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THE FORESTS OF THE PHILIPPINES

PART I

FOREST TYPES AND PRODUCTS

BY

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FORESTER, CHIEF OF DIVISION OF INVESTIGATION

DEPARTMENT OF THE INTERIOR
BUREAU OF FORESTRY

BULLETIN NO. 10

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MANILA, *November 11, 1910.*

SIR: I have the honor to transmit herewith the report entitled "The Forests of the Philippines," by H. N. Whitford, Ph. D., forester, chief division of investigation, and to recommend its publication as Bulletin No. 10 of this Bureau. It consists of two parts for separate publication, Part I, "Forest Types and Products," and Part II, "The Principal Forest Trees." It has been prepared in response to a strong and increasing demand for information concerning the forest resources of the Philippines.

Very respectfully,

GEORGE P. AHERN,
Director of Forestry.

The honorable,
The ACTING SECRETARY OF THE INTERIOR, *Manila.*

EQUIVALENTS OF THE METRIC AND ENGLISH SYSTEMS OF MEASUREMENTS USED IN THIS BULLETIN.

1 inch equals 25.4+ millimeters (approximately 25).
1 foot equals 0.3048+ meter (approximately 0.3).
1 mile equals 1.609+ kilometers (approximately 1.6).
1 centimeter equals 0.3937+ inch (approximately 0.4).
1 meter equals 3.28+ feet (approximately 3.3).
1 kilometer equals 0.62+ mile (approximately 0.6).

1 acre equals 0.404+ hectare (approximately 0.4).
1 hectare equals 2.47+ acres (approximately 2.5).
1 square mile equals 259 hectares (approximately 260).

1 cubic foot equals 0.028+ cubic meter.
1 cubic meter equals 35.314+ cubic feet.

THE FORESTS OF THE PHILIPPINES: PART I.

THE FOREST TYPES AND PRODUCTS.

INTRODUCTION.

The object of this bulletin is to bring together the most important facts concerning the forests of the Philippines and the exploitation of their products. Nontechnical terms have been used whenever possible. The estimates of areas of the different types of vegetation are based upon rough reconnoissance work on a large scale. The estimates of standing timber are based upon the results of rough cruising over large areas, supplemented by intensive valuation surveys over certain small selected stands. The figures given for the total area covered by virgin forests are known to be conservative; and the division of this area into the different types or groups of types is a rough estimate which will be subject to revision when more data have been collected.

Throughout the work emphasis has been laid on the importance of the dipterocarp family; for in spite of the richness of the Philippines in fine furniture woods, the real wealth of their forests consists of construction timbers, such as are represented by the lauans, apitongs, and yacals—all belonging to the dipterocarp family. It is estimated that the dipterocarps include about 144 out of a total of the 200 billion board feet of standing timber in the Islands. Not only is the total amount great, but the members of this family occur in stands sufficiently heavy to be exploited by the use of machinery. The predominance of this family needs emphasis because it is the general belief that the Philippines and the Tropics in general produce only woods of the mahogany and teak grades.

In Part II of this bulletin popular descriptions are given of 106 trees, or all the principal timber trees whose lumber finds a place of some prominence in the markets. Brief mention is made of some 277 other trees that are found commonly in the forests or are cultivated for ornament or for fruit. While this is a very small proportion of the estimated 2,500 or more trees in the Islands, yet it includes practically all the large trees except those of a few families like the Sapotaceæ, Meliaceæ, and Myrtaceæ, whose wood, if it reaches the markets, will probably be classed with some which are already known. All the species, even of the dipterocarps, have not been described because of insufficient data. The unexplored portions of Mindanao will undoubtedly furnish some species that are not as yet known on the markets. It must be remembered that a large number of the estimated 2,500 trees are small; many even in the mature state will not reach a size of 5 meters in height; others are not over 10 meters; and a large number of greater height have either ill-formed short trunks, or produce wood so soft that it will never occupy more than an inferior place in the markets.

Most of the descriptions of the species given in Part II were made in the woods from living trees; and the work was later supplemented and checked by wood and herbarium specimens. The description of the reproductive parts has been omitted altogether, and the form of the leaf can be found in the illustrations. A ranger, forester, or lumberman is called upon to pass judgment upon the trees of the forest that are not in flower and fruit, and if he is to have a working knowledge of the forest he must get it from bark, leaf, or wood characters. Many Filipino woodsmen are keen in distinguishing the forest trees, and to one who first enters the forest their aid is well-nigh indispensable. But it is nevertheless true that their determinations should be constantly subject to check. It should be borne in mind by those who wish to obtain some notion of the varieties and amount of each kind of timber on a given tract that while the forest as a whole is exceedingly complex, yet if the merchantable timber alone is considered, it is comparatively simple. The author has collected 80 different tree species on 1 acre which contained representatives of only two species that reach merchantable size when mature. This of course is an extreme case. The chances are great that for any given tract of forest there will not be more than 15 or 20 species of merchantable kinds. Thus, while the tract may contain 150 to 200 tree species, yet from the lumberman's point of view about nine-tenths of them may be discarded from further consideration by size alone.

In the descriptions, and throughout the text, a number of relative terms are used. For example, as regards size: "Very large" trees are those above 40 meters (134 feet) in height; "large," from 31 to 40 meters (100 to 134 feet); "medium," from 21 to 30 meters (68 to 98 feet); "small," from 11 to 20 meters (36 to 66 feet); "very small," 10 meters (32 feet) and under. While it is probable that there are trees in the Philippines that will reach a height of over 70 meters (230 feet), yet the largest tree measured to date shows 61 meters (200 feet). Very few species will reach a diameter of more than 180 centimeters (6 feet), measured above the root buttresses. The use of the relative terms "hardness" and "weight" is explained in another connection. (See p. 41, Part I.)

The terms "abundant" and "scattered," with qualifying adverbs, are used throughout the text to express the amounts of each kind of timber in the forests. The impression is apt to prevail that because a timber is abundant in the market it is abundant in the woods. Thus, during the fiscal year 1909–10, there were manifested 13,717 cubic meters of ipil, and 20,764 cubic meters of apitong, yet the relative proportion of the amounts cut does not give anything like a true idea of the proportionate amounts of standing timber of the two kinds; for there is probably more than one hundred times as much standing timber of apitong in the Islands as of ipil. The word "abundant" in reference to a species indicates that there are at least four trees to the acre, and that the stand extends over large areas. This restricts its use only to certain members of the dipterocarp family. Thus, one large tract of approximately 40,000 acres, shows the following number of trees 16 inches and over in diameter, per acre, all belonging to the Dipterocarpaceæ:

Apitong	7.77
Almon-lauan	6.55
Tanguile	4.59
Red lauan	8.45

It is very doubtful that there is a single tract of timber in the Islands of 1,000 acres that will contain an average stand of even two trees of ipil to the acre. A yacal forest in Mindanao, covering an area of approximately 4,000 acres, shows a stand per acre of 2.9 trees of lumbayao (belonging to the Sterculiaceæ or dungon family) 16 inches and over in diameter; and a lauan-hagachac forest in Mindoro, comprising about 3,500 acres, contains an average per acre of 1.93 trees of narra. On certain small definite areas, however, these and similar species often are found in relative abundance.

Durability, another relative term, is the most important quality of timber for use in the Tropics. In a general way it is associated with hardness and weight, yet there are important exceptions. For instance, calantas is classified as a soft wood, yet it is durable; on the other hand, many woods classified as hard and heavy, decay rapidly when exposed to soil or weather. It has been found impossible to arrange a table showing the relative durability of the principal timbers, because of the lack of sufficient data. Available data are referred to in the discussion of the woods in Part II and on page 37 in Part I.

In Part II there is given all the available information on the silvicultural characteristics of each species, especially concerning the relation to light and to soil moisture. More or less ill-defined rings of growth are associated with those species which are wholly or partly deciduous and which are intolerant of shade. The two most important tree families in the Philippines, the narra and dipterocarp families, show remarkable contrasts as regards their light relations. The members of the former family are light loving, those of the latter are tolerant of shade. The quality of the dipterocarps, which permits them to bear shade, is thought to be the main cause of their success in occupying large areas in the better soils.

In the United States the contents of round logs are generally measured in board feet. This does not show the entire contents of the logs, but an estimate of the amount of manufactured lumber that can be obtained from them. The logs are measured in the round, and from log rules the number of board feet a log of given dimensions will yield is estimated. Depending on the size of the log, these log rules show that for every cubic foot of timber in the round, approximately 4 to 8 board feet can be obtained. The average is usually taken as 6 board feet. In the Philippines the measurements and forest charges are based on the solid contents of the round logs in cubic meters. This can be expressed in board feet by using the following transposing factors: 1 cubic meter of round timber is taken as equivalent to 250 board feet, or 4 cubic meters as equivalent to 1,000 board feet. This is practically equivalent to stating that 1 cubic foot will yield 7 board feet, or 7.08, to be exact.

In this bulletin the stands of timber are expressed in cubic meters per hectare. To transpose this figure to an equivalent in board feet per acre, it is only necessary to multiply by 100. This factor is obtained by taking 250 board feet as equivalent to 1 cubic meter, and 2.5 acres as equal to 1 hectare. There are really 2.471 acres in 1 hectare, and if this exact figure were used, the transposing factor would be 101.17.

Special credit is due Mr. H. M. Curran, of this Bureau, for assistance in collecting data for the maps and wood specimens for the working museum; to Mr. E. E. Schneider, also of this Bureau, for aid in classifying the uses of the woods, determining their gross characteristics, and for revising the spelling of the common names; and to Mr. Elmer D. Merrill and other botanists of the Bureau of Science for aid in referring the tree species to their scientific names.

CLASSES OF VEGETATION.

1. General.

There is little question that practically the entire land area of the Philippines, from sea level to the highest mountains, was originally covered with unbroken forest growth of some kind. The following represents the present classes of vegetation, with the estimated area of each:

Table 1.

Classes of vegetation.	Area (square miles).	Percentage.
Virgin forests	40,000	33⅓
Second-growth forests	20,000	16⅔
Grass lands	48,000	40
Cultivated lands[a]	12,000	10
Total	120,000	100

[a] It is difficult to estimate, even roughly, the area under cultivation. The above is probably not far from the total amount that has been cultivated some time within the last twenty years. Probably less than half of this is actually under cultivation at any one time.

Put in another way, the land area of the Philippines is about equal to that of the State of New Mexico, while the virgin forest area is approximately equal to the entire area of the State of Kentucky.

2. Grass Lands.

The large grass areas, called *cogonales*, are covered principally with two species—cogon grass (*Imperata exaltata*) and talahib (*Saccharum spontaneum*). Such areas are known as *cogonales*. They are mainly the result of a shifting system of agriculture, which is prevalent throughout the Tropics and known in the Philippines as caingin making.[1]

Cogonales originate in the following manner, and remain as such so long as fires prevail. Usually a small portion of original or second-growth forest is cut during the dry season, the timber and brush are allowed to dry, and are then partially burned. The area thus prepared is planted with rice, sweet potatoes, corn, or other crops. Cultivation then practically ceases, and the jungle growth, consisting of grass, weeds, and tree species, quickly gains ascendancy over the planted crops, and at the end of the first, second, or third year the caingin maker abandons his clearing for a new one in another patch of forest. If the jungle growth is set on fire, as is frequently done, nearly all plants except the grasses are killed. In this way through many years vast areas of forest lands have been converted into *cogonales*, and repeated firings have prevented any change in their vegetation. Abandoned areas, formerly more intensively cultivated, have also become changed to grass lands in the same way. It is surprising how quickly this grass will become dry enough to burn. Three or four rainless days will permit it to burn with sufficient heat to kill nearly all the seedlings of woody species. Grass lands are prevalent on land of nearly all types of topography, from sea level to the tops of the mountains. In the pine region of central and northern Luzon other species of grasses frequently take the place of the cogon, although these grass lands originated in the same way.

The grass lands are a detriment rather than a help to agricultural development. They seem to be the favorite breeding places of grasshoppers which frequently destroy growing crops. It is very expensive to bring them under successful cultivation, for they form dense masses of roots and underground stems which several plowings will not entirely kill. Many Filipino farmers prefer to prepare for cultivation the land covered by virgin or second-growth forests. Indeed, in some instances they will first plant a grass area with seeds of some small rapid-growing trees, allow them to grow and shade out the grass, then cut and burn the wood, and plant their crops. The cogon grass is so coarse that it can not be considered a good forage crop unless it is kept closely cropped, in which case other grasses better for forage gain a foothold.

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[1] Known in India as taungyas.

3. Second-Growth Forests.

The 20,000 square miles of second-growth forests in the Islands, like the grass lands, are due in the main to the caiñgin system of agriculture. If fires are not started when the caiñgin is abandoned, the woody species quickly gain the ascendancy and shade out the little grass that has obtained a foothold. Here, as in temperate regions, certain species of little value enter the freshly deforested regions, giving rise to subtypes of forest known under the Tagalog name of "calaanan," the Visayan name of "late," and the Moro name of "boog." On freshly exposed soil, the first stages of this reforestation process are remarkably similar throughout the Islands. At first, the composition is very simple, being made up principally of the following species: Hamindang (*Macaranga bicolor*), binunga (*Macaranga tanarius*), hinlaumo (*Mallotus ricinoides*), alim (*Mallotus moluccanus*), and balanti (*Homalanthus populneus*), all belonging to the Euphorbiaceæ; anabion (*Trema amboinensis*), belonging to the Ulmaceæ; and anilao (*Columbia serratifolia*), belonging to the Tiliaceæ. For small areas, sometimes one—sometimes another—of these trees are found in almost pure stands. This is particularly true of hamindang, binunga, anabion, and balanti. All these trees are capable of producing seeds within a year or two after germination. Some are edible, and are thus quickly scattered by birds and animals; others have fruits adapted to wind distribution. Most of them mature early, are light loving, and are replaced by a more complex stand, composed of shade-enduring species. Ultimately, these second-growth forests may redevelop into forests whose composition is much like that originally destroyed.

In the natural reforestation of the grass lands, another set of species first gains entrance. In the high regions of central and northern Luzon, the Benguet pine (*Pinus insularis*) is the pioneer species. In the lowlands among those that first gain entrance are binayuyu (*Antidesma ghaesembilla*), alibangbang (*Bauhinia malabarica*), duhat (*Eugenia jambolana*), acleng-parang (*Albizzia procera*), and others. The first two of these are especially able to resist the effect of fires, and thus can occur as scattered trees through the grass lands. When fires are checked for several years, these trees often form the centers for closed stands, and eventually cover large areas. These subtypes become gradually more and more complex, the rapidity of the process depending on their distance from seed-bearing trees, and of course the composition varies according to the character of the species of the seed-bearing centers. Thus so many subtypes exist that it is difficult to make generalizations. Advance stages in the development of second-growth forests are so mixed with tangles of climbing bamboo and other vines that they are difficult to penetrate. Such forests often cover large areas, and are the so-called jungle growths of the Philippines. They often alternate with patches of grass, with which they make the vegetation known as *parang*. Forest fires such as exist in drier portions of the Tropics and in temperate regions do not exist in the Philippines. Surface fires run through the pine forests, destroying young trees and injuring somewhat the older ones. Outside the pine regions there are practically no forest fires, only "prairie" fires and burnings of timber that has been felled previously. These may injure the edge of the original forests, but do not penetrate them and produce conflagrations such as are known in the coniferous forests of the temperate regions. The *parang* districts often show kaleidoscopic changes, due to the rapid development of jungle growth where the fires are checked and the entrance of grass or second-growth forests in newly abandoned caingins. In the more thickly settled portions of the Islands, and along well-traveled trails, practically all the original forests have disappeared, giving place to grass or second-growth forests. The second-growth forests are seen by the average traveler, and have conveyed the wholly wrong impression that the forests of the Philippines, and, it is believed, of the Tropics in general, are a densely overgrown mass of inpenetrable jungle. Little is seen of the original forests of the interior, for the jungle growth on its borders tends to discourage efforts to penetrate within. Over one-half (approximately 68,000 square miles) of the area of the Islands is covered with grass or with second-growth forests. The prevention of further destruction of the virgin forest, and the reforestation of the grassy regions on nonagricultural lands, both by the prevention of fires and by planting, are the greatest forestry problems of the Philippine Islands.

4. Virgin Forests.

Virgin forests are those which either have been undisturbed by man, or have been so little exploited that their original character has not been materially changed. They form the source from which the inhabitants of the Islands may draw and are drawing their main supplies of timber, and also include the protective forests of the high mountain regions. They cover approximately one-third of the total area of the Islands.

I.—CLIMATE.

The average annual rainfall of the Philippines shows pronounced variations in different parts of the Archipelago, ranging from 900 millimeters (36 inches) to 4,000 millimeters (160 inches). The heaviest rains occur during the summer and autumn months (June to October), which is properly called the rainy season. The entire Islands are well watered during these months. During the winter months (November, December, January, and February) the northeast monsoon rains continue to water abundantly the eastern and northern coasts, thus giving the Pacific coasts and the islands bordering the large inland seas a prolonged or second rainy season. The western half of central and northern Luzon, the western coasts of Mindoro and Panay, the Calamianes group, and small areas in other portions of the Islands receive little rainfall from this monsoon, because of intervening mountain masses. Thus a prolonged, comparatively dry season with only occasional showers prevails in these regions for the six months from November to May. In the other portions of the Islands, this dry season varies from two to four months and is more frequently interspersed with showers. In some places the showers are so frequent that there is an entire absence of a dry season. Thus, it will be seen that there are two distinct climates, one in which the dry season is long and pronounced and another in which the dry season is shorter and less pronounced and sometimes wanting. In the former region, the forests during this season shed a portion of their leaves, and some trees are even entirely defoliated for a short time; in the latter, the forests are generally evergreen. Though grass areas are found in both, they more quickly establish themselves in the drier belt. It is a general rule that throughout the Islands during the long or short dry seasons the amount of rainfall in local showers, and the relative humidity, is less in the lowlands than in the high altitudes; consequently, the forests of the low altitudes may show a much less evergreen appearance than the forests of higher altitudes of the adjacent interior mountain passes.

The monthly distribution of the rainfall should be considered, because some localities in the regions of a long dry season receive a greater annual rainfall than others in the region of a short dry season. Thus Balanga (Bataan), in the region of the long dry season, has an annual rainfall of 2,394 millimeters, of which 83.5 per cent falls from June to October; 5.3 per cent from November to February; and 11.2 per cent from March to May. On the other hand, Jolo, in the Sulu Archipelago, with no dry season at all, has an annual rainfall of only 1,666.8 millimeters, of which 49.2 per cent falls from June to October; 28.3 per cent from November to February; and 22.5 per cent from March to May.

Although the Philippines have a range of latitude from 4.5° to 22° north, the variation in the temperature is believed not to be great enough to have any pronounced direct effect on the vegetation below 500 to 600 meters in altitude.

II. TOPOGRAPY AND SOIL.

As a general rule, the topography of the islands of the Archipelago consists of interior mountain ranges, with coastal plains of greater or less width. In some cases these ranges are nearer one side of the Islands than the other; in others, large river valleys separate two parallel mountain

PLATE I.—GENERAL VIEW OF SECOND-GROWTH FOREST.

In the foreground is a remnant of the original forest after being logged.

PLATE II.—VIEW IN SECOND-GROWTH FOREST.

Palosapis (1, 2, and 3) and cupang (4) are remnants of the original forest.

PLATE III.—YOUNG SECOND-GROWTH FOREST.

Hamindang and anabion.

PLATE IV.—OUTSIDE VIEW OF A DIPTEROCARP FOREST OF THE LAUAN TYPE.

This forest will yield 30,000 feet per acre, board measure, clear lumber, and consists of an almost pure stand of the lauans and apitongs.

