles and these are accordingly often made of persimmon (*Diospyros virginiana* L.). The shuttle industry consumes annually about 20,000 cords of dogwood and from 2500 to 5000 cords of persimmon. The center of the industry is in the southern states and the largest remaining supply of the timber is in Mississippi, Alabama, and Georgia. According to estimates of the U. S. Forest Service the total stand of dogwood timber in the United States is about 375,000 cords. A cord of the wood will produce an average of about 350 shuttle blocks.

79 SHECUT, JOHN L. E. W.: *Flora Carolineaensis; or a historical, medical, and economical display 0/ the vegetable kingdom, I.* Charleston, 1806, p. 448.

80 MICHAUX, F. ANDRÉ: *Histoire des arbres forestiers de l'Amerique septentrionale, III.* Paris, 1813, p. 138.

81 EATON, AMOS: *Manual 0/ botany.* Albany, 1817.

82 TORREY, JOHN: *A flora of the state of New York, I.* Albany, 1843, p. 291.

83 BOULGER, G. S.: *Wood.* London, 1908, p. 168.

There are various sizes of shuttle blocks required by the trade, ranging (when thoroughly dry) from 14½″ x 1¾″ x 1½″ to 23″ x 2¾″ x 2½″. Blocks of first quality are quartersa,vn so that a radial line from the pith to the circumference of the log will pass through the middle of the width of the block. They must be straight-grained, and free from knots, black spots, red wood, bark, and checks or splits. Immediately after sawing, each end of the block is painted over or dipped an inch deep in paraffine or paraffine mixed with rosin to prevent checking. Before shipment to the shuttle mill they are stacked up for at least sixty days to permit partial seasoning and the development of imperfections which may not be so easily detected in the green material.

Dogwood has been used to a limited extent for engraving blocks. In 1882, Dr. C. S. Sargent, Director of the Arnold Arboretum, wrote to the Director of the Royal Gardens at Kew, in part, as follows :84 "I have been now for a long time examining our native woods in the hope of finding something to take the place of boxwood for engraving, but so far, I am sorry to say, with no very brilliant success. The best work here is entirely done from boxwood; and some *Cornus florida* is used for less expensive engraving. This wood answers fairly well for coarse work, but it is a difficult wood to manage, splitting or rather 'checking' very badly in drying."

Dogwood has been tried as a substitute for West Indian box\vood in the manufacture of black handles for cutlery. The wood is readily "ebonized," but is very difficult to dry afterward without serious checking and "honeycombing." When dried carefully it serves the purpose well and is much cheaper than boxvvood for this purpose.

COMMON NAMES

Dogwood, flowering dogwood, cornel, flowering cornel, boxwood, American boxwood, false boxwood, dog boxwood, carnelian wood (U.S.A. and England) ; kornelbaumholz, blumen-hartriegel (Gerlnany).

DESCRIPTION OF THE WaoD

Macroscopic Features

General properties.-Wood very heavy, hard and tough; sp. gr. (oven-dry) 0.76 to 0.89 (av. 0.82) (Tenth Census) ; weight 47.5 to 55.5 (av.s!) lbs. per cu. ft.; rather easy to ,york. Grain straight; texture fine and uniform.

84 Boxwood substitutes. *Report on the progress and conditio?! of the Royal Gardens at Kew during the year I882.* Landau; 1884, p. 35.

Color roseate to reddish-brown, sometimes with greenish hue; heart at times of decidedly deeper color than sap,vood and rather sharply contrasted with it.

Odor and taste not distinctive. Aqueous solution rather distinct pinkish-brown.

Growth rings.-Distinct to unaided eye, due to narrow lines of somewhat darker color than background; regular; closely spaced.

Parenchyma.-Present, but not very distinct; faintly visible with lens, especially on moist section, as ,broken tangential ,lines; most numerous toward periphery'of growth rings.

Pores.-Distinct with lens; very small; numerous; well distributed, except in narrow zones terminating growth rings; usually solitary; oval in outline; open.

Vessellines.-Faintly visible to unaided eye; narrow; straight.

Rays.-Numerous; variable in width and height; wider rays very distinct to unaided eye on cross section; readily visible without lens on tangential; on 'radial surface decidedly darker than background and very distinct.

Minute Anatomy

Vessels.-Size of pores, 0.028 to 0.099 mm. (av. 0.061 mm.) tangentially by 0.034 to 0.118 mm. (av. 0.078 mIn.) radially. Vessel segments 0.816 to 1.734 mm. (av. 1.231 mrn.) long, including the overlapping tips, which may attain a length of 0.374 mm. Perforations very oblique, elongated, elliptical, exclusively scalariform, with 20 to 48 bars. (Fig. 1, No.1.) Intervascular pits opposite, more or less elongated and often scalariform, with narrOW-lenticular apertures. Vessel-ray pits similar in size and appearance (radial section) to the intervascular.

Wood fibers.-Ground mass of wood composed of fiber-tracheids, rather irregular in shape, smaller and distinctly flattened in outer late wood, arranged throughout in fairly definite radial rows. Length of fibers, 0.782 to 2.227 mm. (av. 1.530 mm.) ; median diameter, 0.014 to 0.042 mm. (av. 0.022 mm.); thickness of 'vall, 0.005 to 0.012 mID. (av. 0.007 mm.). Pits numerous, irregularly distributed in both radial and tangential walls; aperture narrow and extending obliquely almost to the edges of the distinct and nearly circular border, which is from 0.0056 to 0.009 lum. in diameter.