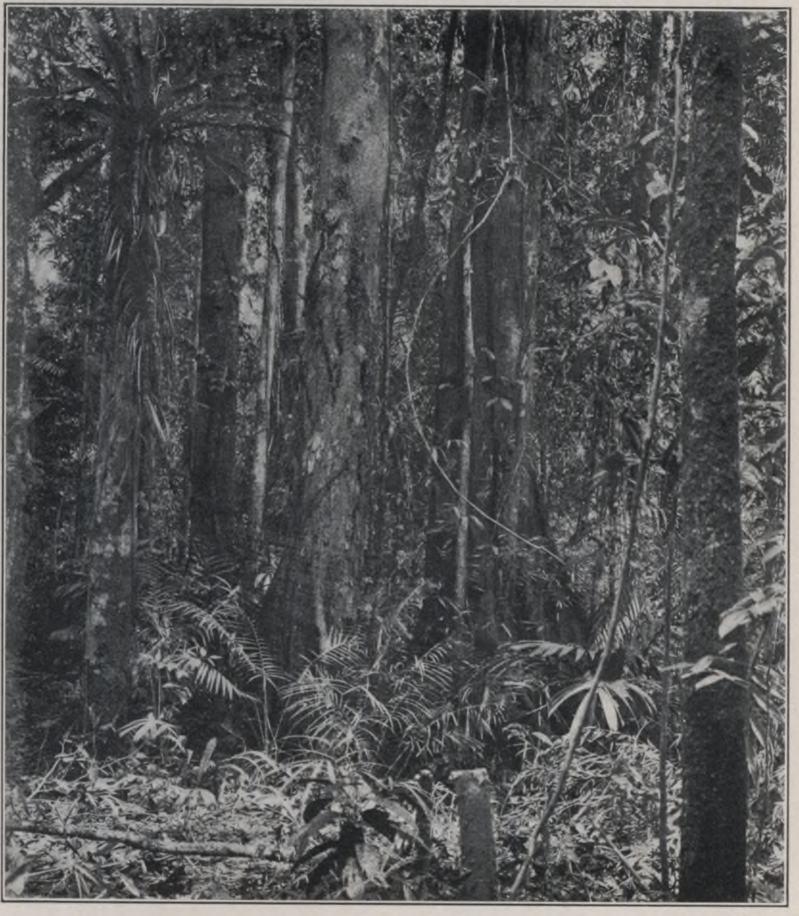

PLATE V.—INTERIOR VIEW OF THE LAUAN FOREST SHOWN IN PLATE IV.

The trees are almon-lauan and red-lauan.

PLATE VI.—INTERIOR VIEW OF LAUAN TYPE.

The trees are almon-lauan, red lauan, and tanguile.

Plate VII.—INTERIOR VIEW OF THE LAUAN-HAGACHAC TYPE.

ranges. The mountains are volcanic in origin. Some isolated volcanic peaks rise abruptly from the surrounding lowlands. Limestone deposits, often crystallized by volcanic action, occur scattered throughout the Islands, especially along the coast. In some portions, large areas of stratified volcanic tuffs exist. These variations in the character of the rock and soils in a measure affect the character of the vegetation. Under a discussion of the forest types, attention will be called to certain pronounced variations due to this cause.

III.—TYPES OF FOREST.

The forest area of the Philippines may be divided into the following types:

1. Lauan type ⎫
2. Lauan-hagachac type ⎪
3. Yacal-lauan type ⎬ Dipterocarp types.
4. Lauan-apitong type ⎪
5. Tanguile-oak type ⎭
6. Molave type.
7. Pine type.
8. Mangrove type.
9. Beach type.
10. Mossy type.

It is convenient to use the term "dipterocarp" to distinguish the first five of the above types, as the characteristic trees belong to the Dipterocarpaceæ, the principal tree family of the Philippines. It is impossible, without more careful study and with the aid of topographical and geological surveys, to delineate the types on the map; and therefore the exact area covered by each type can not be ascertained at present. But the following is a very rough estimate of the area occupied by certain types or groups of types, with an estimate of their volume in cubic meters and board feet:

TABLE 2.

Kinds.	Area.				Volume of standing timber—		Total volume.	
	Per cent.	Square miles.	Acres.	Hectares.	Per acre (board feet).	Per hectare (cubic meters).[a]	Million board feet.	Million cubic meters.
Dipterocarp	75	30,000	19,200,000	7,770,000	10,000	100	192,000	777.000
Molave	10	4,000	2,560,000	1,036,000	3,000	30	7,680	31.080
Pine	5	2,000	1,280,000	518,000	2,000	20	2,560	10.360
Mangrove	2	800	512,000	207,200	2,000	20	1,024	4.144
Mountain	8	3,200	2,048,000	828,800		Purely protective.		
Total	100	40,000	25,600,000	10,360,000	----------	----------	203,264	822.584

[a] See page 12 for explanation of factor used in changing cubic meters to board feet.

A.—DIPTEROCARP TYPES.

(*a*) *General character.*—Covering 75 per cent of the virgin forest area, or 30,000 square miles, and containing approximately 95 per cent of the total amount of standing timber in the Islands, the dipterocarp types are preëminently the most important. They are found on nearly all types of topography, from immediately behind the frontal zone of the beach to an altitude of approximately 800 meters on the slopes of largest mountain masses. From the standpoint of the botanist, the composition of these forests is complex; but from the standpoint of lumbermen it is comparatively simple. As the name implies, the members of the dipterocarp family constitute the prevailing class of timber. Taking it as a whole, it is estimated that 75 per cent of the 192 billion board feet, or 144 billion board feet, are dipterocarps. The remaining 48 billion board feet in the dipterocarp forests are divided among a large number of species, representing many families.

Practically all the species of the dipterocarps are large trees, reaching heights of 40 to 50 meters and diameters of 100 to 150 centimeters or more, and it is not rare to find even these dimensions exceeded. They have straight, regular boles, resembling in size and shape the *Liriodendron tulipiferum* (yellow poplar or tulip tree) of the United States. Some species of other families have a size and form similar to and codominant with the dipterocarps, but by far a greater majority are subdominant species, many of which have ill-formed boles, much smaller in diameter and length. Underneath the dominant and subdominant species are a large number of undergrowth tree species which do not attain more than 10 centimeters in diameter when mature, and a height of 10 meters or less. From a botanical point of view, these add greatly to the complexity of the forests, but for commercial considerations they should be called undergrowth trees. Within the forests there are comparatively few shrubs, or bushes, and herbs.

All the types of dipterocarp forests contain climbing palms (rattans), but the number and size of other large vines (lianas) seem to diminish with the prominence of the dipterocarps. Artificial and natural openings in the forests are often covered with a jungle of climbing bamboos and other large lianas, and the edges of the forests, especially along the streams, present breastworks of twisted vines which are very difficult to penetrate; but as soon as the interior is reached it is easy to pass through the forest with only the occasional use of a bolo (machete).

Practically all the dipterocarps are evergreens, for the new leaves are formed before the old ones drop. In some of the types discussed below, a few of the dipterocarps and many of the other tree species are partially deciduous, dropping a portion of their leaves during the dry season; some species, including one dipterocarp, may become entirely defoliated for a period varying from one day to two months.

As stated above, the dipterocarp forests show more or less distinct types (formations), which are here given the common names of the most numerous species found within them. These may be divided into subtypes (associations); but, except in limited regions where intensive work has been done, little or no attempt has been made to distinguish them. Many of them are only stages in successful movements of the forests. Such movements are either due to the recovery from artificial disturbances or to changes in the character of the topography.

As many of the regions of the Philippines have not yet been fully investigated, the following division of the dipterocarp forests into types is only provisional. It is believed, however, that these types, generally speaking, will hold good, and that if changes are made they will be in the nature of a division into subtypes.

(*b*) *Lauan type.*—To this type is given the name "lauan" because several species (see p. 20) producing similar woods having the name of lauan predominate. It represents the most successful commercial forest in the Philippines, and is confined to regions with a short or no dry season. It reaches its best development on the more gentle slopes near the base of the mountain masses, usually extending to altitudes of 300 to 400 meters, at which height it merges gradually into the tanguile-oak type. In regions of rougher topography it does not produce such heavy stands. In favorable soils it may occupy the low coastal hills, although usually near the sea it merges into the yacal-lauan type or the molave forest. The relative proportion of the dipterocarps is usually heavier in this than in any other type, and the total volume of timber is greater. An indication of the composition and stand of the forest can be best illustrated by the following table, which is based on the results of valuation surveys.

TABLE 3.—*Volume of trees 40 centimeters and over in diameter in northern Negros (average of 54.65 hectares).*

Scientific name.	Common name.	Volume per hectare (cubic meters).	Stand per acre (board feet).
Shorea sp.	Red lauan	185.18	18,518
Shorea furfuracea	Almon-lauan	92.02	9,202
Dipterocarpus grandiflorus	Apitong	66.63	6,663
Shorea polysperma	Tanguile	59.93	5,993
Pentacme contorta	White lauan	25.23	2,523
Parashorea plicata	Bagtican-lauan		
Total Dipterocarpaceæ		428.99	42,899
All others (estimated)		22.58	2,258
Total		451.57	45,157

These figures are fairly representative of a portion of the lauan type, but, depending on the local conditions, the volume and other qualities will vary, and so give rise to the subtypes. Much closer study must be given to these subtypes before they can be accurately described. In parts of Luzon, especially in the Provinces of Tayabas and Camarines, the principal species of the family Dipterocarpaceæ occurring in the largest stands are as follows: Mayapis-lauan (*Shorea squamata*), almon-lauan (*Shorea furfuracea*), bagtican-lauan (*Parashorea plicata*), white lauan (*Pentacme contorta*), tanguile (*Shorea polysperma*), tiaong-lauan (*Shorea* sp.), the apitongs (*Dipterocarpus* spp.). The lauan types of Mindanao, especially in the Zamboanga district, contain mayapis-lauan, almon-lauan, bagtican-lauan, white lauan, kalunti-lauan (*Vatica* sp.), and *Dipterocarpus* spp.

Many other families are represented in this type, but the species which reach codominance with the dipterocarps are much less abundant than in other types in which the Dipterocarpaceæ predominate.

The lauan type is comparatively free from jungle undergrowth. It contains a very complex small-tree flora and a great many climbing palms. Erect palms, some of them reaching the height of subdominant trees, are everywhere present. Contrasted with other types, it presents a more closed canopy and consequently a regular profile. On its borders, and in natural or artificial openings, lianas grow in great profusion, but while lianas occur within the forest itself, yet they are reduced to a minimum in numbers, and especially in size, because of the dense prevalent shade. The forest floor contains a very scanty growth of herbaceous vegetation. The undergrowth of the forest is not an impenetrable jungle. One can pass through it in all directions, encountering difficulties in the way of obstructive vegetation only in artificial or natural openings where light permits the jungle growth. In short, the dominant trees, nearly all dipterocarps, form and maintain a successful forest of trees, which produce a shade so dense as to crowd out many light-demanding species. These are either forced to the edge of the forest, or else exist in the interior in a sickly condition, awaiting as it were the chance entrance of light to permit them luxuriously to fill up the opened space. Stripped of its ornaments of palms, lianas, epiphytic orchids, and ferns, whose importance is exaggerated in the eyes of the inhabitants of the temperate regions, the lauan type bears striking resemblance to the commercial forests of the temperate zone. In simplicity of composition of the dominant trees, and in volume of wood produced, it approaches in value the famous coniferous forests of the more northern latitudes.

It is not possible to estimate the area that this type of forest occupies. It covers a very large part of the entire forests, and probably formerly occupied extensive areas which are now in cogon or second-growth forests, or under cultivation.

(*c*) *Lauan-hagachac type.*—The lauan-hagachac, like the lauan type, is confined to the regions where the dry season is short or wanting. It is restricted to areas where the water level is near the surface of the ground. It reaches its most extensive development in river bottoms, especially on slightly raised river deltas. It extends in narrow strips along the smaller streams through the lauan type, where it resembles this in character, and often they can scarcely be distinguished.

In composition it differs mainly from the previous type in the presence of hagachac (*Dipterocarpus affinis*), and a much larger number of co-dominant species of other families. Where this forest has been analyzed carefully, it shows a large number of subtypes, which are often stages in succession, due to the unstable character of the habitat. Thus, in flood times, slight changes in the level of the soil due to deposits or the formation of new water channels alters the relative height of the ground-water level, which may be great enough to effect a decided change in the character of succeeding generations of trees. Thus, the type as a whole is a complex of many subtypes in various stages of development. Consequently the average hectare will show a greater number of species and fewer individual trees that have obtained maturity. Also, during the rainy season, the soil in large areas is too wet for the best development of many species. These factors reduce the volume of lumber per hectare as compared with forests growing in more stable areas.

In spite of the unstable and moist character of the soil, there is a constant tendency to produce a forest in which the dipterocarps predominate. The following is an estimation of the volume of such a forest:

TABLE 4.—*Volume of trees 40 centimeters and over in diameter, on a delta plain in eastern Mindoro (average of 42.4 hectares).*

Scientific name.	Common name.	Volume per hectare (cubic meters).	Stand per acre (board feet).
Dipterocarpaceæ:			
Pentacme contorta	White lauan	55.83	5,583
Shorea guiso	Guijo	14.5	1,450
Dipterocarpus sp.	Apitong	7.42	742
Dipterocarpus affinis	Hagachac	16.03	1,603
Total Dipterocarpaceæ		93.78	9,378
Leguminosæ:			
Pterocarpus indicus	Narra	8.76	876
Anacardiaceæ:			
Koordersiodendron pinnatum	Amuguis	10.69	1,069
Combretaceæ:			
Terminalia pellucida	Dalinsi		
Terminalia nitens	Sacat	3.13	313
Terminalia edulis	Calumpit		
All others (estimated)		46.67	4,667
Total		163.03	16,303

The principal other trees occurring in this type of forest that are dominant or subdominant with the dipterocarps are dao (*Dracontomelum dao*); malaikmo (*Celtis* sp.); *Canarium* spp.; ilang-ilang (*Canangium odoratum*); various species of the mahogany family (*Meliaceæ*), including very scattered specimens of calantas (*Toona calantas*); species of laurel family (*Lauraceæ*); dapdap (*Erythrina indica*); cupang (*Parkia timoriana*); several soft-wooded species of the dungon family (*Sterculiaceæ*); many species of the binunga family (*Euphorbiaceæ*), especially *Macaranga* and *Mallotus;* biluang (*Octomeles sumatrana*), a tree belonging to Datiscaceæ which reaches very large dimensions.

The portions of this type found along streams in the lauan type are somewhat more stable in character. Temporary flood plains may show pure stands of hagachac. Narra, dao, amuguis, acle (*Albizzia acle*), guisocguisoc (*Hopea philippinensis*), malugay (*Pometia pinnata*), catmon (*Dillenia philippinensis*), and others are found scattered along the streams mixed with various species of lauan, which reach their best development on the adjacent higher and drier soils.

As one would naturally suppose, this forest is more open than the lauan type, consequently the jungle growth consists of tangles of rattan and other large vines. However, mature subtypes are comparatively free from jungle growth.

Erect palms are constantly present. The Mindoro portion of it, above described, shows 66.5 palms to the hectare (not including young ones without stems), composed of six different species. The lowlands near the mouths of rivers at the head of Davao Gulf (Mindanao) will show even a larger stand.

As the lauan-hagachac type occurs on land sought for agricultural purposes, especially the cultivation of rice, the area occupied by it is very limited in extent. In thickly settled agricultural regions it has been entirely destroyed.

(*d*) *Yacal-lauan type.*—This type finds its best development in regions where the dry season is short, on low coastal hills whose basal rock is volcanic in structure. It occurs on headlands projecting into the sea, especially those at the heads of embayments. These headlands usually have drier soils, lower relative humidity, and less rainfall than the region back of them. It also occurs on the hills bordering large river valleys that have approximately the same physical conditions.

This type, in contrast to the two dipterocarp types above mentioned, has a slight deciduous appearance during the driest portion of the year. As it has a large number of codominant species, it more nearly resembles the lauan-hagachac than the lauan type. Erect palms are scattered throughout the forest, although they are not nearly so numerous as in the previous mentioned dipterocarp type. Climbing palms and other lianas are present, but are not especially abundant except in open places. The type can be divided into two subtypes—the ridge subtype which occurs on the tops and exposed slopes of the ridges, where yacal is most abundant, and a subtype found on protected slopes of ravines and along small streams. It is difficult to draw a sharp line between these subtypes, inasmuch as they merge into each other, and from the standpoint of the lumberman they are a unit. Hence they are treated as one. The following is an illustration of the volume of a fair sample of this type of forest in Mindanao.

TABLE 5.—*Volume of trees 40 centimeters and over in diameter, in the Port Banga region, Mindanao (average of 51.17 hectares).*

Scientific name.	Common name.	Volume per hectare (cubic meters).	Stand per acre (board feet).
Dipterocarpaceæ:			
Hopea plagata	Yacal	50.37	5,037
Pentacme contorta Parashorea plicata	White lauan Bagtican-lauan	26.02	2,602
Dipterocarpus sp.	Apitong	12.05	1,205
Shorea guiso	Guijo	16.80	1,680
Vatica sp.	Kalunti-lauan	12.34	1,234
Shorea squamata Shorea furfuracea	Mayapis-lauan Almon-lauan	9.46	946
Vatica sp.	Narig	6.14	614
Hopea sp.	Malayacal	2.83	283
Total dipterocarpaceæ		136.01	13,601
Sterculiaceæ:			
Tarrietia javanica	Lumbayao	21.35	2,135
Leguminosæ:			
Kingiodendron alternifolium	Batete	7.29	729
All others		124.35	12,435
Total		289.00	28,900

Other codominant species and the larger subdominant ones are as follows: Malaikmo; antipolo (*Artocarpus communis*); ilang-ilang; liusin (*Parinarium griffithianum*); *Canarium* spp.; kamatog (*Erythrophloeum densiflorum*); banawi (*Cylostemon grandifolius*); amuguis; malugay; alupag (*Euphoria cinerea*); balacat (*Zizyphus zonulatus*); taluto (*Pterocymbium tinctorium*); *Calophyllum* sp.; *Garcinia* spp.; *Anisoptera* sp. and *Hopea* sp. (*Dipterocarpaceæ*); batitinan (*Lagerstroemia piriformis*); sacat; *Eugenia* spp.; *Palaquium* spp.; lanete (*Wrightia calycina*); molave (*Vitex parviflora*); sasalit (*Vitex aherniana*); bancal (*Sarcocephalus cordatus*); calamansanay (*Nauclea* sp.). This list gives some idea of the complexity of the type.

Forests of the same type in Leyte and in various parts of Luzon, especially the Provinces of Tayabas and Ambos Camarines, show so similar a composition that they may fairly be classed under this type. The actual area that this type occupies is not known at present, but it is not large, as it occurs in narrow belts along the coast, and in many cases has been cleared by caingin makers.

(*e*) *Lauan-apitong type.*—So far as altitude and topography are concerned, this corresponds to the lauan type, but differs from it in having a longer dry season, the effect of which is sufficient to justify its separation into a distinct type. During the dry season, this type shows a decided deciduous element. Except in places of favorable soil conditions, the forest cover is quite open, allowing the entrance of jungle undergrowth, lianas, erect bamboos, and the like. The composition of the dominant species is more complex than the lauan type, and resembles markedly in this respect the lauan-hagachac and yacal-lauan types. Here also the dipterocarps furnish the greatest bulk of timber. Many of the species found in the previous mentioned types are here not present, although all the species occurring in the lauan-apitong type are also found in the other dipterocarp types. This indicates that the distinction is a climatic one. While the dipterocarps show a decidedly less leaf surface during the dry season, only one of them, palosapis (*Anisoptera thurifera*), is wholly deciduous, but only for a day or two. This is true of a great majority of the trees belonging to other families, which contain only a few that become bare, even for a short time. On the clearing edge of this forest, there are good stands of almost pure erect bamboo; these extend into the virgin forests where the dipterocarps are mixed with cupang (*Parkia timoriana*) and other species. The bamboo undergrowth in such places, with the rather scattered trees, gives the forest the appearance of a park.

A typical stand of this forest is as follows:

TABLE 6.—*Volume of trees 40 centimeters and over in diameter in Bataan Province, Luzon (average of 50 hectares).*

Scientific name.	Common name.	Volume per hectare (cubic meters).	Stand per acre (board feet).
Dipterocarpaceæ:			
Dipterocarpus grandiflorus	Apitong	81.6	8,160
Dipterocarpus vernicifluus	Panao		
Pentacme contorta	White lauan	66.5	6,650
Anisoptera thurifera	Palosapis	28	2,800
Shorea polysperma	Tanguile	16	1,600
Shorea guiso	Guijo	4.1	410
Total Dipterocarpaceæ		196.2	19,620
All others		89	8,900
Total		285.2	28,520

Under "all others" are included the following species codominant with, or prominently subdominent to, the dipterocarps: Malaikmo; antipolo; tangisang-bayawak (*Ficus variegata*); tamayuan (*Strombosia philippinensis*); *Xylopia dehiscens;* dalinas (*Cyathocalyx globobus*); duguan (*Myristica philippensis*); lago (*Pygeum glandulosum*); liusin; acle; tanglin (*Adenanthera intermedia*); cupang; tindalo (*Pahudia *rhomboidea*); pili and pagsahingin (*Canarium* spp.); kamingi (*Santiria nitida*); *Dysoxylum* spp.; malakamingi (*Reinwardtiodendron merrillii*); *Amoora* spp.; *Aglaia* spp.; tuai (*Bischofia trifoliata*); hamindang (*Macaranga bicolor*); binunga (*Macaranga tanarius*); gubas (*Endospermum peltatum*); pahutan (*Mangifera altissima*); lamio (*Dracontomelum cumingianum*); dao; amuguis; alupag; balacat; taluto; bitanhol (*Calophyllum blancoi*); mangachapuy (*Hopea acuminata*); biluang; banaba (*Lagerstroemia speciosa*); sacat, calumpit, and binggas (*Terminalia* spp.); nato (*Palaquium luzoniense*); manicnic (*Palaquium tenuipetiolatum*); bolongeta (*Diospyros pilosanthera*); dita (*Alstonia scholaris*).

(*f*) *Tanguile-oak type.*—The forests of this type cover the area extending from the upper limits of the lauan and lauan-apitong types to the lower limits of the mossy-forest type in the higher portion of the mountains. These forests have not been studied in great detail, and more extended investigations are necessary to determine whether more than one type exists or not. When such studies have been made in many parts of the Islands, it may be found that there are a number of distinct types instead of the one here considered. In the meantime, the provisional name of tanguile-oak type has been adopted. Its lower limits are from 400 to 500 meters above sea level, and it extends upward to a height of between 800 and 900 meters. The topography is such as is usually found on mountain sides, gentle to steep ridges and slopes alternating with deep ravines and gorges. The evergreen character of the forests and actual measurements show that rainfall is more evenly distributed throughout the year, and the relative humidity is constantly higher than in the adjacent forests of the lower altitudes.

As its name implies, the principal species represented in this type are tanguile and oak; of these, the former also occurs frequently in dipterocarp types of the lower altitudes. It is found nearer sea level in regions where the dry season is short than in those where the dry season is longer, but in both its numbers increase with the altitude until the mossy-forest type is reached. In the higher portions of the tanguile-oak type, it is the only dipterocarp of numerical importance. In the lower limits of the type occur, of course, scattered specimens of the dipterocarps of the bordering types below. This is especially true of the lauans and the apitongs, although the latter are not nearly so abundant as the former. Some species that usually are found along streams in the types of lower altitudes occur in deeper soils of the tanguile-oak type away from the streams. Thus, tuai, catmon, and pahutan (*Mangifera altissima*) are among those so distributed. Certain species of oak, which occur as scattered trees in the lower types, here become much more abundant, and in some places give a decided tone to the vegetation. Among other species that are numerically prominent in this type are mangachapuy

(*Hopea acuminata*), almaciga (*Agathis alba*), kalingag (*Cinnamomum mercadoi*), and other species of the laurel family, malabayabas (*Tristania decorticata*), *Gordonia luzonica*, and many species of *Eugenia*. Many of the species occurring in this type also occur much dwarfed in the mossy forests higher up. Indeed, the type is the meeting ground of a number of the species which are found in the types both above and below. So far as is known, there are no species of trees that reach large size that are peculiar to this zone, with the exception, perhaps, of certain species of oaks. A number of species, however, reach more successful development, both as regards numbers and size, than in the other types in which they are found. Open places occur in this as in other types, giving rise to many subtypes. The undergrowth trees are numerous, but the composition is not so complex as the types below. The closed portions of the type are comparatively free from large lianas other than rattans, so that the only difficulty in penetrating the forest in any direction is encountered in the tangled growth of the open places.

In high plateau regions, between 500 and 800 meters of altitude, this type attains heavy stands, but usually the topography is so rough that tall forests, covering large areas without a break, are wanting. Large epiphytic plants, like birds'-nest ferns, are more abundant here than lower down. In the upper limits, the trees gradually become more dwarfed, and the trunks are covered with mosses and liverworts, until the type gradually merges into the mossy forests above.

B.—MOLAVE TYPE.

Throughout this type, molave (*Vitex parviflora*) is fairly well distributed. The type occupies a topography similar to that on which the yacal-lauan type is found, except that in a great majority of cases the underlying rock is usually limestone rather than volcanic in nature. The low limestone hills, either coastal or bordering large uplifted river valleys, are usually composed of crystalline coral limestone with a honeycombed structure. These rocks are generally covered by shallow or very scanty soil, and this, together with their honeycombed nature, makes the habitat a very dry one. It is roughly estimated that the area covered by this type comprises some 4,000 square miles (1,036,000 hectares). The trees are the most valuable in the Philippines, and are easily accessible for exploitation. This has brought about the more or less complete destruction of the original forest, and so it is very difficult to analyze the true nature of the vegetation. From the study of virgin and nearly virgin areas, however, the following characteristics seem to be most general. The forest is open. Its large trees are few and far apart, with the intervening spaces filled with small trees, or by a jungle growth usually of sprawling, climbing, or small erect bamboos. With a few exceptions, the dominant trees are short boled, irregular to very irregular in form, and with wide-spreading crowns. The forest has a decidedly deciduous foliage, almost entirely so on rough topography in regions where the dry season is pronounced. The composition of the type varies in different parts of the Islands.

In some expressions of the type, the following dominant trees are present: molave, dungon (*Tarrietia sylvatica*), tindalo, supa (*Sindora supa*), batete, ipil (*Intsia bijuga*), acle (*Albizzia acle*), banuyo (*Wallaceodendron celebicum*), balacat, alupag, bansalaguin (*Mimusops* sp.), calantas (*Toona calantas*), lanete (*Wrightia laniti*), mancono (*Xanthostemon verdugonianus*), batitinan (*Lagerstroemia piriformis*), spiny narra (*Pterocarpus echinatus*), narra, taluto, tucang-calao (*Aglaia clarkii*), and liusin. Of the smaller species, the following may occur: ebony (*Maba buxifolia*), camagon (*Diospyros discolor*), kuyus-kuyus (*Taxotrophis ilicifolia*), caña-fistula (*Cassia javanica*), bayok (*Pterospermum* spp.), and tulu-tulu (*Mallotus floribundus*). It must not be supposed, however, that all these species occur in any one locality. Indeed, the reverse is the case. Mancono, for instance, in merchantable quantities, is restricted to northeastern Mindanao and adjacent islands. Supa, likewise, is found in Tayabas and Ambos Camarines; narra, calantas, and acle are usually scattered along the hill streams. Distinct forms of the type are sometimes present on dry hills of hard volcanic rock—hills too dry to support any forest but members of this type. Often, such species as molave, batete, ebony, liusin, batitinan, and others, are found scattered throughout the open places of the yacal-lauan type. This is especially true of batete. Even in some limestone regions, the slopes of valleys often contain clearly defined expressions of the dipterocarp types, and in the very humid atmosphere of the Davao Gulf, the Island of Samal (mainly of a crystalline coral limestone formation) contains a dipterocarp forest of guijo, white lauan, bagtican-lauan, and other species that causes it more nearly to approach a dipterocarp type than any other, with trees of the molave type scattered among the thinner portions of the forest. North of this is a small coral island which contains an almost pure stand of ipil. Indeed, so far as observations go, with the single exception of supa, all the trees mentioned above are found growing scattered in the various types of dipterocarps, and occupy positions either along the streams or in drier portions. Some of them reach better individual development in such situations than when growing on limestone hills. It will thus be seen that many of these species occupy limestone soils, not because they prefer them to any other, but because they are shaded out of the moister soils by the more successful development of the shade-enduring dipterocarps. The dipterocarps, on the other hand, have soil-moisture requirements that will not permit them to exist in the drier soils of the limestone regions. In a word, the limestone habitat is one that contains a mixture of certain species of the various types of dipterocarp forest.

As one would suppose, the volume of the molave type is much lower than that of any of the dipterocarp types. This is due both to the thin stand and to the short boles of the trees. It is estimated that the type will average not more than 30 cubic meters per hectare of timber of merchantable size (3,000 board feet to the acre). However, the type is a valuable one, because it contains hard, durable timbers, many of which are very valuable cabinet and furniture woods.

C.—MANGROVE TYPE.

The mangrove type is in many respects the most peculiar one in existence. It is literally a forest of the sea. Where conditions are favorable, it occupies the beach washed by the tides. It is especially well developed on the mud flats at the mouths of rivers entering the sea at the heads of protected bays. Wherever wave action allows a fairly stable shore line, trees of the type are present. They occur on the quieter portions of the coral reefs, and are thinly scattered on many wave-made terraces that are exposed at low tide. A majority of the stand is composed of the members of one family, the Rhizophoraceæ, or bacauan family, comprising the following principal species: Bacauan (*Rhizophora mucronata*), bacauan-lalaki (*Rhizophora conjugata*), busain (*Bruguiera gymnorrhiza*), pototan (*Bruguiera eriopetala*), pototan-lalaki (*Bruguiera caryophylloides*), langarai (*Bruguiera parviflora*), and tangal (*Ceriops tagal*). The following principal species of other familes are pagatpat (*Sonneratia pagatpat*), pedada (*Sonneratia* sp.), api-api (*Avicennia officinalis*), tabao (*Lumnitzera littorea*), tabigi (*Xylocarpus obovatus*), piagao (*Xylocarpus granatum*), *Excoecaria agallocha,* and dungon-late (*Heritiera littoralis*).

On the muddy flats at the mouths of large rivers in protected bays, the pioneer plant is bacauan. Back of this come the bacauans mixed with pototan and other species of *Bruguiera,* and then, usually covering large areas, is langarai, mixed in varying proportions with bacauan, pototan, busain, tangal, and pedada. In more open bays, where the soil is mixed with considerable sand or coral limestone, occurs a distinct frontal zone of pagatpat, with more or less api-api. Wave-cut coral terraces often contain nearly pure stands of pagatpat. The inner margins of the swamps usually have scattered specimens of dungon-late, tangal, piagao, tabigi, and tabao. In many instances, a distinct zone of the nipa palm (*Nipa fruticans*) is present near the upper limits of this type. This palm also forms thickets along the streams where the water is less brackish. Where the type is less distinct, all sorts of mixtures of the above species are present.

The capacity of this type to produce firewood and timber varies according to the degree in which it has been exploited. In thickly populated districts, the forest has been reduced to such an extent as to render it valueless for anything except firewood. Virgin areas show surprisingly large stands of poles and trees, some of which are sufficiently large to produce lumber. In Mindanao, valuation surveys made on a very good stand show 149 trees per hectare of more than 25 centimeters in diameter, yielding 130 cubic meters of timber per hectare, or 13,000 board feet per acre. Pagatpat has been measured with a height of 31 meters, a diameter, breast-high, of 137 centimeters, and a merchantable length of 17.5 meters; bacauan, a height of 28 meters, a diameter above the stilt roots of 70 centimeters, and a merchantable length of 16.5 meters; pototan, a height of 28.8 meters, a diameter, breast-high, of 80 centimeters, and a merchantable length of 18.3 meters. It is estimated that the swamps of the Islands will show an average volume of 20 cubic meters per hectare of trees over 20 centimeters in diameter, and if, as is usually the case, the branches and large twigs are used, this amount will be exceeded.

The forest itself has rather an even top profile. The canopy is fairly well closed, and the forest is practically clear of undergrowth, except at its inner edge. The presence of a complex system of stilt roots, as high as 3 meters and wide spreading, of the two species of *Rhizophora* presents a tangle through which one can make his way with difficulty. A number of the species, such as pagatpat and api-api, show characteristic aërial roots. The leaves of all are hard and leathery in texture. The seeds of the Rhizophoraceæ begin to germinate on the trees, finally drop, and are distributed by the tides until they find a favorable lodging place, where they continue their development.

D.—BEACH TYPE.

Sandy beaches above high-tide limits are found throughout the Philippines. They are favorite places for settlements and so the original vegetation has been greatly modified. In those places where it has kept its original form, it presents a distinct type. Usually the frontal zone has a tangle of vegetation in which pandans (species of *Pandanus*) form a conspicuous part. The principal trees are as follows: Talisay (*Terminalia catappa*), dapdap, (*Erythrina indica*), botong (*Barringtonia speciosa*), malubago (*Hibiscus tiliaceus*), bani (*Pongamia glabra*), banalo (*Thespesia populnea*), dungon-late, palo maria (*Calophyllum inophyllum*), agoho (*Casuarina equisetifolia*), tawalis (*Osbornia octodonta*), and bantigi (*Pemphis acidula*). In some places ipil, narra, bansalaguin, and other valuable trees are encountered. Talisay often occurs in patches of pure stands in rich river bottoms. On sandy flood plains of large rivers, in various parts of the Islands, agoho often forms small pure forests.

Behind the frontal line, the vegetation partakes more of the nature of other types. Series of old beaches sometimes cover quite extensive areas, on which the lauan-hagachac type usually is found. This type is especially well developed on old beaches where the dry season is wanting. In the Davao Gulf, for instance, are encountered heavy stands of very large trees of hagachac, guijo, and bagtican lauan that will scale as high as 100,000 board feet to the acre. It must be remembered that in such places the ground water level is not far below the surface, and the atmospheric moisture conditions are constantly humid. The humus accumulations of previous generations of vegetation enriches the well-drained soil. Altogether, these conditions make the habitat an exceedingly favorable one.

E.—PINE TYPE.

This type reaches its best development in the high plateau region of northern and central Luzon. The greater part of it, although at an altitude ranging from 900 to 1,500 meters, is in a region with a distinct dry season. The rain-bearing winds of the dry season deposit most of their moisture before they reach this rough plateau region. The pines are scattered as single individuals, or in open to nearly closed patches throughout a large grass area. In many ravines and along water courses are stands of broad-leaved trees. There is much evidence to show that formerly this area was covered with forest growth consisting principally of broad-leaved trees, and although pines were undoubtedly present, they were of little relative importance, being confined to the steeper and drier situations where the broad-leaved trees could not grow. Through the activities of man, however, in the centuries of occupation, the broad-leaved trees have been cleared off, and repeated fires have prevented their reproduction. The pine, however, is less sensitive to fires, and consequently at present there are broad areas of grass lands with many groves of pines. There is little doubt that if fires were kept off, the pine, in the absence of broad-leaved competition, would quickly seed up the entire area, for its reproduction is abundant and rapid; and gradually the pines themselves would be replaced by the original broad-leaved vegetation. This struggle between the pines and the broad-leaved trees is often shown in caiñgins bordering situations where both types occur. The pines, because of their numerous winged seeds, will make their appearance first; the other vegetation comes more slowly, but will gradually prevent the starting of a new generation of the light-demanding pines. This last movement of vegetation is a much slower one. Not only are the pines found in regions where the dry season is pronounced, but at higher altitudes in the mossy-forest belt, where the humidity is greater and more evenly distributed throughout the year. Thus, pines occur in abandoned caiñgins at an altitude above 1,500 meters, and even as high as 2,500 meters. Here they alternate with patches of grass or mossy forest. The rainfall of this region, as in many other portions of the Islands, is exceedingly heavy from June to October. Especially in the deforested regions, landslides occur frequently on the mountain slopes, making the natural reforestation of such places difficult. In the more level places, where fire lines have been established, grass patches become quickly covered with pine seedlings.

Benguet pine (*Pinus insularis*) is the only species in the highlands of central and northern Luzon. In some places, scattered pines are found in the grass lands, as low as 500 meters altitude, bordering on the upper limits of the lauan-apitong type. Pines are also found in Zambales and Mindoro. In Zambales, two species occur: *Pinus insularis* and *Pinus merkusii*. Their altitudinal range is usually from 500 to 1,500 meters, although scattered trees of *Pinus merkusii* are found at as low an altitude as 60 meters. In Mindoro, *Pinus merkusii* occurs in pure stands and in open groves scattered throughout the grass lands, southwest of a high mountain mass. It is found as low as 60 meters above sea level in one situation, although usually it is not found below 900 meters.

Measured groves of Benguet pine show a volume of 74 cubic meters per hectare (7,400 board feet per acre) of trees 25 centimeters and over in diameter. The trees will reach a height of 40 meters and a diameter of from 90 to 100 centimeters.

F.—THE MOSSY-FOREST TYPE.

Some 3,200 square miles (828,800 hectares), or 8 per cent of the land area of the Philippines, is the estimated amount of the high and very rough mountain region covered by virgin forests. They are essentially protective forests. Many such mountainous regions have already been cleared of their forests by caiñgin makers and are now covered with grass. These regions show such a complex set of conditions, both as regards habitat and vegetation that as yet our knowledge is too incomplete to carefully distinguish the types. Perhaps, in a broad sense only, one type exists, with certain variations or subtypes. Because of the presence of moss and liverworts in great abundance, it has been designated as the mossy-forest type.

The topography is rough and constantly changing. It consists of steep main ridges, rising to exposed peaks, and whose sides are in turn cut into smaller ridges by the deep cañons. Land slips are frequent, and these in all stages of being reclothed with vegetation add to the difficulty of analysis. The soil is shallow or nearly absent. Rock exposures occur, often covering large areas; but except on very steep slopes or on fresh slides they are covered with vegetation. Some mountains have more rounded dome-shaped tops, and on these the topography is much more stable.

As a rule, the climatic conditions are exceedingly moist, both as regards rainfall and relative humidity. Opposed to this favorable climate is the very great exposure to winds. The former is the cause of the mossy condition; the latter, of the dwarfed habit of the trees. The temperature conditions are much lower than those of the coastal region.

The tree vegetation is complex, yet not so much so as the forests lower down. Especially on the highest mountains, owing to these very unstable conditions, or where volcanic action has not been long extinct, trees are absent or nearly so. On mountains above 1,200 meters, the mossy forest appears at its best. *Dacrydium* and *Podocarpus* spp., *Eugenia* spp., *Tristania decorticata, Leptospermum amboinense, Decaspermum* spp., *Quercus* spp., *Myrica* spp., *Englehardtia spicata, Acronychia laurifolia, Symplocos* sp., *Ternstroemia toquian,* are some of the principal trees, only a few of which are found lower down. All of these trees are usually dwarfed in appearance, seldom reaching a height of more than 20 meters, and usually not over 5 meters. The trunks and branches are generally covered with mosses, liverworts, filmy ferns, and epiphytic orchids. The open places are usually occupied with ferns, and sometimes with grass. Tree ferns occur on the slopes within the forests, and on some steep slopes give a decided character to the vegetation. Rattans and other climbers, especially Pandanaceæ, are common, as are also small erect palms. Few mountains in the Philippine Islands attain a height of more than 2,000 meters. In general, the vegetation at such altitudes is much more dwarfed; in some cases, good-sized trees are found, even at high elevations; on others, no tree vegetation occurs at all.

G.—SUMMARY.

The following is a tabular summary of the types of vegetation found in the Philippines. [See pp. 34, 35.]

WOOD USES.

It is estimated that the Philippines contain more than 2,500 tree species, of which probably 300 find their way into the Manila and provincial markets in the form of timber. Of this number, less than 100 are commonly encountered.

1. DIPTEROCARPS.

As stated previously, the dipterocarp family furnishes the main bulk of standing timber. These woods can be roughly divided into three groups, viz, the lauans, the apitongs, and the yacals.

LAUANS.

Among the lauan group are white lauan, kalunti-lauan, almon-lauan, bagtican-lauan, malaanonang-lauan, mangasinoro-lauan, tiaong-lauan, mayapis-lauan, red lauan, and tanguile. Many shades of brown and red are comprised in the different species. White lauan and mangasinoro-lauan are of a light creamy brown color; bagtican-lauan and almon-lauan show shades of pink, which becomes a clear red in the case of mayapis-lauan, tiaong-lauan, and some grades of tanguile, and even a dark red color in the case of red lauan. In hardness they grade from soft to moderately hard in the approximate order outlined above. Their weight is light to moderately heavy. They are all coarse but straight-

PLATE VIII.—EXTERIOR VIEW OF YACAL-LAUAN TYPE.

Also shows the method of logging with carabao.

PLATE IX.—INTERIOR VIEW OF YACAL-LAUAN FOREST AFTER BEING PARTIALLY LOGGED.