Wood parenchyma.-Sparingly diffuse and in interrupted tangential lines fairly abundant in late wood; cells as wide as the fibers, sometimes decidedly flattened, especially at termination of growth rings. Strands 0.442 to 0.748 mm. long, composed of 4 to 12 cells which frequently are conjugate.

Rays.-Distinctly heterogeneous and 1 to 7 cells wide. Uniseriate rays, 2 to 32 cells high, measuring 0.051 to 0.901 mm. (av. 0.374 mm.); multiseriate, 5 to 83 cells high, 0.136 to 1.705 mm. (av. 0.738 mm.), and 0.034 to 0.153 mm. (av. 0.068 mm.) wide in middle; usually with uniseriate margins. Most of the interior cells of the larger rays are procumbent, sometimes square in part, while the marginal ones vary from square to palisade, as throughout the uniseriate rays, and rarely are conjugate. Small rhombohedral crystals occasionally noted.

Material.-Various unnumbered specimens in the Yale collection of United States woods.

VIII. FLORIDA BOXWOOD OF THE FAMILY CELASTRACEAE

THE FAMILY

THIS family embraces nearly 50 genera and upward of 400 species of trees, shrubs, and woody climbers, well distributed throughout both temperate and tropical regions of the world. The plants yield very few economic products. The wood of some of the smaller trees in India is employed locally for carving, turnery, domestic utensils, and combs. In China, *Euonymus Sieboldianus* Blume, closely related to the European spindle-tree, *E. europaeus* L., supplies wood for engraving purposes, but it is not exported. *Gyminda latifolia* Urb., a little tree of southern Florida, West Indies, and southern Mexico, is sometimes called false boxwood, but the dark brown or nearly black wood is not used as a substitute for boxwood. *Schaefferia* is so often credited with furnishing some of the so-called West Indian boxwood of the trade that it is described below in some detail, although the authors have no evidence of its being on the market.

Schaefferia frutescens Jacquin

Of the five known species of the genus *Schaefferia,* distributed in the tropical and sub-tropical regions of the New World, one, *Schaefferia frutescens* Jacq., is known as F'lorida boxwood and yellow-wood and supplies

material which, according to Sargent,[85] is sometimes used as a substitute for boxwood in wood-engraving. It is a small tree, rarely 35 to 40 feet high and 8 to 10 inches in diameter, or often a high or a low shrub. Its range includes some of the islands of southern Florida, the West Indies,[86] and Venezuela.

Description of the Wood

Macroscopic Features

General properties.—Wood hard and heavy; sp. gr. (oven-dry) 0.77 (Tenth Census); weight about 48 lbs. per cu. ft.; susceptible of a high polish. Grain straight; texture fine and uniform.

Color clear light yellow; sapwood a little lighter.

Odor and taste not distinctive. Aqueous solution faint yellow-green.

Growth rings.—Mostly rather faintly visible to unaided eye, and often more distinct with lens than under microscope; due to very narrow zone deficient in pores and denser than other portion of ring; closely and fairly uniformly spaced.

Parenchyma.—Apparently absent.

Pores.—Distinct under hand lens; minute; numerous; solitary or more noticeably in short, usually radial, groups of 2 to 4 or more; open.

Vessel lines.—Faintly visible with lens; very fine; straight.

Rays.—Very numerous; narrow; low; visible but not very distinct to unaided eye on cross section; not visible on tangential; on radial surface are of about same color as background, but readily visible without lens.

Minute Anatomy

Vessels.—Size of pores, 0.020 to 0.051 mm. tangentially by 0.020 to 0.059 mm. radially. Vessel perforations exclusively simple. Intervascular pits minute, alternate, with circular borders and slit-like apertures, the latter tending to coalesce. Vessel-ray pits (radial section) similar in size and appearance to the others, though one simple pit of ray cell may correspond to several bordered ones of the vessel.

Wood fibers.—Thick-walled, arranged in regular radial rows, often

[85] Sargent, Charles S.: *Manual of the Trees of North America (exclusive of Mexico)*. Boston and New York, 1922, p. 680.

[86] The name of this species in Santo Domingo is "cabra."

considerably larger and thicker-walled in late \vood, at times more or less flattened. Distinct gelatinous layers sometimes present. Pits mostly confined to radial walls, often very numerous, indistinctly bordered, the apertures narro"v-lenticular. Fibers may be falsely septate by means of thin resin plates.

Wood parenchyma.-Apparently absent.

Rays.-Decidedly heterogeneous; 1 to 4 (rarely 5) cells wide and 2 to 66 cells (0.085 to 1.190 mm.) high; the\vider rays usually with uniseriate margins, which, like the uniseriatelow rays, are composed of square or palisade cells; no conjugate cells observed. Small irregular crystals common in upright cells.

Materia1.-Yale No. 4792 CFlorida); 7453 (Haiti; collected by Dr. W. L. Abbott).