Black yacal in the center.

PLATE X.—GENERAL VIEW OF A LAUAN-APITONG TYPE ON THE EDGE OF A CLEARING.

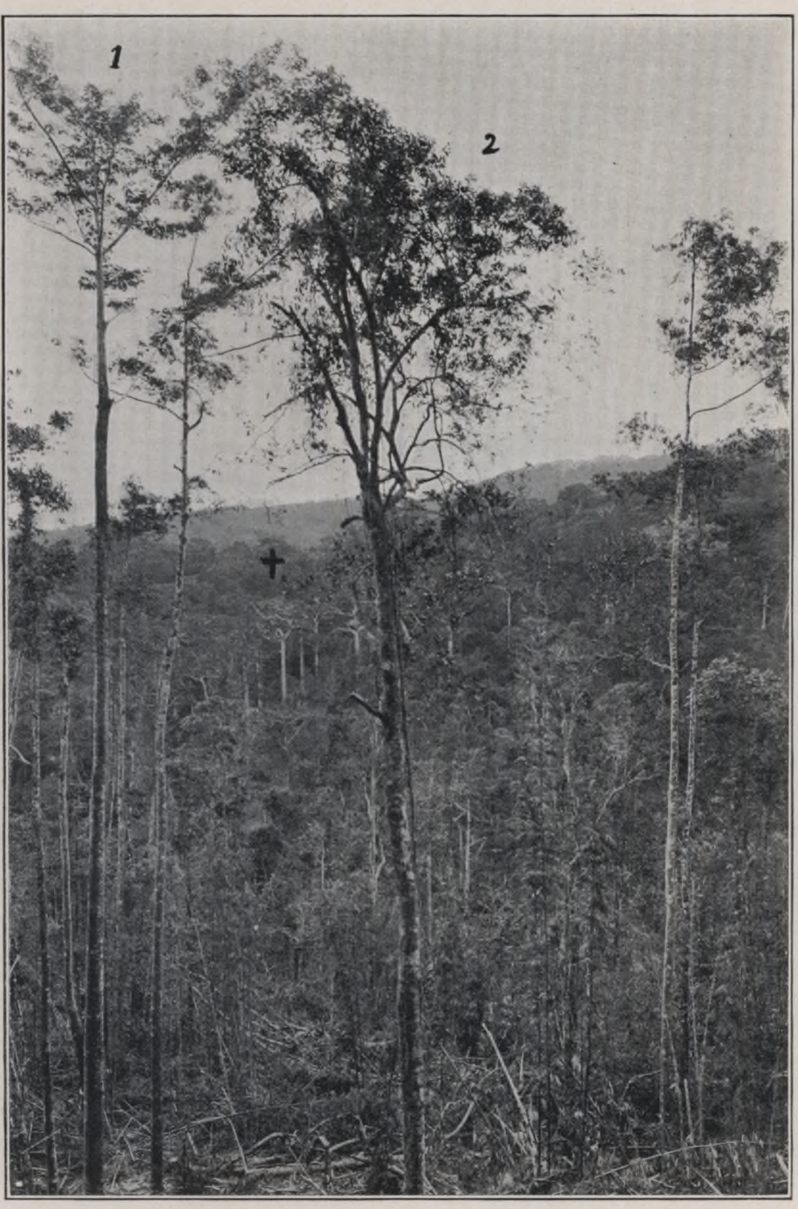

PLATE XI.—GENERAL VIEW OF LAUAN-APITONG FOREST.

Original forest in the background; cut-over forest in the foreground.

PLATE XII.—INTERIOR VIEW OF LAUAN-APITONG FOREST.

Apitong ridge.

Plate XIII.—VIEW IN LAUAN-APITONG FOREST.

Tree of panao showing form of bole and crown.

PLATE XIV.—INTERIOR VIEW OF TANGUILE-OAK FOREST.

The trees are tanguile and lauan.

grained, free from knots, easily worked, and in general mechanical properties are not greatly dissimilar to the pines. When quarter-sawn or slash-sawn with a figure, they show a beautiful grain. The lauans, without exception, come from tall trees, 100 to 150 or more feet in height, 6 feet or less in diameter, and with straight, regular trunk up to 100 feet to the first limb.

The lauans are readily attacked by fungi and white ants, but not more so than is Oregon pine, their chief competitor. They can be divided into three groups, the white lauans, the red lauans and tanguile, which are the usual trade names.

Locally, they are used for a great variety of purposes. They are especially adapted for light and medium construction work, in which they will find their greatest usefulness. In this respect they are to the Tropics what the lighter grades of pines and their allies are to the temperate regions. Nevertheless, for many classes of construction, because of their color and beautiful grain, they are superior to the pines. This is especially true for interior finish of all classes. The better grades of lauan and tanguile are now being shipped to the United States under the trade name of "Philippine mahogany."

APITONGS.

The trees that furnish timbers of this group are apitong, hagachac, panao, and guijo. They grade in color from a dirty brownish red to red. In hardness they are moderately hard to hard; in weight they are moderately heavy. The first three appear in the market under the trade name of apitong, the last as guijo. The former are coarse but generally straight-grained; the latter has a somewhat finer grain.

They are used for many purposes, but are especially adapted for heavier construction where contact with the ground is not necessary. Guijo is considered more valuable than apitong. They are not durable timbers, being susceptible to the attacks of white ants and fungi. Of the two, guijo is somewhat the more resistant. The apitongs have general construction qualities comparable to the hard pines of the temperate regions. In abundance, they are next in importance to the lauans.

YACALS.

The trees that produce timber of this group are yacal, guisoc, guisoc-guisoc, malayacal, narig, karig, mangachapuy, and dalingdingan-isac. The woods as a whole are yellowish brown, becoming darker with old age. They are all considered very durable timbers. This is especially true of yacal, guisoc, and malayacal, which invariably appear under the market name of yacal. Narig is often mixed with and sold as yacal. Mangachapuy and dalingdingan-isak are sold as mangachapuy.[1]

[1] Other trees, closely related botanically to these, yielding woods somewhat softer and less durable, are also found under the name of mangachapuy.

TABLE 7.—*Comparative characteristics*

CHARACTER OF

Types.	Lauan.	Lauan-hagachac.	Yacal-lauan.	Lauan-apitong.
Rainfall	Fairly well distributed throughout year: short or no dry season.	Fairly well distributed throughout year; short or no dry season.	Fairly well distributed throughout year: short or no dry season.	Pronounced dry season.
Relative humidity.	High and fairly well distributed throughout the year.	Medium during short dry season; high during rainy season.	Fairly low for short dry season; high during rainy season.	Fairly low throughout long dry season.
Altitudinal range.	From near sea level to 300 or 400 meters.	Near sea level	Near sea level	From near sea level to 300 or 400 meters.
Soil and underlying rock.	Medium shallow to fairly deep; rock volcanic; moist; sometimes fairly dry.	Usually alluvial; deep; alternatingly very moist and quite dry; underground water level near surface.	Shallow and fairly dry or very dry; volcanic rock.	Shallow to fairly deep; part of year very dry; volcanic rock.
Topography	Slight to steep slopes.	Level or nearly level.	Slight to steep slopes.	Slight to steep slopes.

CHARACTER OF

Merchantable timber per hectare.	50 to 450 cubic meters.	25 to 200 cubic meters.	50 to 300 cubic meters.	50 to 300 cubic meters.
Composition of dominant species.	Nearly pure stands of dipterocarps to complex.	Complex	Complex	Complex
Canopy of dominant species.	Closed or nearly closed; evergreen.	Open to closed; nearly evergreen.	Medium open: slightly deciduous.	Medium open; decidedly deciduous.
Profile of forest	Fairly regular to regular.	Very irregular	Irregular	Irregular
Erect palms	Abundant	Abundant	Fairly abundant	Almost absent
Erect bamboo	None or very few	None or very few	None or very few	Usually abundant.
Large lianas	Not abundant	Abundant	Fairly abundant	Fairly abundant
Composition of small trees.	Very complex	Very complex	Very complex	Very complex

of the different forest types.

THE HABITAT.

Tanguile-oak.	Molave.	Pine.	Mangrove.	Beach.	Mossy forest.
Fairly well distributed throughout the year; short or no dry season.	Fairly well distributed throughout the year to a distinct dry season.	Usually a distinct dry season.	Long, short, or no dry season.	Long, short, or no dry season.	Usually well distributed throughout the year.
High to very high, except in dry season.	Fairly low during dry season; high during rainy season.	Low to high___	Fairly high, or low during dry season.	Usually low during dry season.	Daily range great, but high at night.
From 400 to 900 meters.	Usually near sea level to 150 meters.	Usually above 900 meters.	Between low and high tide.	Near sea level.	Above 900 meters.
Very shallow to fairly deep; sometimes fairly dry: volcanic rock.	Usually on limestone rock; shallow soil; dry.	On shallow soil above limestone, or in deep soils not limestone; dry to moist	Usually a muddy, deep, delta soil; also coral limestone and sandy soil; wet.	Sandy or pebbly soil; very dry during dry season.	Rock exposure near surface; soil shallow; volcanic rock.
Usually rough; some gentle slopes.	Usually steep slopes; some gentle.	Steep slope to level ground.	Gently shelving.	Gently shelving.	Very rough.

THE VEGETATION.

20 to 150 cubic meters.	50 cubic meters and under.	100 cubic meters and under.	130 cubic meters and under.	Under 25 cubic meters.	No estimate.
Medium complex.	Fairly complex.	1 or 2 species of pines.	About 10 species.	Simple ________	Simple to medium complex.
Open to closed; evergreen.	Open; decidedly deciduous.	Open; evergreen.	Open to closed; evergreen.	Open; decidedly deciduous.	Open to closed; evergreen.
Very irregular.	Very irregular.	Regular to irregular.	Fairly regular.	Irregular ______	Irregular.
Fairly abundant but small.	None _________	None__________	Almost stemless nipa palm.	Very few ______	Many small ones.
None _________	Abundant or none.	_____do ________	None __________	Very few, if any.	Practically none.
Fairly abundant.	Abundant climbing bamboo.	_____do ________	_____do _________	Very few ______	Fairly abundant.
Complex _____	Complex _____	Very few _____	Very few______	Complex_______	Complex.

The yacals are usually hard and heavy. They are as free from the attacks of white ants and fungi as any so-called durable wood used for construction purpose. Yacal is a general all-round construction timber where contact with the ground is necessary, and because of this is much sought for railroad ties, paving blocks, and house posts. It is also used as bridge timber, in various parts of ships, and for construction of houses. It is estimated that there is more standing timber of the yacals in the Islands than all the other so-called standard durable timbers put together.

2. Substitutes for Mahogany.

The term "mahogany" is here used in its broadest sense. The true mahogany, the product of *Swietenia mahagoni,* does not occur in the Philippines. However, the narra family contains a group of woods of more or less brilliant color and beautiful grain which are capable of taking a high polish, and which can not be excelled as substitutes for mahogany. These are narra, tindalo, ipil, acle, and banuyo. Narra varies in color from a light yellow to a brilliant red. It is moderately heavy, moderately hard to hard, has a rather coarse more or less twisted grain, and is very durable. It is practically the same as the padouk of India, and is sometimes sold as Philippine mahogany. It is used principally for fine furniture, interior finish, doors, flooring, and windows. Large one-piece table tops come from the buttressed roots. Tindalo has a saffron red color, which becomes darker with age. It has a fine, more or less straight grain, and is heavy, hard, and durable. It is used in fine furniture and cabinetmaking, and is one of the best timbers for hardwood floors, stairways, and interior finishings, where beautiful expensive woods are required. Ipil, while used principally in the Philippines for construction work in contact with the ground, is nevertheless a wood of the mahogany grade. It is very durable, heavy, and very hard, has a fine, sometimes twisted, grain, and is one of the most satisfactory woods for fine furniture and cabinetmaking. Banuyo is moderately heavy and moderately hard, is golden brown in color, with a fine grain. It is used for fine furniture, cabinetmaking, carriage bodies, and carving. While none of the above are found in very large quantities, there is a sufficient supply to meet a small steady demand. All could probably be worked into veneers.

Besides the above, there are a number of other woods that are good substitutes for mahogany. Palo maria, sometimes called Borneo mahogany, is a hard and moderately heavy, reddish brown wood, with a fine twisted grain, that is capable of taking a good polish. Calantas is the only one of the true mahogany family that is sometimes sold under the name of Philippine mahogany. It is light and soft, reddish in color, and has a distinct odor resembling that of cedar. It is closely related to the West Indian cedar, and while making admirable furniture, piano cases, etc., it is much sought after for cigar boxes. It, however, like the other fine woods, is not plentiful.

Because of their abundance, and therefore their ability to supply the demands for a steady product, the finer grades of red lauan and tanguile will no doubt be known to the outside world as Philippine mahogany. These woods have a beautiful grain and color, and are susceptible of a good polish. They have already found a place in the United States as a substitute for mahogany. Such a market can be steadily supplied with large quantities of these woods.

3. Durable Timbers.

Next to fine furniture and cabinetmaking woods, the Tropics are noted for their hard durable timbers. Because of the warm climate and continuous moisture conditions, fungous growths and white ants rapidly destroy those timbers that are not able to withstand their attacks. No timber is able to do so indefinitely, but some are much more durable than others. Teak is perhaps the best known of this class of woods. This timber, while not indigenous to the Philippines, occurs in plantations in Mindanao and the Sulu Islands, and it has been demonstrated that the tree can be grown here successfully. It will no doubt become one of the planted tree crops of the Philippines, and the Islands will thus be enabled to furnish their share of the world's supply of this timber.

Because of their excellent qualities and comparative abundance, three Philippine timbers may be classed with teak, or at least may be regarded as substitutes for it. These are molave, ipil, and yacal.

Molave is perhaps the best known hardwood in the Philippines, and more of it is extracted than of any other one kind of wood in proportion to the amount of standing timber. It is a member of the teak family. The wood is hard and heavy, pale yellow in color, and has a fine but usually twisted grain. It is especially valuable for house posts, hardwood floors, window sills, railway ties, bridge timbers, paving blocks, salt-water piling, carvings, and many parts of shipbuilding. Trees of molave occur scattered usually on the limestone coastal hills throughout the Philippines. They generally have short, irregular boles, and this renders the timber less valuable than it would otherwise be. It is in such demand locally that little is now exported.

Attention has already been called to ipil as a valuable wood of the mahogany grade. Nevertheless, the demand for hard durable timbers is so great that it is usually considered as one of the best construction timbers, exposed to soil and weather. Like molave, its principal uses are for house posts, hardwood flooring, railway ties, paving blocks, and telegraph poles.

Yacal has also been discussed elsewhere. Because of its abundance, it is probably the only one of the hard durable timbers that will find much of a place in the markets outside of the Philippines. Prominence is given to the above-mentioned woods, not because they are the only hard durable timbers the Islands contain, but for the reason that they are the only ones in anything like sufficient quantity to supply the demands of the trade. Other principal timbers that resist well the attacks of fungi and white ants are narra, tindalo, acle, banuyo, calantas, palo maria, mancono, dungon, aranga, banaba, anubing, bansalaguin, batitinan, betis, the macaasims, pagatpat, supa, and agoho.

4. Salt-water Piling.

There is a strong demand for woods that will resist even fairly well the attacks of the shipworm (teredo), and few species are able to meet the necessary requirements. The woods most commonly sought for such purposes are molave, dungon, aranga, betis, liusin, and piagao.

Molave is one of the best woods for this purpose. The chief objection to it, however, is its irregular form, and the fact that it is difficult to find piles of sufficient length to meet the demands. Dungon has long been considered a valuable pile for salt water. The wood is very hard and heavy, tough, chocolate-brown in color, fine and cross grained, and difficult to saw. Besides piling, it is used for a large number of purposes, the principal ones being various kinds of naval construction, railway ties, and paving blocks. The amount that can be obtained in very limited. Aranga, formerly more plentiful but now very scarce, has long had the reputation of being one of the best woods for salt-water piling. It is very hard and heavy, ranging in color from yellow to chocolate brown. Betis, like the others, is a very hard and heavy wood, dark reddish brown in color. Liusin is one of the woods which has only recently come into use for this purpose. It is very hard and heavy, and pale red to red in color. Liusin piles, placed beside dungon, seem to last better than the latter. The part above water is more readily subject to fungous attacks. Piagao is said to resist the teredo well, but there is as yet no direct evidence to confirm this statement. None of the above woods are plentiful, especially in sizes suitable for piling.

5. Shipbuilding.

Teak, of course, is the standard shipbuilding wood. In the Philippines, the following are considered adapted to this purpose: Molave, dungon, yacal, mangachapuy, betis, ipil, guijo, narra, batitinan, palo maria, banaba, aranga, liusin. The following seem to be those in most common use for the different parts of the ship: Keels—Dungon, ipil, aranga, banaba, bansalaguin, betis, guijo, liusin, molave, narra, palo maria, yacal. Ribs—Molave, dungon, apitong, malugay. Sides—Yacal, guijo, banaba, apitong, batitinan, mangachapuy. Rudders—Molave, yacal, dungon, guijo. Spokes and handles of ships' wheels—Bansalaguin. Keelson—Batitinan. Masts—Palo maria, guijo, mangachapuy, and lauan. Decks—Mangachapuy, batitinan, palo maria. Rails—Yacal, guijo. Booms—Guijo, palo maria, mangachapuy.

6. A Substitute for Lignum-Vitæ.

True lignum-vitæ does not occur in the Philippines. Mancono has been tried, and seems likely to find a place as one of the lignum-vitæs in the world's markets.[1]

7. Bridges.

The following woods are most commonly sought for bridge building: Ipil, yacal, guijo, dungon, macaasim, and apitong.

8. Railroad Ties and Mining Timbers.

The railroads are accepting the following woods for ties: Ipil, molave, yacal, tindalo, betis, acle, anubing. To these can be added narig, mangachapuy, sasalit, banaba, malaruhat, macaasim, palo maria, batete, supa, and perhaps guijo and pagatpat. If creosoted, it is believed that the apitongs and the lauans would make very desirable ties.

The above woods could also be used as mining timbers. The scarcity of durable woods in the vicinity of mines, however, compels the use of any wood near at hand. In the Benguet mines, pine is practically the only timber used. Arrangements are being made for the use of preservatives on this wood. Where near at hand, the bacauans are also commonly used.

9. House Construction.

The choice of woods in building houses depends very much on the taste and means of the owner. The list given below is arranged approximately in the order of the quality, regardless of cost. It is well to explain that houses in the Philippines are usually built on posts known as *harigues* (from the Tagalog word *haligi*). This method doubtless comes from the original custom of building houses on posts to raise them above water or swampy ground, especially along the seashore, or as a protection against enemies. The custom still prevails, because the health conditions are better when the houses are some distance from the ground, and besides, they resist better the effects of earthquakes. As a usual thing the base or stump of the *harigue* is made of a durable wood, on which are spliced woods of a less durable quality.

Stumps: Ipil, molave, sasalit, bansalaguin, betis, dungon, yacal, banaba, and anubing.

Posts above stumps: Ipil, yacal, tindalo, dungon, aranga, anubing, macaasim, guijo, palomaria, supa, apitong, palosapis.

Trusses, girders, joists, framing, etc.: Yacal, dungon, ipil, tindalo, aranga, guijo, macaasim, supa, apitong, palosapis, amuguis, tanguile, lumbayao, red and white lauans.

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[1] See Hutchinson, W. F.: A Philippine Substitute for Lignum-vitæ. Bulletin No. 9, Bureau of Forestry, Manila, P. I.

Floors and stairs: Molave, ipil, tindalo, aranga, calamansanay, narra, pagatpat, palo maria, yacal, malacadios, supa, amuguis, mangachapuy, apitong, tanguile, palosapis, red and white lauans.

Interior trimming: Acle, narra, tindalo, molave, palo maria, malacadios, banuyo, calantas, malugay, supa, guijo, amuguis, tanguile, lumbayao, palosapis, red and white lauans.

Interior sheathing, doors, sash, etc.: Narra, molave, ipil, palo maria, malacadios, malugay, supa, guijo, tanguile, palosapis, lumbayao, red and white lauans.

Many houses are built cheaply now by using guijo and apitong for the trusses, girders, etc., guijo, amuguis, or tanguile for the flooring, and tanguile and red or white lauans for interior trim. These latter make a beautiful finish. Of course, all sorts of combinations of timbers are possible, depending upon the taste and means of the owner, and upon the local supply.

10. Paving Blocks.

Molave is the favorite paving block. Ipil and yacal are also used extensively. Tests are being made of treated blocks of the cheaper and less durable kinds. Creosoted paving blocks of lauan and other nondurable timbers have been in use over two years and as yet show no signs of decay or wear. Pagatpat blocks have been laid recently and are expected to give good results.

11. Furniture and Cabinetmaking.

The list of woods used for cabinetmaking and furniture is a long one. Of the durable woods, narra seems to be the favorite. Of the less durable ones, red lauan and tanguile are extensively used. Nearly all the woods of the narra family are used more or less for this purpose, especially tindalo, banuyo, ipil, acle, and supa. Other woods are ebony, camagon, bolongeta, palo maria, batitinan, baticulin, catmon, lanete, calamansanay, lumbayao, banaba, calantas, bancal, anubing, molave. (See under substitutes for mahogany, p. 36.)

12. Carving and Engraving.

Lanete is the favorite wood for carving. Others principally used are ebony, molave, camagon, banuyo, narra, acle, acleng-parang, tindalo, bansalaguin, and baticulin.

13. Canes.

The favorite woods for canes are ebony, camagon, and bolongeta; others are kuyus-kuyus, camuning, mancono; woods of various palms are also used for canes.

14. Boxes and Dry Measures.

The lauans and the natos are the favorite woods for these purposes. Narra is often used for the larger sizes of measures.

15. Tool Handles.

The following are the woods most suitable for tool handles: Dungon, dungon-late, kulis, bansalaguin, banaba, alupag, liusin, camagon, tindalo, narra.

16. Carriage Building.

For this purpose the common woods are: Shafts—Guijo, lanutan. Hubs—Palomaria, guijo, dungon, ipil. Spokes and felloes—Guijo, yacal, molave. Covering of the body—Banuyo, amuguis, white and red lauans, and the natos. Floor and back—Red lauan, guijo, apitong, narra, natos. Axles—Guijo.

17. Wooden Shoes.

The following are used for the soles of wooden shoes and slippers: Tui, dita, anabion, bayabas, cupang, balacat, ligaa, lumbang, pinkapinkahan, white natos, daluru (air roots of pagatpat and api-api).

18. Telegraph and Telephone Poles.

Here, as in many other instances, almost any available wood is used. Ipil seems to be the favorite, although pagatpat is now coming into use. Green poles of kapok (cotton tree) are placed in the ground, take root, and become trees. As such, they are extensively used in some parts of the Philippines.

19. Matchmaking.

The woods most commonly used for matchmaking are malapapaya and taluto. The following are also used: Pinkapinkahan, cupang, biluang, hamindang, binunga, lumbang, and gubas.

20. Musical Instruments.

The following is a list of woods used for making musical instruments: Sides of guitars and mandolins—Lanutan, nangka, banuyo, acle. Bottoms—Banuyo, camagon, nangka. Necks—Lanete, kayutana, camagon. Tops of necks—Camagon. Sounding board—Imported and native pines. Pins—Dungon and camagon. Calantas is used for piano cases, and ebony for keys.

In Part II of this bulletin there is arranged, for the various species discussed, a list of the uses to which each wood is put.

WEIGHT AND HARDNESS.

Weight and hardness are relative terms. In the United States the woods of all broad-leaved trees are considered hard. In this sense, all the woods of the Philippines, except the pines, are classified as hard. Using the term "hard" in a more rational way, a number of Philippine woods could be classified as soft.

Weight in woods is a variable quality. It depends, for woods of the same species, on the age of the tree; on the conditions in which it is grown; on the portion of the tree from which the sample weighed is taken; and on the amount of moisture contained. The latter variability is eliminated by basing the specific gravity on the dry wood, as is done in the following table. Taking everything into consideration, it would be misleading to apply a fixed specific gravity to each wood; therefore it is thought best to group the woods in such a way as to allow for a range in weight and hardness by using relative adjectives to designate these qualities.

The following tables are based mainly on the work of Gardner [1] and Foxworthy,[2] with some modifications and additions:

TABLE 8.—*Table of weights of the principal Philippine woods.*

Very heavy.	Heavy.	Moderately heavy.	Light.
Sp. gr. 0.90 or more; 900 kilos or more per cubic meter; 56 pounds or more per cubic foot.	Sp. gr. 0.70–0.90; 700 to 900 kilos per cubic meter; 44 to 56 pounds per cubic foot.	Sp. gr. 0.50 to 0.70; 500 to 700 kilos per cubic meter; 31 to 44 pounds per cubic foot.	Sp. gr. 0.50 or less; 500 kilos or less per cubic meter; 31 pounds or less per cubic foot.
Bacauans.	Agoho (*a*). [a]	Acle.	Almon-lauan.
Billian.	Alupag (*a*).	Acleng-parang.	Antipolo.
Bolongeta.	Aranga (*a*).	Amuguis (*a*).	Bagtican-lauan.
Camagon.	Bansalaguin (*a*)	Anubing.	Baticulins.
Camuning.	Batete.	Apitong (*a*).	Biluang.
Ebony.	Betis (*a*).	Banaba (*a*).	Calantas.
Mancono.	Batitinan.	Balacat.	Cupang.
Pototans.	Binggas.	Balinghasay.	Dita.
Sasalit.	Calamansanay.	Bancal.	Duguan (*a*).
Tangal.	Catmon.	Banuyo.	Gubas.
	Dalindingan-isak.	Batino.	Kalunti-lauan.
	Dungon (*a*).	Benguet pine.	Lauan, red (*a*).
	Dungon-late (*a*).	Calumpit.	Lauan, white.
	Guisoc (*a*).	Dalinsi.	Malapapaya.
	Guisoc-guisoc.	Dao.	Mayapis-lauan.
	Ipil (*a*).	Guijo (*a*).	Mangasinoro-lauan.
	Lanutan.	Hagachac (*a*).	Palosapis (*a*).
	Liusin (*a*).	Lanete.	Pinkapinkahan.
	Malayacal (*a*).	Lumbayao.	Taluto.
	Macaasim.	Malasantol.	Tiaong-lauan.
	Mangachapuy.	Malacadios (*a*).	
	Molave.	Malacmalac.	
	Narig (*a*).	Manicnic.	
	Pagatpat.	Malugay.	
	Tindalo.	Nangka.	
	Tucang-calao.	Narra.	
	Yacal (*a*).	Nato.	
		Palo maria.	
		Piagao.	
		Panao (*a*).	
		Salinkugi.	
		Santol.	
		Sacat.	
		Supa (*a*).	
		Tabigi.	
		Talisay.	
		Talisay-gubat.	
		Tamayuan (*a*).	
		Tanguile.	
		Teak.	
		Toog.	
		Tuai.	

[a] The woods followed by (*a*) also have representatives in the class immediately higher than the one in which they are placed.

[1] Gardner, R.: Mechanical Tests, Properties, and Uses of Thirty-four Philippine Woods. Bulletin No. 4 (2d ed.), Bureau of Forestry, Manila, 1907.

[2] Foxworthy, F. W.: Philippine Woods, Phil. Jour. Sci., Sec. C, Vol. II (1907), pp. 351–404, and Indo-Malayan Woods, same Journal, Vol. IV (1909), pp. 412–415.

TABLE 9.—*Table of hardness of the principal Philippine woods.*

Very hard.	Hard.	Moderately hard.	Soft.
Agoho.	Acle.	Anubing.	Almon-lauan.
Alupag.	Acleng-parang.	Apitong (*a*).[a]	Antipolo (*a*).
Aranga.	Amuguis.	Banuyo.	Bagtican-lauan.
Bacauans.	Batino.	Banaba (*a*).	Balacat (*a*).
Bansalaguin.	Batitinan.	Batete.	Bancal (*a*).
Betis.	Binggas.	Balinghasay.	Baticulins (*a*).
Billian.	Calamansanay.	Calumpit.	Binunga.
Bolongeta.	Catmon.	Dalinsi.	Calantas.
Camagon.	Guijo.	Dao.	Cupang.
Camuning.	Guisoc.	Hagachac (*a*).	Dita.
Dungon.	Guisoc-guisoc.	Malasantol.	Duguan.
Dungon-late.	Ipil.	Malacadios (*a*).	Gubas.
Ebony.	Macaasims.	Malacmalac.	Hamindang.
Liusin.	Mangachapuy.	Manicnic.	Kalunti-lauan.
Mancono.	Malayacal.	Nangka.	Lanete (*a*).
Narig.	Malugay.	Narra (*a*).	Lauan, red (*a*).
Pototans.	Molave.	Nato.	Lauan, white.
Sasalit.	Pagatpat.	Panao (*a*).	Lumbayao (*a*).
Tangal.	Palo maria.	Salinkugi.	Malapapaya.
	Piagao.	Talisay.	Mangasinoro-lauan.
	Supa.	Talisay-gubat.	Mayapis.
	Tabigi.	Tanguile.	Palosapis (*a*).
	Talisay.	Teak.	Benguet pine (*a*).
	Tamayuan.	Toog.	Santol (*a*).
	Tindalo.	Tuai.	Taluto.
	Tucang-calao.		Tiaong-lauan.
	Yacal.		

[a] The woods followed by (*a*) also have representatives in the class immediately higher than the one in which they are placed.

LUMBERING IN THE PHILIPPINES.

1. MARKETS.

The demand for lumber in the Philippines is greater at the present time that the local lumbering operations can supply. The volume of native timbers that passed through the official channels for the fiscal year 1909–10 amounted to 176,758 cubic meters (44 million board feet). During the same time there were imported into the Islands approximately 20 million board feet, 12 millions of which was for the United States Army. Besides this, 798 gratuitous licenses were issued for both public and private use, and a large amount of timber was obtained without license under the free-use privilege. The quantity used without charge is estimated to be at least 25 million board feet. This makes the total consumption of timber in the Islands as follows:

	Million board feet.
Regular licenses	44
Free use	25
Imported	20
Total	89

This amount does not include 246,776 cubic meters of firewood upon which forest charges were paid but which can not be expressed in board feet; nor an unknown, but large, amount of firewood extracted and used free of charge.

The lumber markets in the principal centers of the Islands are unstable, although they are more satisfactory to-day than ever before. Previously a large number of the dealers handled a mixture of many kinds of timbers which were often unassorted even as to classes, to say nothing of grading within the classes. The lumber was often poorly sawed, and not trimmed or edged. This condition still exists among many dealers. The larger firms are putting on the market more perfectly sawed timber, edged and trimmed, and in many instances graded. They confine their efforts to handling a few kinds, and keep a supply on hand to satisfy demands up to a million or more board feet. As a rule, however, a great deal of the lumber reaches the market green, and is sawed, sold, and put to use at once, shortly after it is cut. As a result, it is poorly seasoned, and can not but give the timber a bad name. It is hoped that some time in the near future concerted action can be taken by dealers to establish a uniform system of grading.

The market with regard to prices of the principal kinds is becoming more and more stable. Previously, small cutters with little capital, who brought timber to market, were at the mercy of the commission merchants, and often had to sell at a sacrifice in order to continue operations. This is not so true to-day as it was three or four years ago.

The average Manila retail price of the cheaper grades of the lauans is ₱50 to ₱60 per thousand feet board measure; better grades of red lauan and tanguile sell for ₱60 to ₱80; apitong sells for ₱70 to ₱80; guijo, ₱80 to ₱90; yacal for ₱120 to ₱150; molave, ₱150 to ₱200; ipil, ₱150 to ₱200. Oregon pine, the chief foreign competitor of the cheaper construction timbers, retails for ₱50 to ₱70. With the present strong demands for timber, there is little inducement to handle native timbers to undersell the Oregon pine. When well seasoned, the lauans are as good as Oregon pine for certain classes of construction, and are much better for other purposes for which they are used.

The increased activity in all lines of business during the past year has created great demands for all classes of construction timber, especially dipterocarps (lauan, apitong, and yacal), ipil, and molave. At the present time, this demand is too great to warrant large shipments to America or foreign countries. Should the local market become overstocked—and with greatly increased exploitation it can easily become so—the China market alone could consume the surplus. Philippine timbers have an excellent reputation in China, where the better grades from Borneo and Singapore are often sold under the name of Philippine hardwoods. This being the case, it is all the more imperative that a good system of grading should be established, with Government inspection for exported lumber. During the fiscal year 1909–10, 1,300,000 feet of lumber were exported, which is twice the amount exported during any previous year since the American occupation.

2. Logging Operations.

During the fiscal year 1909–10, there were issued 969 ordinary and exclusive licenses. Deducting 20 per cent for licenses which were not used, there are left 775 licensees, who extracted 44 million board feet of timber, an average of about 57,000 board feet for each licensee. During the fiscal year 1909–10 the largest licensee cut about 8 million board feet; the next largest cut and manufactured about 3 million board feet. A number reached over 250,000 board feet, but by far the majority of the licensees placed on the market much less than this amount.

From the above it will be seen that the majority of the licensees are small operators. They use human and animal motor power to get their timber to tide water. In a very few instances, hand labor is employed, but only when the timber is within a few hundred feet of the coast; in fact, in most instances, this method is utilized only on the slopes of hills fronting tide water. The animals used in hauling the logs are, almost without exception, carabaos (water buffaloes).

The method used in extracting timber by carabao is crude and wasteful at its best. This crudeness, coupled with the usual methods of financing the operation and getting the timber to market, is the main cause of the high price of lumber. As a general rule, the Filipino licensee is of the upper class, known as "ilustrados." He often controls a following of workmen who are practically under his power. He seldom, if ever, visits the woods. He furnishes a follower, or friend, with the carabao and other equipment, in consideration for which he receives a certain percentage of the value of the logs that are cut and hauled to the beach. This man in turn selects the woodsmen from his following, who are paid so much per cubic foot for the timber delivered on the beach. These men may or may not be advanced provisions and held responsible for the equipment and the health of the carabao. In some instances, the men who really do the work get no pay, except provisions, and usually are kept so deeply in debt that they become almost the slaves of their landlords and creditors. This is especially the case, as often occurs, when the licensee stakes the workmen with provisions direct, and holds them responsible for the condition of the carabao. Sometimes the licensee is the friend or relative of local native officials, who use their influence to help him get or control the labor. In return, political help is expected.

In the Moro country, the retainers of leading datos are used in the following way: A merchant in a coastal town, usually a Chinaman or American, who may or may not be a lumberman, gets on friendly terms with a leading dato who has a large following throughout a wooded district. The merchant obtains the license, and makes a bargain with the dato to furnish him with timber at so much per cubic foot. The dato issues orders to each of his henchmen, who are under his control, to cut and remove a certain amount each month, for which they are paid so much a cubic foot, usually in provisions. In this way, the dato and the merchant both get their timber cheap at the expense of the man actually doing the work. In defense of such methods, it is only fair to state that they are usually in operation in the outlying districts, and the forest wealth can not at present be utilized in any other way. With the development of the lumber industry, such methods will go and are going out of use.

In many instances, the licensee is a lumberman himself, pays his workman a direct wage, and treats them fairly. The policy of the Bureau of Forestry is to favor such licensees. Too often, however, the licensee pays little attention to the actual cutting in the woods, leaving this to the ignorant workmen without adequate attention, confining his own efforts to the milling operations and to the disposal of the product. The result is that his men are not utilized to the best advantage. This makes the cost of extracting the timber abnormally high, and places the licensee at a disadvantage, as compared with those who use the system of logging by contract. This handicap, however, may be overcome by the better milling he secures.

In many instances, the trees are cut with rude, narrow-blade axes, although American axes and crosscut saws are coming more into use. The logs are cut into proper lengths; one, two, three—sometimes as many as fifteen—carabaos are hitched tandem fashion to each one; and with one man to control each carabao the log is drawn to its destination. Sometimes the logs are squared, and sometimes they are removed in the round. Frequently a rude sled is used, one end of the log resting on the ground; but two-wheeled carts are sometimes substituted. The harness is often a rude affair, consisting of a yoke, with ropes made of rattan. Occasionally good logging trails are constructed, over which the logs are dragged. The length of haul varies from a few meters up to 5 and 8 kilometers (3 to 5 miles).

The above description of the financing system usually in vogue, and of the rude methods of logging, is sufficient to show that both the system and methods are capable of improvement, and until they are improved the actual cost of logging will be proportionately higher than it ought to be. What is needed more than anything else is competent supervision of the logging operations. It is believed that with such supervision the cost of cutting and removing timber to tide water can, in many instances, be reduced at least one-half. The removing of logs by man force, in use to some extent in Borneo and other neighboring countries, can not be adopted to any extent in the Philippines, principally on account of the scarcity of labor.

Certain portions of our forests are adapted to logging by animal labor and no other. This is true of the molave type, that contains scattered valuable trees too far apart to warrant the establishment of expensive steam logging. It is also true of isolated remnant patches of the dipterocarp types, where the amount of timber is limited.

Steam logging, with a railroad from the cuttings to the mills at tide water, is in successful operation by three companies. These companies have installed a logging system, patterned after the methods in use in the United States. The trees are cut by crosscut saws, bucked up into the proper lengths with saws, hitched to cables, pulled to landings by donkey engines, loaded on cars, and carried on a logging railway to the mill, 5 to 8 miles distant. These companies are exploiting forests covering large areas, that contain from 20,000 to 40,000 feet per acre of merchantable timber, composed principally of the lauans and the apitongs. With American foremen, they have been successful in accustoming their labor to the use of the crosscut saws and to the handling of the timber by machinery in all stages of the operations.

There are a number of locations in the Islands where equally good forests are found, but in some instances engineering obstacles will have to be overcome to obtain access to them. These difficulties, however, are no greater than those encountered in many parts of the United States where steam logging is in successful operation.

3. Milling Operations.

I.—STEAM SAWING.

The number of saw mills in the Islands has grown from 31 in 1907 to 60 in 1910. This increase has been mostly in the installation of small mills in the provincial towns, or in or near the cutting areas. Manila contains 11 steam mills, and the provinces the remainder. Outside of Manila, there are three band-saw mills. These contain modern appliances to handle the logs, the finished product, and the waste.

A majority of the provincial sawmills do not cut more than 3,000 board feet daily when running at their full capacity. Nearly all the small sawmills are greatly handicapped by the lack of sufficient power. Some of them can not handle many of the large logs, except by first cutting them up by handsaws.

II.—HAND SAWING.

Hand sawing, known also as whipsawing, is still extensively used throughout the Islands, principally by Chinese lumbermen. There are several firms, located in Manila, Cebu, Iloilo, and other large towns, who can manufacture from 3,000 to 10,000 board feet per day. Nearly every town of any importance has its whip sawyers. In most towns, no other kind of sawed lumber is used at all, so that the merchants find no competition from steam-sawed material. The firms in places where there is competition are able to hold their own because they utilize almost the full contents of the log. In the first place, the saw kerf is as low as 0.08 of an inch, as contrasted with 0.16 to 0.30 of the band and circular saws. As a rule, the lumber is neither edged nor trimmed, being sold in the full length and width of the portion of the log from which it is taken. Great care is taken to utilize all the waste; as much of the log as possible is converted into lumber, and the remainder is sold for firewood and other purposes. The hand sawyer is often able to manufacture from 9 to 10 board feet from each cubic foot of lumber, as against the steam mills' cut of 5, 6, or 7 board feet per cubic foot of the raw product. The Chinese and Filipino contractors demand a great deal of lumber ½ inch or less in thickness, which they use mostly for partitions and boxes. Hand sawyers often buy 1-inch steam-sawed material, and whipsaw it into two boards that sell for ½-inch lumber. Chinese merchants often contract with steam mills to have their logs sawed. They are usually on the ground watching the process, and save every scrap of the so-called waste.

Sawmills that are located in the large cities, or in heavily populated centers, find a ready marked for at least a portion of the waste. The merchants operating the smaller mills often carefully sort their timber into many grades, and find a ready sale for the slabs and edgings that are not used as fuel in the mill. In mills some distance from the centers of the population, the waste is usually burned, except that utilized for fuel or sold by the small boatload to any buyer who cares to come for it. The whipsawed material would become a more severe competitor of that from the steam sawmills if enough of it could be placed on the market to supply the demand, and were it not that large contractors will not handle it because it is not sized, edged, or trimmed. The lack of labor as cheap as that found in China will always limit the output of whipsawed lumber in the Philippines.