IX. KEYS FOR THE DETERMINATION OF THE BOXWOODS

I. KEY BASED UPON CHARACTERISTICS OF THE BARK

a. Bark very thin, usually less than 1/16 inch; color gray or greenish-gray.
  a¹. Bark not laminated; does not break off in flakes; somewhat corky in large specimens. TURKISH BOXWOOD) *Buxus sempervirens* L.
  b¹. Bark distinctly laminated; breaks off in irregular flakes leaving spots that are reddish-brown \vhen fresh; not corky. SIAI\1ESE *BoxwooD) Gardenia* sp.

b. Bark rarely less than 1/8 inch thick; usually thicker.
  a¹. Bark with distinct vertical ridges suggesting white ash.
    a². Inner layer rather thick and conspicuously darker than outer corky one; surface of outer bark light-colored. Thickness 1/8 to 1/4 inch. EAST LONDON BOXWOOD, *Buxella Mac-Owanii* (Oliv.) Van Tiegh.
    b². Inner layer thin and inconspicuous; surface of outer bark dark-colored. Thickness 1/8 to 3/16 inch. BALEARIC BOXWOOD) *Buxus balearica* Lam.
  b¹. Bark not in distinct vertical ridges.
    a². Resin ducts present; contents exuding and staining end of logs in fresh material. Inner bark with distinct wedge-shaped rays and concentric zones; outer bark reddish-bro\vn to gray, often flaking off irregularly_ Thickness 1/8 to 3/16 inch. ZAPATERO or WEST INDIAN BOXWOOD) *Casearia praecox* Gris.

b^2. Resin ducts absent; ends of logs not stained by exudations.

as. Bark chaffy; fairly distinctly two-layered, the outer yellow on cross section, but dark gray on unbroken surface; the inner one bro\vn; not laminated; rays indistinct. Thickness about ¼ inch. KAMASSI or KNYSNA BOXWOOD) *Gonioma Kamassi* E.Mey.

b^3. Bark not chaffy.

a^4. Outer bark reddish-brown; broken into small checkered plates; inner bark pinkish; not laminated; rays rather coarse and fairly distinct. Thickness ⅛ to ⅜ inch. FLOWERING DOGWOOD, *Cornus florida* L.

b^4. Outer bark gray; not broken in small checkered plates; rays very fine and scarcely distinct.

a^5. Inner bark decidedly yellow; not laminated; inner surface smooth; no ripple marks; outer bark much thinner, composed of alternating light and dark laminations; outer surface shows irregular, very shallow vertical fissures and short horizontal ones; irregularly splotched. Thickness about ¼ inch. AMARILLO, *Aspidosperma Vargasii* DC.

b^5. Inner bark pale brown; very finely laminated; rays with coarse irregular wedge-shaped patches extending from outer surface to varying depths; inner surface often with conical or ridge projections; ripple marks fairly distinct with lens; outer surface rough, suggesting sugar maple in old specimens. l'hickness 3/16 to 7/16 inch. SAN DOMINGAN BOXWOOD, *Phyllostylon brasiliensis* Cap.

2. KEY TO THE PRINCIPAL BOX\VOODS, BASED UPON MACROSCOPIC FEATURES OF THE WOOD

A. Parenchyma not visible, although flattened fibers at outside of late wood at times appear as more or less distinct lines of terminal parenchyma. Pores open.

a. Pores mostly solitary. Growth rings usually due to narrow zones deficient in pores.

a^1. Color of wood clear light yellow; taste more or less bitter. TRUE BOXWOOD) *Buxus* spp.; CAPE BOX\VOOD, *BuxeZla Mac-Owanii* (Oliv.) Van Tiegh.

b^1. Color of wood whitish, with faint brown tinge; not yellow; taste not bitter. SIA1\1ESE BOXWOOD, *Gardenia* sp.

b. Pores mostly in radial rows of 2 to 4 or more. Growth rings not due to poreless zones, but to flattened fibers at outside of late ,vood. Color of \vood clear light yello\v, or nearly white. ZAPATERO or WEST INDIAN BOXWOOD} *Casearia praecox* Gris.

B. Parenchyma distinct under lens; in numerous, irregular tangential lines.

a. Many vessels filled with white deposits of calcium carbonate, which effervesce in contact with hydrochloric acid. Pores mostly single, although often in radial groups of 2 to 4. Parenchyma about pores and pore-groups and usually connecting them in irregular tangential lines; also in fine terminal lines. Ripple marks visible with lens on moist tangential section, although not very distinct. Color deep clear yellow, sometimes with pale brownish tinge. Wood without, distinctive taste. Aqueous solution practically colorless. SAN DOMINGAN Boxwood, *Phyllostylon brasiliensis* Cap.

b. Vessels frequently contain reddish-brown to black deposits. Pores mostly solitary; not in noticeable radial rows. Parenchyma in very numerous, fine, closely spaced, tangential lines; usually independent of pores. Ripple marks absent. Color mostly deep yellow, with slight greenish or orange tinge. Wood with pronounced bitter taste. Aqueous solution distinctly greenish-yellow. KAMASSI or KNYSNA BOXWOOD} *GoniomaKamassi* E. Mey.

3. KEY TO ALL OF THE WOODS DESCRIBED} BASED UPON THEIR MINUTE ANATOMY

A. Perforations scalariform. Rays heterogeneous.

a. Rays 1 to 4 (in most instances 1 or 2) cells wide; less than 40 cells high.

a^1. Fiber pits with indistinct borders. Perforations usually with 8 or more bars.

a^2. Perforations rarely with more than 13 bars.

a^3. Rays frequently over 20 cells high (max. noted, 36 cells). Perforations with 5 to 15 (mostly 10 to 12) bars. *Buxus sempervirens* L.

b^3. Rays only occasionally over 15 cells high (max. noted, 22 cells). Perforations with 6 to 13 (mostly 8 to 11) bars. *Buxus balearica* Lam.

b^2. Perforations usually with morethan 13 bars.

a³. Rays usually less than IS cells high (max. noted, 18 cells); 1 or 2 cells\vide. Perforations with 9t024 (mostly 14 to 21) bars. *Buxus microphylla* S. & Z., var. *japonica* R. & Z.

b³. Rays frequently over IS cells high. Perforations with not over 20 bars.

a⁴. Rays only occasionally triseriate; up to 27 cells high. Perforations with 12 to 20 (mostly IS or more) bars. *Buxus Wallichiana* Baili.

b⁴. Rays very frequently 3 (occasionally 4 or 5) cells wide; up to 31 cells high. Perforations "vith 8 to 20 (mostly 14 to 19) bars. *Buxus microphylla* S. & Z., var. *sinica* R.& W.

b¹. Fiber pits with distinct borders.

a². Perforations \vith 2 to 10 (mostly 4 to 8) bars. Rays mostly uniseriate; up to 16 cells high. *Buxella Mac-Owanii* (Oliv.) Van Tiegh.

b². Perforations ,vith 11 to 40 (mostly 20 to 36) bars. Rays mostly biseriate; up to 23 cells high. *Notobuxus natalensis* Olivo

b. Rays 1 to 8 cells wide; 2 to 80 cells high. Perforations ,vith 20 to SO bars. Intervascular pits scalariforln. C*ornus florida* L.

B. Perforations simple.

a. Wood parenchyma absent or very rare. Rays decidedly heterogeneous; T to 4 cells wide; crystals common.

a¹. Pores usually in radial groups of 2 to 10 (mostly 2 to 4). Fiber pits simple, distinct. Rays 1 to 77 cells high. *Casearia praecox* Gris.

b¹. Pores mostly in radial groups of 2 to 5. Fiber pits indistinctly bar.. dered. Rays 2 to 66 cells high. *Schaefferia frutescens* Jacg.

b. Wood parenchyma present and distinct.

a¹. Rays normally homogeneous; 1 or 2 cells wide (mostly 1) ;lt025 cells high. Fiber pits distinctly bordered. *Aspidosperma Vargasii* DC.

b¹. Rays heterogeneous.

a². Pores usually solitary, occasionally in groups of 2 or 3. Fiber pits distinctly bordered. Parenchyma cells mostly 4 per strand.

a³. Rays 1 to 6 (mostly 1 to 4) cells ,vide; 1 to 47 (seldom over 34) cells high. *Gonioma Kamassi* E. Mey.

b³. Rays 1 to 2 cells wide; 1 to 18 cells high. *Gardenia* sp.

b². Pores mostly, or very frequently, in short radial groups of 2 to 4, or occasionally more. Fiber pits shnple and indistinct.

as. All elements, except higher rays, distinctly storied. Parenchyma diffuse, terminal (1 or 2 cells wide) and metatracheal (1 to 4, or more, cells wide, often embracing pores); mostly 2 cells per strand; crystals absent. Rays 1 to 4 (mostly 2 or 3) cells wide; 1 to 45 cells high; crystals of frequent occurrence. *Phyllostylon brasiliensis* Cap.

b^3. Elements not storied. Crystals commonly present in chambered parenchyma strands; absent in ray cells.

a^4. Rays 1 or 2 cells wide; 1 to 9 cells high. Parenchyma diffuse and terminal (1 to 5 cells wide, mostly 1); longitudinal strands composed of 2 to 4 (mostly 2) cells. *Esenbeckia Atata* Pittier.

b^4. Rays 1 to 3 (mostly 2 or 3) cells wide; 1 to 30 cells high. Parenchyma diffuse and metatracheal (1 cell wide); longitudinal strands composed of 4 to 8 cells. *Sideroxylon* Spa