4. Transportation.

The high cost of getting timber to market in the form of logs or manufactured lumber is at present the bugbear of the lumbering business. Few companies have as yet succeeded in successfully solving this problem. The product of no single company is sufficiently large to warrant its maintaining a steamer built especially to carry lumber. Until such time as a single company or a combination can manufacture enough lumber to warrant its shipment direct from the mill to the markets they can not hope to compete sucessfully with Oregon pine in the Chinese or other markets. At present all the lumber for foreign markets is transshipped at Manila or Singapore. This, with the necessary handling in transshipping, approximately doubles the cost of a direct shipment, as the local freight rates are excessively high. From remote districts, out of the regular lines of steamers, it often costs as high as ₱60 a thou-

PLATE XV.—INTERIOR VIEW OF TANGUILE-OAK TYPE.

Tanguile and *Eugenia* sp.

Plate XVI.—INTERIOR VIEW OF MANGROVE SWAMP.

Plate XVII.—INTERIOR VIEW OF MANGROVE SWAMP.

Plate XVIII.—VIEW OF THE BEACH TYPE.

PLATE XIX.—PINE FOREST OF BENGUET.

PLATE XX.—EXTERIOR VIEW OF MOSSY-FOREST TYPE AND UPPER PORTION OF TANGUILE-OAK TYPE.

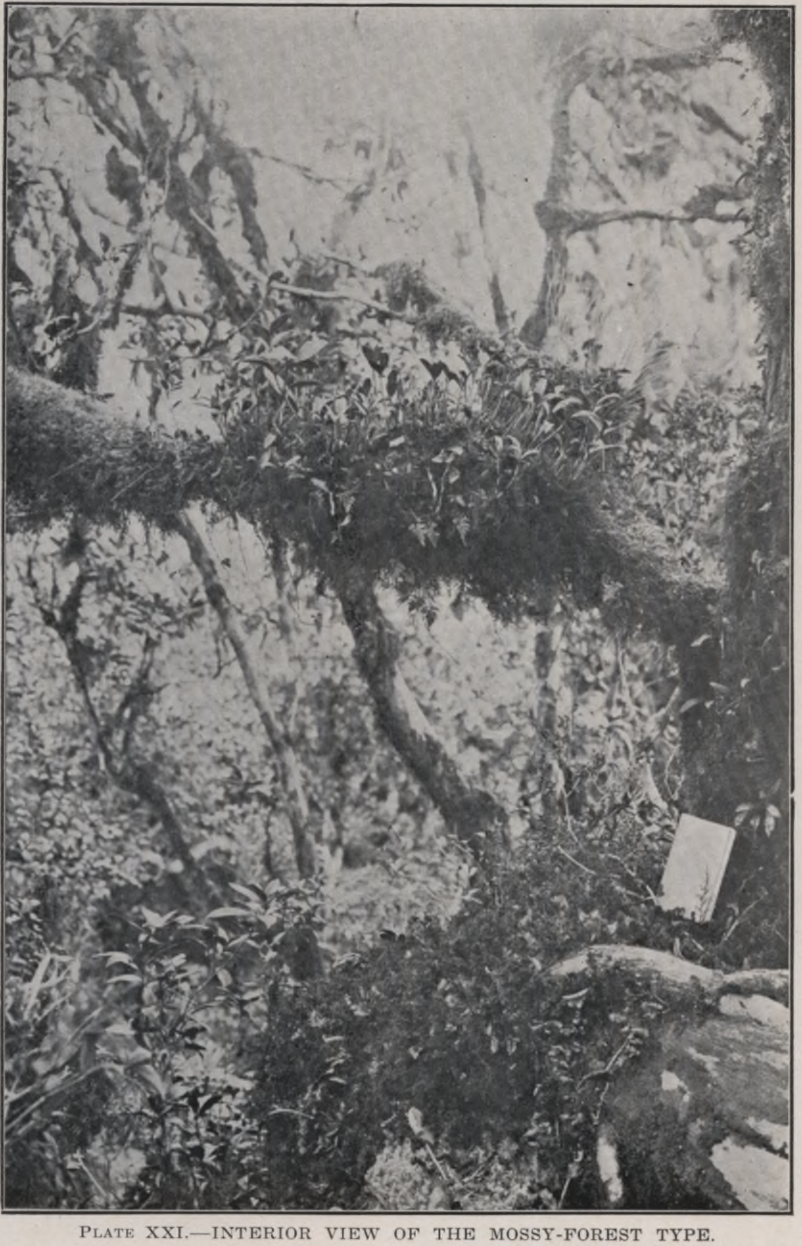


PLATE XXI.—INTERIOR VIEW OF THE MOSSY-FOREST TYPE.

sand board feet to transport timber in the form of logs. From distances equally remote from Manila in the line of travel of the interisland steamers, the cost is ₱11 to ₱29 per thousand board feet of the manufactured product. These boats are ill adapted to carrying lumber or logs.

Logs are occasionally transported short distances by rafts. These rafts are usually rudely constructed affairs, with the logs tied together with rattan. Light logs are used for buoys, and heavy timbers can thus be transported. However, the principal forest regions are remote from the lumber centers, and no attempt has been made to raft timber from them to the markets. Some of the larger companies use barges to transport the finished product. The smaller concerns are dependent upon small sailing vessels.

To sum up, the high cost of placing the timber of the Philippines on the market is due to the following causes: (1) The high cost of logging, due principally to the crude methods employed and to lack of proper supervision; (2) the excessive cost of milling, due to (*a*) insufficient equipment and poor arrangement of the mill, (*b*) to the difficulty of getting competent men to manage the operations, and (*c*) to a consequent loss in sawing due to excessive waste and poorly manufactured material; (3) as yet no company has a capacity sufficient to warrant their owning or hiring vessels especially adapted to carrying lumber to the home or foreign markets. The conditions above described are distinctly pioneer in nature. A few companies have sucessfully met some of them, but none have as yet succeeded in meeting the entire situation. When they do, they will be able to compete with all other timbers of like grades in the foreign and home markets.

The scarcity of the high-grade timbers needed in construction work in contact with the ground can and will be overcome by artificially preserving timbers of the cheaper construction kinds. This is the solution of the problem, especially so far as concerns the timber used in railroad construction and mines.

5. Labor.

Much has been written concerning the labor problem of the Philippines. That it is a serious one with many industries in the Philippines can not be denied; that it can be successfully solved is an established fact, so far as lumbering and logging are concerned. With good American foremen, crews of native laborers have been trained to conduct successfully the operations both in the woods and in the mill. Where the best results have been obtained, they are at least equal to and sometimes better than American labor, considering dollar for dollar of outlay. The wages vary from ₱0.50 to ₱1.50 per day. When properly treated, Filipinos make fairly steady workmen. In thinly settled forest regions, it is necessary to import labor from the more thickly settled districts. Many difficulties naturally stand in the way of doing this, but with some patience it can be and has been successfully accomplished. Colonies must be established, schools and churches built, and amusements provided. Once the lumberman gains the confidence of the men working for him, he will find laborers coming of their own accord. Failures in getting labor in the Philippines are less frequent in the lumbering business than in other pursuits. The Filipino has a natural aptitude for running machinery, and it is the kind of labor that he likes. He must, however, be constantly supervised by Americans or other foreigners who understand their business and the men working under them.

6. Opportunities for Lumbering.

A reference to the description of types will show that certain of our forests produce heavy stands of timber of a few kinds, and are therefore adapted to lumbering on a large scale. This is especially true of the lauan and the lauan-apitong types; less so of the lauan-hagachac and yacal-lauan types only because these do not cover so large a territory. With sufficient capital and modern methods of logging and milling, these forests can be successfully exploited.

There are a number of desirable tracts suitable for large operations in the dipterocarp types that await capital for the utilization of the timber upon them.

As already stated, the entire area of some of the forest types, and isolated patches of others, are not adapted to large operations simply because the supply of timber is not great enough to warrant great expenditure in extracting it. Opportunities for the small investor in these are not lacking. Indeed, a large proportion of the most valuable timber placed on the market to-day comes from the tracts granted to small licensees.

7. Conclusion.

As shown above, the lumber business in the Philippines is at present a small one. The handling of 89,000,000 board feet annually can not be considered, comparatively speaking, a large business. Yet the possibilities are great. A number of large tracts of virgin timber are ready for the ax. To exploit them successfully capital is necessary.

It is estimated that the forests properly managed can be made to yield two billion board feet annually, without being damaged. This will allow a rotation of one hundred years. While there is no prospect of the full utilization of the forest wealth in the immediate future, with sufficient investment of capital there is little reason to doubt that within the next ten or fifteen years the annual output of timber in the Philippines will reach the 500-million mark.

MINOR FOREST PRODUCTS.

Minor forest products include everything derived from the forest with the exception of timber. Most of the forest plants are put to some practical use—either the entire plant or some portion of it, as the bark, leaves, fruit, etc.—and in general the dependence of the neighboring peoples upon the forest for the means of existence is in inverse proportion to their stage of civilization. As they become more and more civilized, commerce offers them a wider range of choice and they become less dependent upon the local supply. Thus it happens that savage or semisavage tribes have shown great ingenuity in discovering uses for the forest products within easy reach, and as they are gradually thrown in contact with neighboring tribes the uses are extended, until eventually many of the forest products find a permanent place for themselves in the markets of the world. At the present time, therefore, minor forest products may be divided into two classes: Those whose uses are widely recognized, and which have a market value sufficiently definite to permit them to be assessed for the forest charges; and, second, those whose use is so purely local, or the demand for which is so unsteady, that they are not sold in the market, or which for some other reason it is impracticable at present to bring under the Internal Revenue Law.

1. Woods Used for Fuel.

FIREWOOD.

More wood is annually used for fuel in the Islands than for lumber. Records for the fiscal year 1909–10 show that 246,776 cubic meters of firewood were cut, and it is probable that an even greater amount was cut and used without record.

While all kinds of woods are used for firewood, the favorite source is the mangrove swamps, producing a group of woods which may be classed under the names of bacauans, pototans, and tangal. These woods have calorific power higher than that of oak,[1] and are among the best firewoods in the world. They constitute the principal value of the mangrove swamps which are found scattered along the seacoasts throughout the Islands, varying in width from a few feet to several miles. They probably cover about 2 per cent of the forest area of the Islands, or about 800 square miles.

There are other woods in the Philippines that have perhaps an even higher heating power than the mangroves. Among these is agoho (*Casuarina equisetifolia*), but because of its scarcity it can never take the place of the bacauans. Many species of trees found in the second-

[1] According to tests made by the Bureau of Science, Manila, the gram calories of bacauan is 8,161, of tangal 8,055, and of oak 7,965.

growth forests yield excellent firewood. Among these are bayabas (*Psidium guajava*), ipil-ipil (*Leucaena glauca*), and madre-cacao (*Gliricidia sepium*).

Firewood is sold under the name of *rajas* and *leñas*. The former are from 60 to 150 centimeters in length and from 7 to 15 centimeters in diameter. *Leñas* are of smaller dimensions. It is impossible to estimate the value of the firewood used annually in the Philippines. The average retail price of bacauan in the Manila market is about ₱25 a cord.

CHARCOAL.

The principal woods employed in the manufacture of charcoal, like those used for fuel, come from the mangrove swamps. They include the bacauans, the pototans, tangal, tabigi, and dungon-late. In places where mangrove woods are not available, agoho, binayuyu, bayabas, madre-cacao, and other species of the second-growth forest furnish the supply. Kilns for burning charcoal, as a rule, are rudely constructed. A number of Japanese licensees have introduced the methods employed in their own country; and if their kilns would find general acceptance the usual methods of burning charcoal would be improved.[1] The charcoal industry of the Philippines is not a large one and does not supply the full demand, for small quantities are annually imported. Official records for the fiscal year 1909–10 show that 4,315 cubic meters[2] were used. During the same time 50,538 kilos were imported.

2. Barks.

Under the local name of cascalote, the barks of many trees are utilized for various purposes, principally for tanning and dyeing.

TAN BARKS.

The tanning industry in the Islands is not highly developed, and as there is no export trade in the barks or their products the amount utilized for this purpose is small. The principal source of tan bark is the bacauan family of the mangrove swamps. The crude product derived from the bark is known as mangrove cutch, which has to be put through certain processes of refinement before it is ready for tanning. There are no cutch factories in the Philippines, but some are in successful operation in Borneo, where the mangrove swamps are more extensive. However, the swamps in Mindanao, Palawan, and other islands in the southern portion of the Archipelago cover a sufficient area to justify the establishment of cutch factories, and there seem to be

[1] For a description of the two types of kilns see Maule, Wm. M.: The charcoal industry of the Philippine Islands. Bull. 2, Bureau of Forestry, Manila, P. I., 1908.

[2] Approximately 1,000,000 kilos; 230 kilos equal 1 cubic meter.

excellent prospects for introducing the industry and for thus utilizing the bark from a large proportion of the swamp timber felled for firewood. Through certain chemical changes coloring matters begin to appear in the bark soon after felling, and for this reason it is considered necessary to work up the bark within forty-eight hours. This requires the factories to be located in or near compact mangrove areas. Four to 6 tons of bark are necessary to produce 2 or 2½ tons of cutch.

The barks of the following species of the mangrove trees contain tannin: Bacauan (*Rhizophora conjugata*), bacauan-lalaki (*Rhizophora mucronata*), pototan (*Bruguiera eriopetala*), busain (*Bruguiera gymnorrhiza*), langarai (*Bruguiera parviflora*), pototan-lalaki (*Bruguiera caryophylloides*), tangal (*Ceriops tagal*).

Recent analyses of barks from Mindanao made in the laboratories of the Bureau of Plant Industry, Washington, D. C., show the following results:

Kind.	Total solids.	Soluble solids.	Reds.	Nontannins.	Tannins.
Tangal	58.58	49.02	9.56	13.19	35.83
Bacauan	53.91	51.03	2.88	11.64	39.39
Pototan	37.36	36.81	.55	10.15	26.66
Langarai	24.43	19.82	4.61	7.27	12.55

The proportion of tannin according to these analyses compares favorably with that of barks of the same species from Borneo. It is estimated that the swamp area of one bay in Mindanao contains 25,000 hectares and that it will yield approximately 25 tons of bark to the hectare, making a total of 625,000 tons of bark. With a rotation of twenty years this is a sufficient quantity to supply a large factory indefinitely.

While there are probably many other trees in the Philippines besides the mangroves whose bark produces tannin, camanchile (*Pithecolobium dulce*) and agoho (*Casuarina equisetifolia*) are the only ones utilized to any extent.

OTHER BARKS.

The bark in the Philippines used most extensively for dyeing purposes comes from tabigi or nigi (*Xylocarpus obovatus*), also a tree of the mangrove swamps.

The extract from the bark of tangal is employed for flavoring and coloring the sap of coconut and other palms used as alcoholic beverages. By far the largest proportion of the bark of this tree now gathered in the Philippines is used for this purpose.

A number of small trees contain barks used for tying purposes. In some instances they are used direct; in others they are first made into ropes. Among these may be mentioned the following: Malubago (*Hi-*

biscus tiliaceus), anilao (*Columbia serratifolia*), tanag or taloktok (*Kleinhofia hospita*), danling-aso (*Helicteres hirsuta*).

The barks of a number of vines and trees produce materials suitable for soap. Gogo (*Entada scandens*), the principal one of these, is a large vine. Sections of the vine are pounded to a pulp, bound into small bales, and are used extensively for washing hair. Salinkugi or gogong-toko (*Albizzia saponaria*) is a tree containing a bark that is used for the same purposes as the gogo vine. While other vines and trees yield soapy barks, none are used to the same extent.

The total amount of tan bark officially manifested during the fiscal year 1909–10 was 3,302,939 kilos, two-thirds of which came from Mindanao. The amount of dye bark manifested amounted to 98,482 kilos.

3. Dyewood.

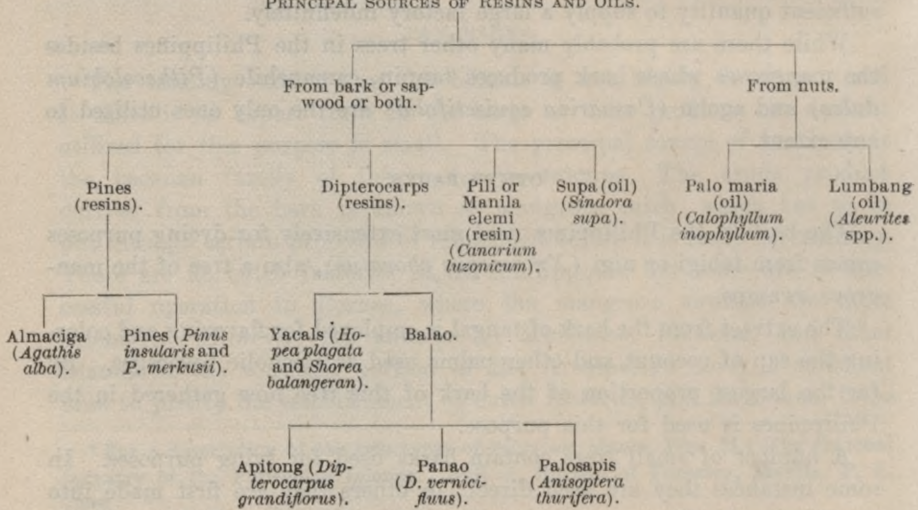
While a number of woods of the Philippines can be used for dyes, only one, sibucao (*Cæsalpinia sappan*), is so used to any extent. This is practically the equivalent of the Brazil wood (*Cæsalpinia echinata*). It is a small bushy tree and is semicultivated, especially in the Island of Guimaras, from which most of it comes. During the fiscal year 1909–10, 1,154,614 kilos of dyewood passed through official channels, practically all of which was sibucao.

4. Resins and Oils.

The following diagram shows the sources of the principal oil and resinous products of the Philippines:

Table 10.

Principal Sources of Resins and Oils.



ALMACIGA.

The local commercial name of the resin produced by *Agathis alba* is almaciga. This is a tree of the pine family, closely related to the species yielding the kauri resin of New Zealand. It grows in the mountainous regions of the Philippines usually between altitudes of 400 and 1,000 meters. The resin is gathered by the hill people. It accumulates as a hardened product on the trunk after incisions are made in the bark, or at the base of the trunk where it is deposited in the ground through ruptures made usually near the junction of the roots and the trunk. The latter deposits remain in the ground after the tree dies and decays and are discovered by the collector, who thrust a sharp pointed stick in the ground to determine their location. Almaciga to the amount of 1,092,398 kilos passed through official channels during the fiscal year 1909–10. Approximately four-fifths of this amount came from the Moro Province of Mindanao.

DIPTEROCARP RESINS.

While all the dipterocarps are resinous, only a few of them yield products that have reached the markets. Locally they are used extensively as torches, for calking small boats, etc. As explained in Part II, under a discussion of the dipterocarp family, these deposits are wood oils which quickly or slowly transform into a resin on exposure to the air. Some of these are encountered in a solid form, others are plastic, and still others harden so slowly that they are removed as fluids. The latter are known as wood oils and bear the local name of the tree from which they are collected. To the former class belongs the resin of yacal (*Hopea plagata*) and guisoc (*Shorea balangeran*). This is collected by making incisions through the bark. The oil hardens to a brittle brownish-black resin and is collected in this form. It is used locally for torches and is often mixed with softer resin for calking.

Apitong, panao, and palosapis are the principal dipterocarps that yield fluid resins, or wood oils. The resins of these trees are usually known as balao. The oil is allowed to collect in cup-shaped incisions made in the wood. As the flow ceases the surfaces are recut and fired, which greatly increases the deposit. It is used locally for lighting, and, when mixed with powdered charcoal, for calking boats. Other dipterocarps produce resins, but the amount that can be collected is much less than from those mentioned above.[1]

The amount of wood oils that passed through official channels during the fiscal year 1909–10 was 131,377 liters, mainly from the Provinces of Leyte and Occidental Negros.

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[1] For a discussion of the chemical nature of the oils of supa, balao, panao, and palosapis see Clover, A. M.: Philippine wood oils, Phil. Jour. Sci., 1 (1906), 191–202.

MANILA ELEMI.[1]

The resin produced by pili (*Canarium luzonicum*), a tree growing wild or as a planted crop in the Philippines, is known commercially as Manila elemi and locally as brea or pili resin. Incisions are made in the bark usually at the beginning of the rainy season. About once a month the resin is collected and the bark recut. This keeps up till December, when the resin practically ceases to flow for that year. The resin is graded into two classes, viz, "brea blanca" and "brea negra," the principal difference being one of cleanliness. It is soft, sticky, and opaque, slightly yellow in color, has a very agreeable resinous odor, and burns with a smoky flame. It is used extensively for torches and with other resins is mixed with powdered charcoal, brick, and ashes for calking boats. During the fiscal year 1909–10, 57,629 kilos of Manila elemi were officially manifested. The resin came principally from the Province of Tayabas, where the tree is quite extensively cultivated.[2]

OTHER RESINS AND OILS.

The two pines (*Pinus insularis* and *P. merkusii*) of the Philippines are rich in turpentine. As yet however the resinous products of these trees are used only locally. Lumbang oil is the product of the nuts of two species of *Aleurites*. *A. moluccana* (lumbang) is an introduced, semicultivated tree confined principally to the provinces near Manila and to the Davao district of Mindanao. *Aleurites trisperma* (balukanad), is a closely related species that is found wild or semicultivated. The nut is about the size and shape of a hickory nut. The hard shell is removed, and the oil is extracted from the kernel. It is used in the Philippines for illuminating purposes, in the manufacture of soap (usually known as Chinese soap), for painting small boats, and for treating timbers intended for use in water. It seems to be closely related to the Chinese wood oil or tung (tung yu or Ningpo varnish), which is extracted from a nut coming from another species of the genus *Aleurites*.[3] During the fiscal year 1907–8 some ₱22,000 worth of lumbang nuts were gathered in the Moro Province alone.

From the fruits of palo maria (*Calophyllum inophyllum*) an oil known as the "oil of palo maria" is extracted (known in India as domba

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[1] For a full discussion of this see Clover, A. M.: The terpene oils of Manila elemi, Phil. Jour. Sci. 2 (1907), Gen. Sci., 1–40.

[2] Forms of *Canarium luzonicum* produce a much-prized edible nut that is rich in oil and has a flavor not unlike that of the almond. There seem to be three varieties of the nuts known locally in Tayabas as basiad, tugdugin, and pilauai. Basiad is said to have the best flavor, though pilauai attains the largest size.

[3] For a discussion of the chemical properties of this and other oil-bearing seeds see Richmond and Vivencio del Rosario: Commercial utilization of some Philippine oil-bearing seeds: preliminary paper, Phil. Jour. Sci. 2 (1907), Gen. Sci. 439–449.

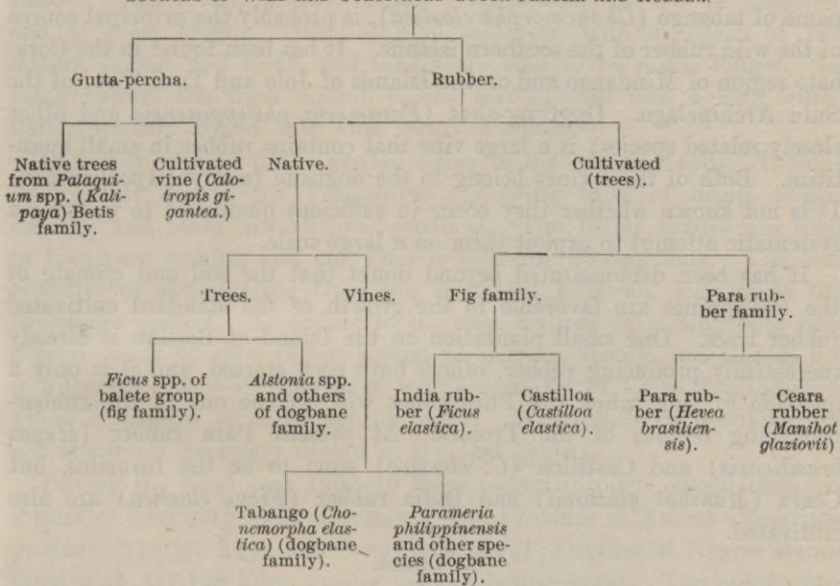
oil). This oil is used in small quantities in the Philippines chiefly for illuminating purposes.

5. Gutta-percha and Rubber.

The following diagram shows the wild and cultivated sources of gutta-percha and rubber in the Philippines.

Table 11.

Sources of Wild and Cultivated Gutta-percha and Rubber.



Gutta-percha is the product of certain species of *Palaquium* found in Mindanao and adjacent islands. The gutta-percha (kalipaya) trees are found scattered over a large area. The crude product is collected after felling the tree by ringing the bark at regular intervals. It is gathered by the wild tribes principally from the Cotabato Valley of Mindanao. No attempt has yet been made to cultivate trees producing gutta-percha. Official reports show that 96,169 kilos were collected during the fiscal year 1909–10. In Jolo and certain other ports it is rudely refined and eventually reaches the Singapore market. *Calotropis gigantea,* a vine belonging to the Asclepiadaceæ, yields a kind of gutta-percha. It is found in a few provinces in and about towns, and is undoubtedly an introduced plant in the Philippines. Only scattered specimens are to be found, and we have no information that it is utilized for any purpose locally.

Rubber is often confused with gutta-percha and for that reason the Philippines have gained the reputation of containing considerable quantities of wild rubber. It is probable that a small quantity of the product known officially as gutta-percha is really wild rubber, but it is impossible to state the exact amount. Investigations to determine the source and amount of wild rubber in the Philippines indicate that certain vines and trees produce it, but not in large quantities. The diagram (Table 9) shows the native trees and vines that are known to yield rubber. Certain species of *Ficus* belonging to the balete group of the *Moraceæ* produce rubber, but little is known about the quality or amount. Species of *Alstonia* (dita, etc.) and other trees of the dogbane family yield rubber of a poor grade in small quantities. A large vine, known under the Moro name of tabango (*Chonemorpha elastica*), is probably the principal source of the wild rubber of the southern islands. It has been found in the Cotabato region of Mindanao and on the Islands of Jolo and Tawi Tawi of the Sulu Archipelago. Dugtung-ahas (*Parameria philippinensis* and other closely related species) is a large vine that contains rubber in small quantities. Both of these vines belong to the dogbane family (*Apocynaceæ*). It is not known whether they occur in sufficient quantities to warrant a systematic attempt to exploit them on a large scale.

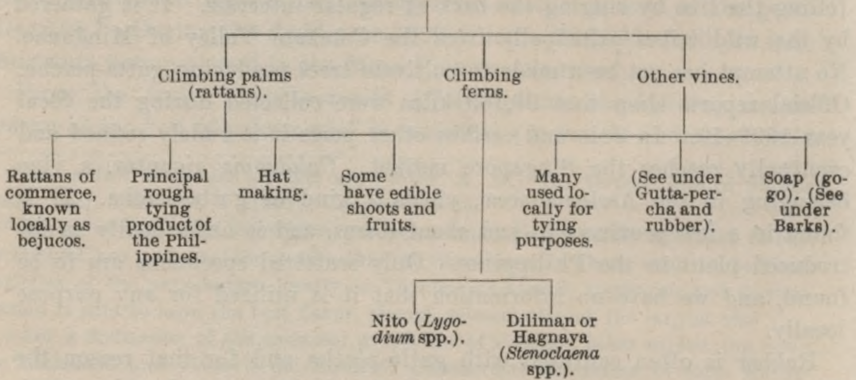
It has been demonstrated beyond doubt that the soil and climate of the Philippines are favorable to the growth of the standard cultivated rubber trees. One small plantation on the Island of Basilan is already successfully producing rubber, others have been started, and it is only a question of time when the Philippines will become one of the rubber-producing regions of the Tropics. At present Para rubber (*Hevea brasiliensis*) and Castilloa (*C. elastica*) seem to be the favorites, but Ceara (*Manihot glaziovii*) and India rubber (*Ficus elastica*) are also cultivated.

6. Vines.

The following diagram shows the principal minor products produced by vines:

TABLE 12.

PRINCIPAL MINOR PRODUCTS FROM VINES OR LIANAS.



RATTAN.

This is the product of a large number of species of climbing palms (the genus *Calamus*), and is known locally as bejuco. The best qualities are found in the lauan, the lauan-apitong, the tanguile-oak, and the mossy-forest types. The hill people are the principal rattan collectors. Rattan palm starts as a rosette of leaves from the center of which a stem develops. At first this is covered with prickly leaf sheaths, but as it develops, the old leaves with their sheaths drop off leaving a smooth jointed stem usually about 4 centimeters or less in diameter and of great length. One has been measured with a length of 122 meters (about 400 feet), and others are said to be much longer. In many species the stout midrib of the leaf extends into a long whip-like projection armed with stiff recurved spines.

Rattan is brought to the market either in the round or split. It finds its greatest use in the Philippines for tying bales of hemp, sugar, tobacco, and other agricultural products. The better grades are used in furniture making and one kind is used for making hats. The best qualities of rattan come from the Island of Palawan, and go to the Singapore market. According to the specifications of a Singapore firm a good grade of split rattan should be mature, strong, not ribbed, 3.7 to 5 meters (12 to 16 feet) long, with a diameter of 4.5 to 9 millimeters (three-sixteenths to three-eighths inch). Bright color is desirable but not absolutely necessary except in the best quality.

During the fiscal year 1909–10 there passed through official channels a total of 3,069,212 kilos of rattan. The Province of Ambos Camarines produced 759,278 kilos, and Sorsogon 607,951; Occidental Negros stands third with 347,138 kilos, mostly used in baling sugar. The other provinces producing more than 100,000 kilos are as follows: Mindoro, Tayabas, Oriental Negros, and Cagayan. This is not the arrangement of provinces according to the actual amount they contain. It merely means that the exploitation is greater because these provinces lie nearer the centers of demand. Probably the Moro Province and Palawan contain a larger supply than any of those mentioned above.

OTHER VINES.

Diliman or hagnaya (*Stenoclaena* spp.) are climbing ferns used principally as a string to bind the parts of fish traps. Black and white nitos (*Lygodium* spp.) are also climbing ferns and are employed in making wickerwork and for the borders of hats. The forest abounds in many kinds of other vines used for tying purposes, generally without being made into ropes.

7. Bamboo.

While wild bamboo of some kind is found scattered everywhere throughout the Islands, yet wild structural bamboo in commercial quantities is confined to regions with a pronounced dry season. Introduced bamboos are planted in all parts of the Philippines and with the wild forms play an important part in the domestic and economic life of the Islands.

The following is a list of the uses of bamboo: House construction (posts, beams, rafters, floors, siding, stairways, doors, windows, roofs); fencing; rafts, rude piling and decking for wharves; fish traps; bridges; parts of carts; parts of small boats; handles for tools and weapons; bows and arrows; musical instruments; hats; baskets; mats; sawali (a coarse kind of mat used principally for partitions and the siding of houses); picture frames; decorative arches and many kinds of ornaments; and temporary construction of all kinds.

8. Erect Palms.

In many places where bamboo is wanting or scarce the trunks of erect palms are extensively used as a substitute for many classes of construction. They are used in the round or split into narrow pieces and the pith removed. The following palms are most commonly used for structural purposes: *Livistona* spp. (anahao and palma brava), *Oncosperma* spp. (anibong), *Caryota* spp. (pugahan or fish-tail palm), *Heterospatha* sp. (sagasi), *Pinanga insignis* (sarawag), and many species of *Pinanga* under various local names.

The sap of the inflorescence of nipa palm (*Nipa fruticans*), a wild and semicultivated palm of the tide-water swamps, is the source of a large part of the alcohol and vinegar of the Philippines and its leaf is the principal roofing and thatching material of the Islands. The leaves of anahao and other palms are also used for this purpose, especially in places remote from nipa swamps. Next in importance to the nipa palm is the buri palm (*Corypha elata*). This grows wild and semicultivated. The sap of the inflorescence is fermented and used as an alcoholic drink (tuba).[1] The leaves are used for roofing, for making mats, sails, bags, hats, and ropes.

Many less important minor forest products are treated briefly in Part II of this bulletin.

RELATION OF THE GOVERNMENT TO THE FORESTS AND THEIR PRODUCTS.

1. Legal Status of the Public Forests and Forest Reserves.

The public forests of the Philippines include all unreserved public lands covered with trees of any age. By the action of the Governor-

[1] Tuba is the general term for the fermented sap of a number of palms. The principal source of this drink is the coconut palm.

General of the Philippines any portion of the public domain may be set aside as a forest reserve. Both the public forests and the forest reserves are administered by the Bureau of Forestry "for the protection of the public interests, the utility and safety of the forests, and the perpetuation thereof in productive condition by wise use." No land containing public forests can pass out of the control of the Bureau of Forestry until the Director certifies that it is more valuable for agricultural than for forest purposes.

2. Disposal of Forest Products.

The following diagram illustrates the various ways of disposing of forest products:

TABLE 13.

HOW THE GOVERNMENT DISPOSES OF ITS FOREST PRODUCTS.

- Free of charge.
  - Without license. (Second and lower group timbers and minor products for domestic purposes.)
  - Gratuitous license.
    - To miners from claims, for development of mines.
    - To home builders. (First-group timbers.)
    - For public works. (Second and lower group timbers and minor products.)
- With charge.
  - Miners' license. (From public forest for development of claims. Half charge.)
  - Ordinary license. (Full charge.)
  - Exclusive license. (Full charge.)
  - Exclusive license agreement. (Full charge.)

I.—FOREST PRODUCTS OBTAINED FREE OF CHARGE.

Certain forest products can be obtained without charge with or without license. The Free-use Act provides that until Oct. 25, 1915, inhabitants of the Philippine Islands can gather without license and free of charge all products to be used for domestic purposes except first-group timbers. Special areas of public forests, known as communal forests, are established for the use of certain settlements, from which the inhabitants are required to obtain all of their free-use products. Where such areas have not yet been set aside, the free-use products can be gathered in any portion of the public forests within the provinces in which the collector resides.

Gratuitous licenses may be issued (1) under certain conditions to inhabitants of the Philippines for first-group timbers to be used for the construction of homes; (2) to miners for all forest products from their claims used in the development of the mines; and (3) for minor products and second and other lower group timbers to be used in the construction of public works of all kinds.

II.—FOREST PRODUCTS GATHERED WITH CHARGE.

The following classes of licenses are issued for the cutting, collecting, and removal of products upon which forest charges are imposed: miners' licenses, ordinary licenses, exclusive licenses, and exclusive license agreements.

Miners' licenses provide for the gathering of products from areas outside of the claims, and that the products so collected be paid for at one-half the regular rates, and are to be used for the development of mines mentioned in the license. Ordinary licenses provide for the collecting of product upon which the full charges are made. The territory granted is restricted to definite areas, for which one or more licenses may be issued. Ordinary licenses are usually granted for terms of from one to three years and may be renewed at their expiration. Exclusive licenses grant to a single licensee the right to gather forest products in a particular area. Exclusive license agreements are granted for periods up to twenty years in large areas which can be extensively lumbered without permanent injury to the forest. Applications for such for an area of more than 1,000 hectares (approximately 2,500 acres) must secure the approval of the Secretary of the Interior. Thereupon proposal for competitive bids are published in the Official Gazette and other periodicals, and the license will be granted to the bidder who makes the most satisfactory offer, including a guaranty to install the most complete and efficient plant most promptly, and to do a sufficient amount of annual development work. A bond is required for the proper performance of all obligations.

The right to reject any and all bids is expressly reserved, and in general no proposal for an exclusive license agreement will be approved except upon a reasonable showing that the licensee will be able within the period fixed in his license actually to exploit the resources of the forest tract. The man who means business must show that he really intends to develop the tract for which he wishes to secure an exclusive license, and that he will protect the interests of the public in the concession.

3. CHARGES FOR FOREST PRODUCTS.

I.—LUMBER.

For the purpose of forest charges the present grouping of the timber is as follows:

TABLE 14.

Group I.	Group II.	Group III.
Acle.	Alupag.	Agoho.
Baticulin.	Aranga.	Amuguis.
Betis.	Banaba.	Anubing.
Camagon.	Bansalaguin.	Apitong.
Ebony.	Banuyo.	Batino.
Ipil.	Batitinan.	Bitanhol.
Lanete.	Bolongeta.	Catmon.
Mancono.	Calamansanay.	Calumpit.
Molave.	Calantas.	Cupang.
Narra.	Dungon.	Dalinsi.
Tindalo.	Guijo.	Dita.
Yacal.	Macaasim.	Dungon-late.
	Malacadios.	Malacmalac.
	Mangachapuy.	Malapapaya.
	Palo maria.	Malasantol.
	Supa.	Mayapis.
	Teak.	Palosapis.
	Tucang-calao.	Panao.
		Sacat.
		Santol.
		Tamayuan.
		Tanguile.

All other timbers are placed in Group IV.

The metric system of measurement has been officially adopted by the Philippine Government, and the charges are based on the volume of round timber. The forest charges of the different groups are as follows:

TABLE 15.

Group.	Charge per cubic meter.		Charge per 1,000 board foot.	
	Philippine currency.	United States currency.	Philippine currency. [a]	United States currency.
1	₱2.50	$1.25	₱10.00	$5.00
2	1.50	.75	6.00	3.00
3	1.00	.50	4.00	2.00
4	.50	.25	2.00	1.00

[a] Assuming that 4 cubic meters will cut 1,000 feet board measure. (See p. 12.)

II.—MINOR PRODUCTS.

The charges on minor products is 10 per cent of the market value. This may change from time to time. The following is a list of the principal minor products, except firewood, with their respective forest charges:

Almaciga	per 100 kilos	₱1.50
Manila elemi	do	1.50
Gutta-percha	do	7.00
Rubber	do	7.00
Rattan	do	1.00
Charcoal	per cubic meter	.40
Dyewood	per 100 kilos	1.50
Dyebark	do	.50
Tanbark	do	.30
Wood oils	per liter	.01

The forest charges on all firewood is ₱1 for 1,000 pieces, each from 60 centimeters to 1½ meters in length and from 7 to 15 centimeters in diameter; for all firewood of lesser dimensions the charge is 10 centavos per cubic meter.

No other charges are collected from the licensees. The land from which the timber is taken is free from all taxation, as it remains Government property. There are no export duties on forest products; all enter the United States free from duty, and logging and milling machinery and supplies can be imported from the United States without import charges.

4. Cutting Regulations.

The cutting regulations are simple and are devised merely to insure the wise use and perpetuity of the forest. On land that is more valuable for agriculture than for forest growth, clear cutting may be allowed. On trees cut from land suitable for forests and for no other more valuable purpose a minimum diameter limit is established. For the lower group timbers this is usually 40 centimeters (16 inches), measured breast-high outside of the bark. In some cases it is lower, depending upon the mature size of the species and on the silvicultural condition of the forest. For the higher group timbers the minimum diameter limit is usually 60 centimeters (24 inches). Where there is danger of the extinction of valuable species, the Government reserves the right to select the trees to be cut. The licensees are expected to utilize all merchantable timber that they cut; the stumps must not be unnecessarily high, and no timber must be abandoned in the forest. These rules are simple and no lumberman who has good control of his logging crew will find that he is hampered by carrying them out. On the other hand, he will generally be the principal gainer by doing so.

5. How the Bureau of Forestry Assists the Lumbermen.

The Bureau of Forestry will furnish advice in all classes of forest work. Nearly all the Islands of the Archipelago have been explored, and while much yet remains to be done, the results already obtained enable the Bureau to suggest profitable areas to lumbermen who are considering applying for a concession. Foresters are available to investigate and report upon special timbered areas.

The museum of the Bureau of Forestry contains more than 1,000 species of Philippine woods. These have been carefully studied by the experts of the Bureau, who are now in a position to identify samples of most of the native timbers.

Coöperative work with companies to ascertain the ability and methods of preserving the different timbers have been taken up; and there is little doubt that cheap timbers, which are abundant but decay quickly in their natural state, can be made to take the place of the scarcer, high-priced timbers for many structural purposes where contact with the ground is necessary.

Plate XXII.—LOGGING SLED.

Plate XXIII.—STEAM LOGGING; DONKEY ENGINES.

PLATE XXIV.—LOGGING RAILROAD.