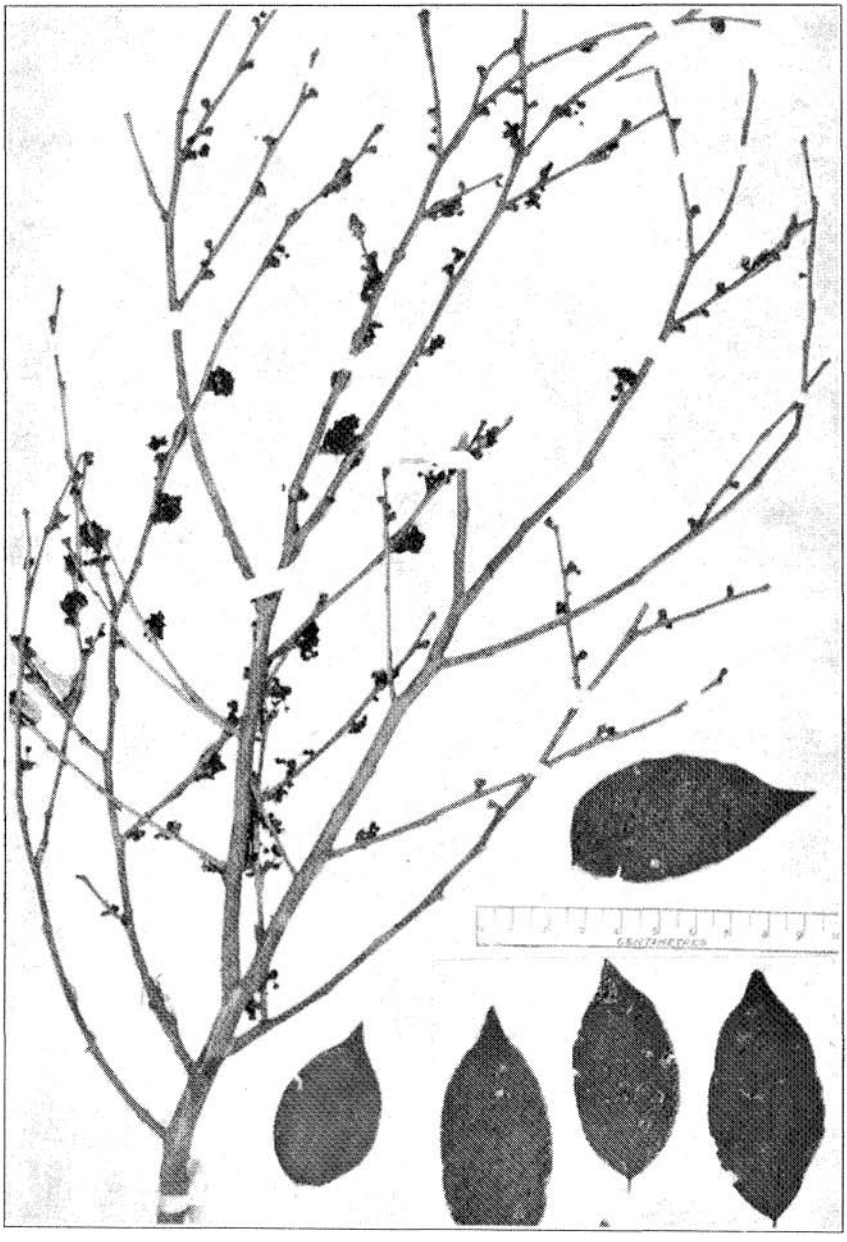

Plate 1. Leaves and flo\vering Twigs of *Casearia praecox* Grisebach fronl Maracaibo, Venezuela.
(Herb. lIort. Bot. Reg. Kew. See *Kew Bulletin,* 1914, p. 214.)

Argentina Haiti Costa Rica Mexico

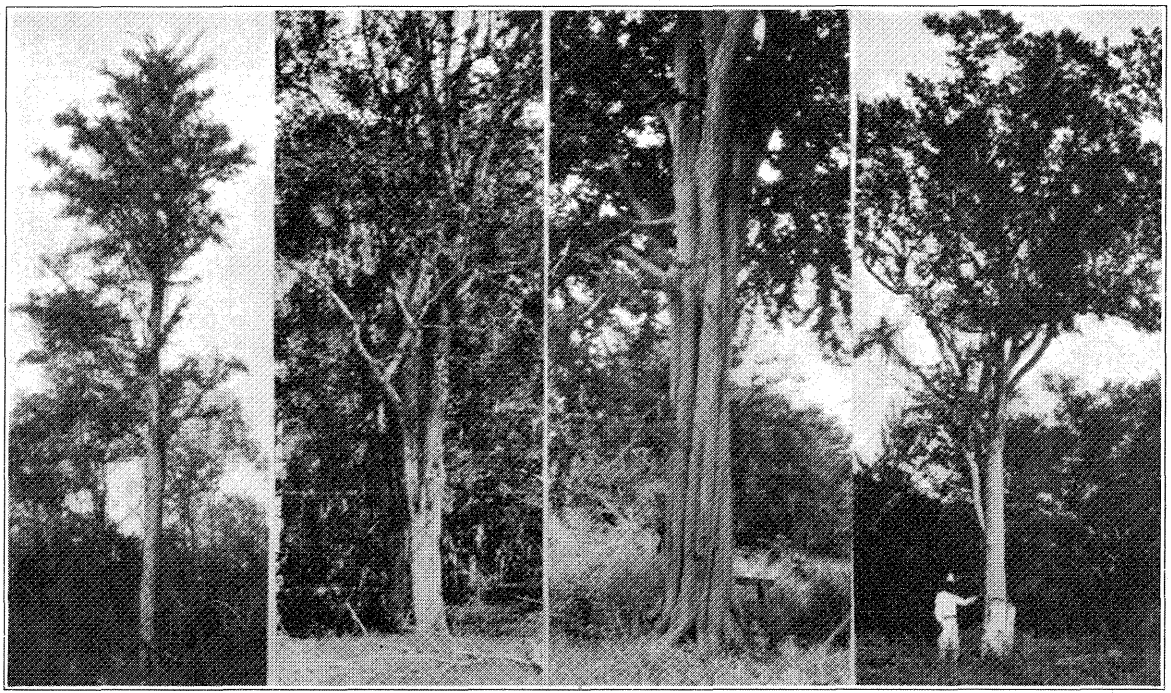

Photo by Curran *Photos by Mell* *Photo by Garcia*

Plate II. *Phyllostylon brasiliensis* Capanema.

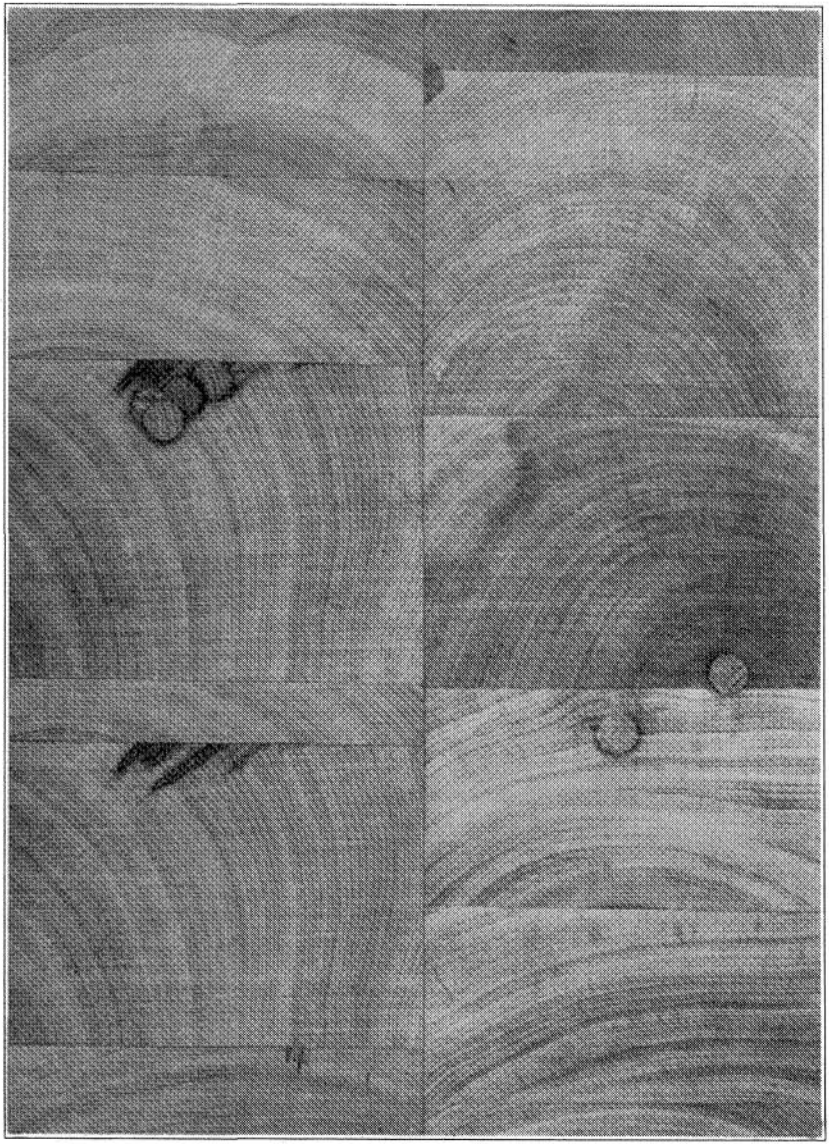

Plate III. Portion of built-up engraver's block ofbox\vood. (Nat. size.)
(Third quality, showingplugs and stains.)

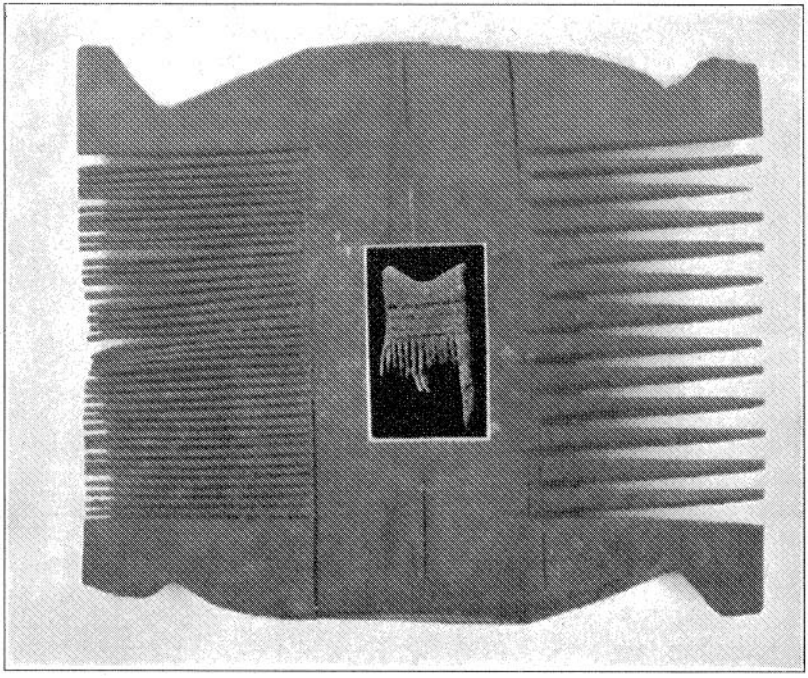

Plate IV, No. 1. Graeco-Roman conlb of boxwood; J 700)'rs. old. (Nat. size.) (In Haskell Oriental Museum, University of Chicago.) Inset: Boxwood comb of Early Egyptians. (½ nat. size.) (In Metropolitan Museum of Art, New York.)

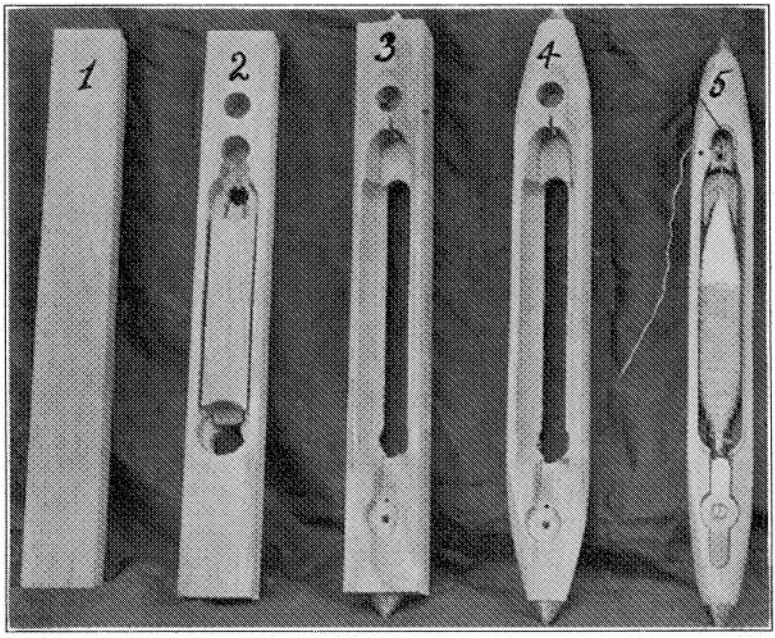

Plate IV, NO.2. Five stages in the manufacture of a shuttle. (⅕ nat. size.) (Nos. 1-4, persimmon; No. 5, dogwood.)

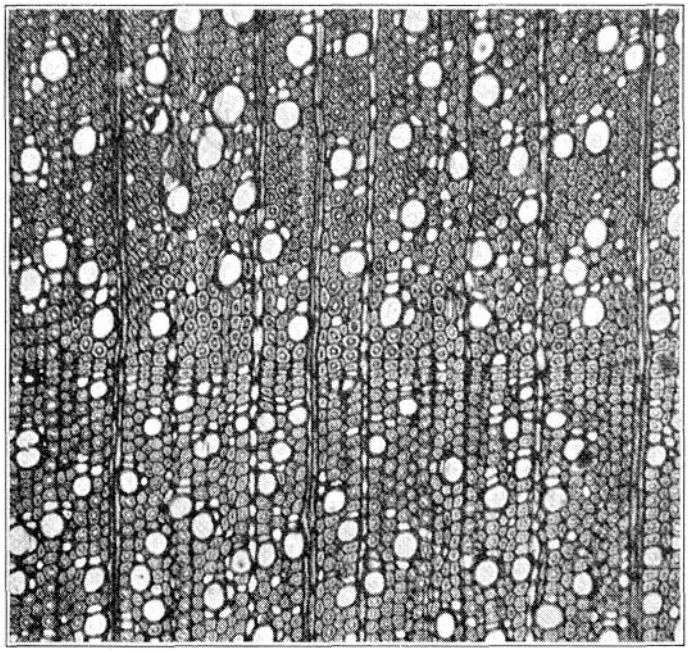

Plate V,No. 1. Cross section of the wood of *Buxus sempervirens* Linnaeus. (X 100.)

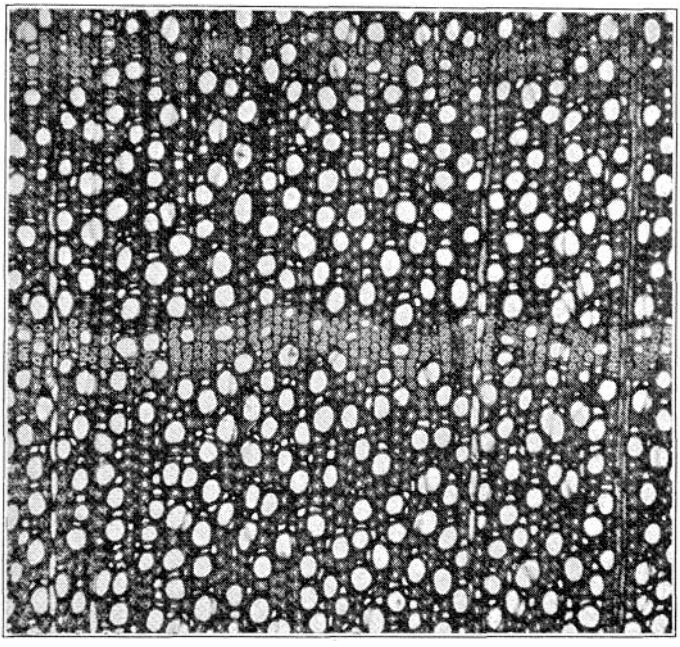

Plate V, No. 2. Cross section of the wood of *Buxella Mac-Owanii* (Oliv.) Van l'ieghern. (X. 100.)

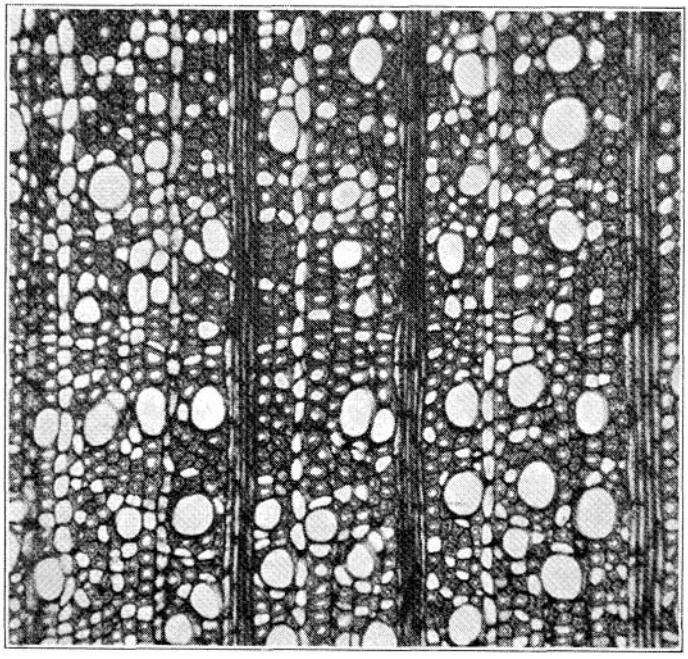

Plate VI, *No.* 1. Cross section of the wood of *Gonioma Kamassi* E. Meyer. (X 100.)

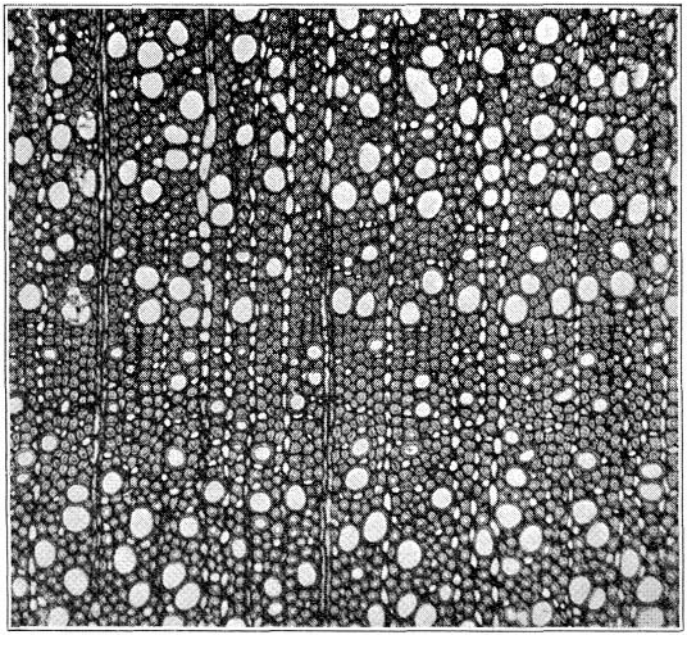

Plate VI, NO.2. Cross section of the wood of *Gardenia* sp. from Siam. (X 100.)

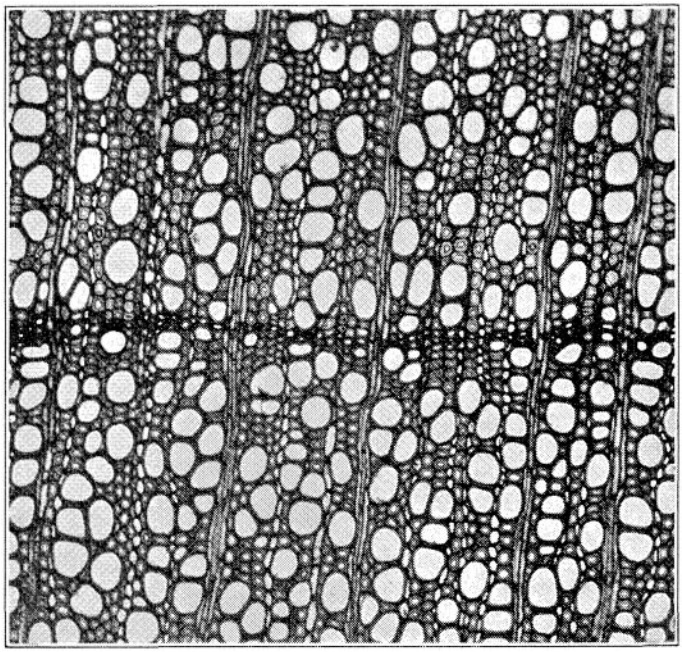

Plate VII, No. 1. Cross section of the wood of *Casearia praecox* Grisebach. (× 100.)

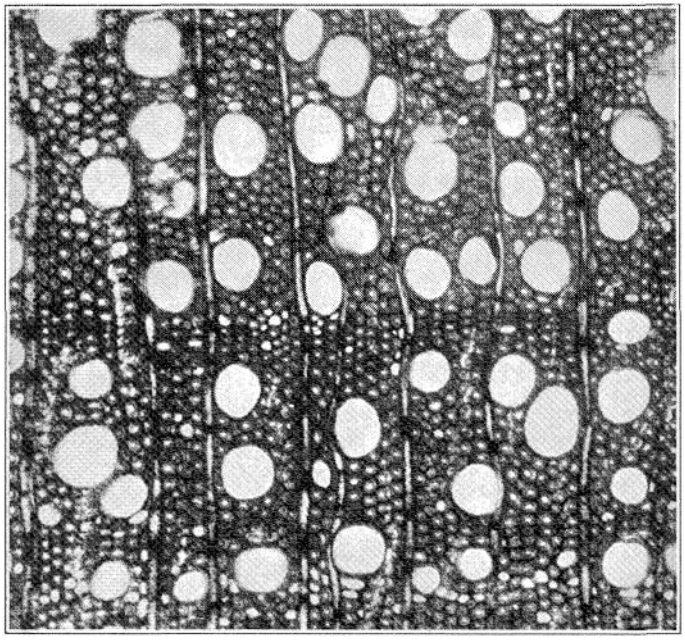

Plate VII, No. 2. Cross section of the wood of *Aspidosperma Vargasii* De Candolle. (X JOo.)

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