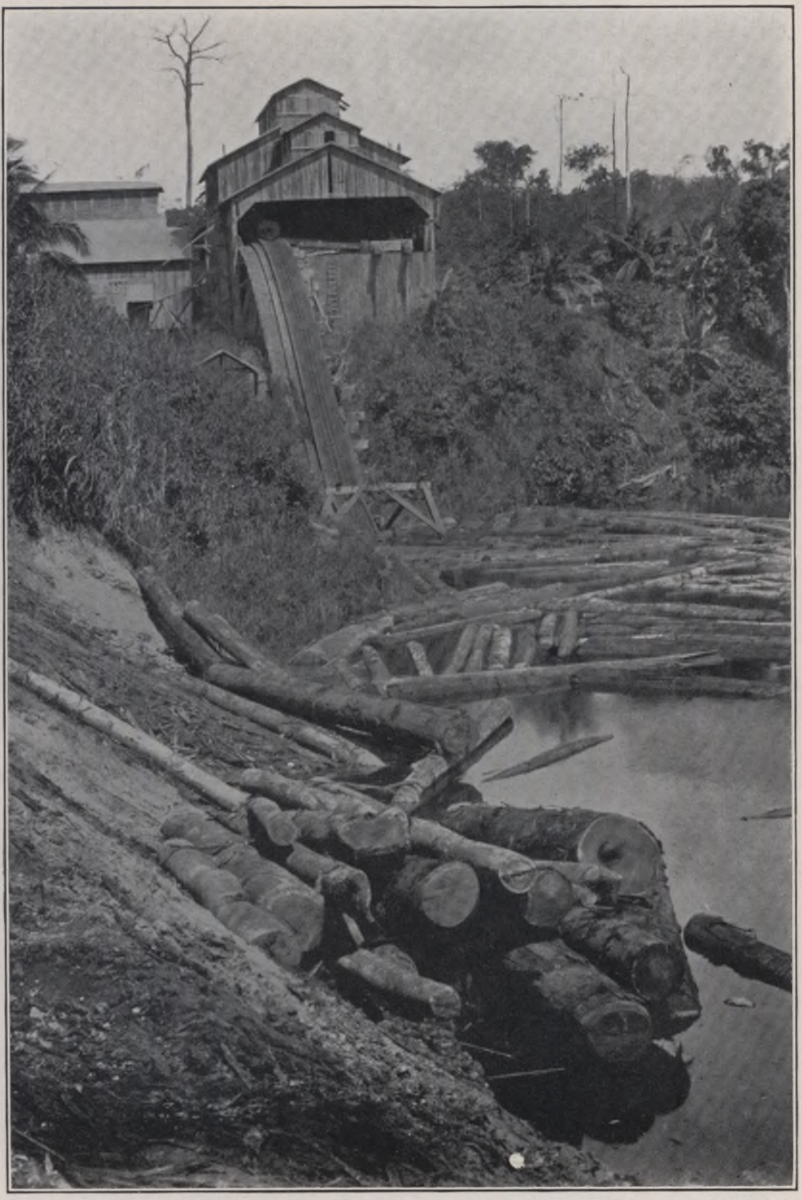


Plate XXV.—STEAM SAWMILL.

Plate XXVI.—STEAM SAWMILL.

PLATE XXVII.—GUTTA-PERCHA AS IT REACHES THE MARKET.

Plate XXVIII.—A BAMBOO FOREST.

APPENDIXES.

APPENDIX I.

MECHANICAL PROPERTIES OF THIRTY-FOUR PHILIPPINE WOODS.

Gardner[1] has published the mechanical tests of thirty-four Philippine woods. The results of this work are given in the following tables:

[1] Gardner R.: I. Mechanical tests, properties, and uses of thirty-four Philippine woods. II. Philippine sawmills, lumber market, and prices. Bull. 4 (1907). Second edition revised.

TABLE I.—*Cross-bending strength of Philippine timber.*

Name.	Locality.		Moisture over 35 per cent.							Moisture 20 to 35 per cent.							Moisture under 20 per cent.								
			Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).[a]	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch.)	Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).	Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).	Total number of tests.	Specific gravity of dry wood, all tests.
Lauan	Mindanao	Average	38	51.8	0.444	2,630	4,570	6,870	1,464	21	29.8	0.442	3,350	5,300	7,200	1,462	14	10.4	0.457	5,730	8,240	9,760	1,653	73	0.446
		Maximum		75	.485	5,340	5,840	7,950	1,820		35	.47	6,190	7,740	8,920	1,790		17.5	.488	10,550	12,640	14,250	1,840		.488
		Minimum		35.5	.405	1,410	3,160	5,340	975		20	.40	1,550	3,520	4,220	1,050		3	.404	3,390	5,480	7,020	1,395		.40
Do	Zambales	Average	36	63	.478	5,260	6,410	8,040	1,438															36	.478
		Maximum		86.4	.529	7,450	7,880	9,770	1,740	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.529
		Minimum		41.6	.412	2,810	4,510	4,510	1,050																.412
Almon	Occidental Negros.	Average	18	59.2	.464	5,400	6,380	8,260	1,377															18	.464
		Maximum		70	.52	6,750	7,310	9,430	1,500	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.52
		Minimum		49	.378	3,800	4,360	5,980	1,120																.378
Apitong	Mindanao	Average	52	53.9	.62	3,750	5,550	7,350	1,754	10	26.8	.699	6,190	8,220	10,230	2,033	13	14	.706	7,340	9,760	11,620	2,144	75	.645
		Maximum		81	.715	6,330	8,720	10,550	2,580		33.6	.74	9,150	9,850	11,640	2,550		19.8	.825	10,550	12,480	15,600	2,425		.825
		Minimum		36	.56	1,970	3,730	5,540	1,320		22	.658	4,220	6,320	8,600	1,710		9	.618	4,920	6,050	6,050	1,900		.56
Do	Zambales	Average	30	55.8	.679	5,220	6,790	8,910	1,428	1	20.8	.93	2,950	4,150	5,100	1,000								31	.687
		Maximum		84.6	.721	7,030	8,430	10,470	1,740		20.8	.93	2,950	4,150	5,100	1,000	--	--	--	--	--	--	--		.93
		Minimum		48.8	.588	2,530	3,230	3,910	900		20.8	.93	2,950	4,150	5,100	1,000									.588
Do	Negros	Average	11	95.5	.564	5,960	7,060	9,470	1,565															11	.564
		Maximum		107	.581	7,040	8,300	10,960	1,740	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.581
		Minimum		76.8	.55	4,920	6,050	8,040	1,370																.55
Guijo	Ambos Camarines.	Average	27	43.7	.677	6,330	8,660	12,050	1,915	15	26.6	.72	7,820	9,940	12,860	2,077	13	13.7	.759	10,080	12,850	15,150	2,158	55	.708
		Maximum		56	.735	8,150	10,200	13,820	2,240		35	.776	9,850	12,380	14,600	2,370		18.6	.82	12,650	19,700	21,500	2,480		.82
		Minimum		37.2	.629	4,920	7,180	10,380	1,635		20.3	.673	4,920	7,800	10,540	1,660		7	.718	7,730	8,940	11,900	1,740		.629
Do	Mindoro	Average	49	57.8	.696	6,420	8,780	11,350	1,825	1	23.3	.724	7,740	9,150	12,650	2,110								50	.697
		Maximum		89.8	.806	9,140	11,450	14,200	2,210		23.3	.724	7,740	9,150	12,650	2,110	--	--	--	--	--	--	--		.806
		Minimum		41	.596	2,110	4,570	6,210	1,190		23.3	.724	7,740	9,150	12,650	2,110									.596
Molave	Near Laguna de Bay.	Average	47	45.5	.772	4,870	8,380	10,610	1,503	11	31.8	.803	5,010	9,000	10,190	1,602	9	10.4	.824	8,240	8,580	8,580	1,614	67	.785
		Maximum		62	.858	9,150	13,600	14,600	2,000		35	.848	7,030	10,700	12,150	1,950		19.5	.88	10,550	13,600	13,600	1,980		.88
		Minimum		36.4	.69	1,410	4,360	5,200	895		24.8	.725	3,520	7,740	9,530	1,400		3.5	.79	4,920	4,920	4,920	1,240		.69
Do	Ambos Camarines.	Average	29	54.4	.782	6,840	8,640	10,380	1,381															29	.782
		Maximum		72.5	.825	9,850	11,950	14,380	3,090	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.825
		Minimum		43.8	.712	2,100	2,460	3,820	1,050																.712
Yacal	do	Average	21	43.3	.823	7,270	10,160	13,070	2,079	42	29.6	.846	8,180	10,700	14,090	2,368	17	15.6	.848	9,650	12,130	15,690	2,583	80	.843
		Maximum		54.2	.906	9,850	11,600	15,350	2,650		34.3	.94	11,250	13,600	17,650	2,870		19.8	.90	12,230	17,480	21,800	3,000		.94
		Minimum		35.3	.76	4,920	7,750	10,260	1,680		21.5	.77	4,220	5,480	7,700	1,680		11.4	.81	6,680	9,140	13,580	1,844		.76
Narra	Near Laguna de Bay.	Average	11	79	.563	3,000	6,300	8,390	1,509															11	.563
		Maximum		93	.59	4,500	8,100	11,300	1,850	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.59
		Minimum		65	.535	2,110	4,500	5,300	1,130																.535
Do	Cagayan	Average	11	51.8	.63	6,020	7,960	10,220	1,352	7	26.9	.508	5,650	6,570	7,380	1,462	13	9.6	.487	6,440	7,070	7,560	1,510	31	.54
		Maximum		81.7	.77	7,730	10,830	13,500	1,630		32.7	.56	8,430	9,850	11,020	1,710		13.8	.531	10,550	10,680	11,730	1,670		.77
		Minimum		35.5	.475	4,360	6,050	7,190	1,050		22.9	.438	2,110	3,090	3,460	870		4.6	.384	2,810	2,810	2,960	1,050		.384
Tanguile	Unknown	Average	8	39.9	.536	5,180	6,780	9,160	1,576	12	30.6	.487	5,310	6,960	9,110	1,456	16	13.7	.422	6,440	7,380	8,360	1,232	36	.469
		Maximum		45.4	.565	5,900	7,600	10,210	1,685		34.6	.524	6,740	7,600	10,230	1,685		18.7	.58	9,150	11,400	12,560	1,610		.58
		Minimum		35.5	.51	4,640	5,760	7,030	1,380		21.8	.38	4,220	6,190	7,030	1,050		5	.355	4,500	4,920	4,920	976		.355
Do	Zambales	Average	27	47.7	.457	4,010	4,980	6,380	1,241	1	34.5	.54	6,050	6,330	7,700	1,320	19	9.7	.535	6,430	7,470	8,570	1,594	47	.491
		Maximum		80	.54	5,620	7,170	9,450	1,660		34.5	.54	6,050	6,330	7,700	1,320		18.4	.606	10,550	11,520	13,220	1,950		.606
		Minimum		38.9	.405	2,110	2,110	3,040	950		34.5	.54	6,050	6,330	7,700	1,320		1.6	.478	2,110	2,110	2,300	1,120		.405
Tanguile-balacbacan	Occidental Negros.	Average	15	58.1	.509	5,030	6,280	8,670	1,348															15	.509
		Maximum		62.5	.53	5,900	6,900	9,330	1,530	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.53
		Minimum		53	.479	2,950	5,350	7,920	1,180																.479
Sacat	Lamao Forest Reserve, Bataan.	Average	8	48.5	.561	3,340	5,030	6,960	1,584															8	.561
		Maximum		54.4	.585	4,220	5,380	7,670	1,710	--	--	--	--	--	--	--	--	--	--	--	--	--	--		.585
		Minimum		45.2	.54	2,110	4,120	4,840	1,340																.54

[a] The apparent elastic limit was used in order to compare tests of native woods with similar tests of American woods. See table of tests, pp. 83, 84.

TABLE I.—*Cross-bending strength of Philippine timber*—Continued.

Moisture over 35 per cent.

Name.	Locality.		Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).[a]	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).
Sacat	Tarlac	Average	42	55.2	0.60	5,800	7,050	9,300	1,569
		Maximum		82.6	.657	7,740	9,000	12,450	1,920
		Minimum		35.3	.478	2,250	2,810	3,120	920
Ipil	Ambos Camarines.	Average	19	52.7	.79	4,360	6,690	7,960	1,295
		Maximum		76.1	.872	5,620	9,420	11,680	1,680
		Minimum		36.1	.68	2,670	5,620	5,620	1,000
Do	Mindoro	Average	44	63.1	.67	5,450	7,430	9,410	1,226
		Maximum		106	.77	9,150	10,820	13,640	1,840
		Minimum		35.6	.56	1,480	2,050	2,050	550
Do	Palawan	Average	41	52.2	.807	9,170	11,210	13,520	1,953
		Maximum		60.1	.867	12,220	13,750	17,000	2,210
		Minimum		46.6	.75	2,110	2,810	6,330	1,420
Dungon	Ambos Camarines.	Average	6	42.2	.824	5,660	7,400	11,770	1,680
		Maximum		66.4	.895	7,880	9,570	14,980	2,080
		Minimum		35.2	.723	1,410	2,540	4,370	1,050
Do	Masbate	Average	3	36.3	.827	4,730	6,420	10,250	1,593
		Maximum		37.2	.845	4,920	7,030	11,400	1,790
		Minimum		35.5	.816	4,360	5,620	8,640	1,470
Do.[b]	Mindanao	Average	21	49.4	.668	4,520	5,740	7,870	1,317
		Maximum		81.6	.707	5,900	6,890	9,520	1,690
		Minimum		35.5	.636	2,810	4,150	5,510	920
Malasantol	Unknown	Average	21	66.2	.633	4,500	6,480	8,690	1,518
		Maximum		84.5	.689	6,330	7,380	10,040	1,670
		Minimum		35.4	.608	2,810	5,280	5,870	1,420
Supa	do	Average	5	37.3	.673	6,410	8,180	10,050	1,435
		Maximum		40.8	.692	8,440	8,870	11,150	1,530
		Minimum		35.6	.61	4,920	7,180	8,630	1,370
Do	Tayabas	Average	12	38.7	.755	4,890	7,170	8,700	1,415
		Maximum		46.7	.843	6,720	8,920	10,500	1,650
		Minimum		35.1	.70	2,810	4,920	6,490	1,160
Balacat	Lamao Forest Reserve, Bataan.	Average	9	56.1	.517	5,120	6,280	8,540	1,293
		Maximum		86	.57	6,190	6,750	9,200	1,450
		Minimum		45.7	.478	4,220	5,780	7,730	1,105
Do	Tarlac	Average	21	45.4	.56	5,210	6,200	7,780	1,221
		Maximum		59.8	.62	6,330	7,390	9,370	1,420
		Minimum		36.5	.515	3,520	3,940	4,790	870
Macaasim	Unknown	Average	35	68.4	.695	4,370	6,120	8,660	1,416
		Maximum		87.9	.734	8,440	8,790	10,880	1,750
		Minimum		36.3	.667	1,546	3,550	5,180	1,070
Calantas	Albay	Average	15	75.4	.357	3,000	4,240	5,650	961
		Maximum		94	.379	3,949	4,920	6,600	1,185
		Minimum		61	.336	1,970	3,100	4,400	738
Do	Mindoro	Average	10	57.3	.511	3,560	4,900	6,250	940
		Maximum		67	.54	5,620	6,180	7,950	1,160
		Minimum		38	.492	2,110	3,020	3,060	580
Tindalo	Unknown	Average	6	40.4	.747	8,090	10,770	15,000	2,226
		Maximum		44.6	.77	9,140	11,940	16,980	2,340
		Minimum		35.8	.734	6,330	8,430	12,300	2,050
Do	Ambos Camarines.	Average	12	44.7	.808	7,070	9,005	11,330	1,588
		Maximum		55	.86	10,400	12,400	14,200	1,750
		Minimum		37.7	.757	5,350	5,350	8,600	1,130

Moisture 20 to 35 per cent.

Name.	Locality.		Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).
Sacat	Tarlac	Average	10	24.2	0.606	5,930	7,290	9,050	1,637
		Maximum		35	.677	7,600	9,140	12,470	1,900
		Minimum		20.2	.485	2,110	2,390	4,220	1,160
Ipil	Ambos Camarines.	Average	14	25.8	.783	5,580	6,640	7,900	1,470
		Maximum		34.6	.83	7,730	9,420	12,600	1,730
		Minimum		21	.685	3,520	5,070	5,620	1,260
Do	Mindoro	Average	2	34.5	.743	7,530	9,520	13,040	1,750
		Maximum		34.5	.77	7,740	9,700	13,520	1,840
		Minimum		34.4	.717	7,320	9,350	12,560	1,660
Do	Palawan	Average							
		Maximum	---	---	---	---	---	---	---
		Minimum							
Dungon	Ambos Camarines.	Average	40	26.4	.878	6,870	8,940	13,510	1,947
		Maximum		33.9	.924	9,850	11,400	16,900	2,260
		Minimum		20	.788	3,800	5,910	7,900	1,240
Do	Masbate	Average	21	30.1	.854	4,960	6,910	10,600	1,442
		Maximum		34.5	.89	6,330	8,440	13,150	1,900
		Minimum		26.3	.822	3,520	4,220	7,260	1,050
Do.[b]	Mindanao	Average	2	30.7	.685	5,060	6,540	9,070	1,525
		Maximum		31.9	.69	5,200	7,040	9,200	1,530
		Minimum		29.5	.68	4,920	6,050	8,940	1,520
Malasantol	Unknown	Average	2	26.3	.663	5,840	7,180	10,310	1,595
		Maximum		27.1	.68	6,330	7,600	10,550	1,610
		Minimum		25.6	.646	5,350	6,760	10,080	1,580
Supa	do	Average	23	29.3	.711	7,360	10,070	12,390	1,907
		Maximum		34.4	.835	11,250	12,660	16,450	2,870
		Minimum		20	.644	4,220	7,450	9,140	1,370
Do	Tayabas	Average	49	30.1	.827	5,280	7,520	9,050	1,510
		Maximum		34	.955	9,250	11,010	13,220	1,930
		Minimum		26.6	.712	1,680	2,410	3,230	750
Balacat	Lamao Forest Reserve, Bataan.	Average							
		Maximum	---	---	---	---	---	---	---
		Minimum							
Do	Tarlac	Average	7	26.6	.579	5,710	6,060	7,010	1,204
		Maximum		30	.602	6,330	8,090	10,000	1,310
		Minimum		24.1	.561	3,800	4,220	4,690	1,110
Macaasim	Unknown	Average	8	26.7	.77	5,200	8,130	10,560	1,778
		Maximum		30.4	.81	5,910	10,400	13,130	1,950
		Minimum		23	.734	3,870	6,330	8,940	1,630
Calantas	Albay	Average							
		Maximum	---	---	---	---	---	---	---
		Minimum							
Do	Mindoro	Average	8	28.9	.547	3,460	4,500	5,210	801
		Maximum		34.5	.583	4,920	6,330	7,200	1,050
		Minimum		23.7	.505	1,410	1,410	1,610	580
Tindalo	Unknown	Average	4	28.9	.787	9,490	12,750	16,570	2,182
		Maximum		35.5	.864	11,250	14,340	17,650	2,230
		Minimum		23.3	.756	8,440	11,380	15,100	2,160
Do	Ambos Camarines.	Average	16	26.6	.802	5,800	7,470	8,680	1,445
		Maximum		33.4	.866	9,710	11,250	12,830	1,580
		Minimum		20.6	.72	2,890	2,890	3,030	1,180

Moisture under 20 per cent.

Name.	Locality.		Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).	Total number of tests.	Specific gravity of dry wood, all tests.
Sacat	Tarlac	Average	16	12.8	0.664	8,350	9,610	11,440	1,886	68	0.616
		Maximum		19.3	.70	10,540	12,230	15,600	2,080		.70
		Minimum		4.2	.622	4,220	4,500	4,920	1,710		.478
Ipil	Ambos Camarines.	Average	8	18.1	.816	6,000	6,440	6,980	1,383	41	.792
		Maximum		19.6	.99	7,580	7,740	9,040	1,630		.99
		Minimum		16	.713	4,780	4,780	4,780	1,180		.68
Do	Mindoro	Average								46	.673
		Maximum	---	---	---	---	---	---	---		.77
		Minimum									.56
Do	Palawan	Average								41	.807
		Maximum	---	---	---	---	---	---	---		.867
		Minimum									.75
Dungon	Ambos Camarines.	Average	26	11.6	.845	10,160	13,460	17,110	2,209	72	.857
		Maximum		17.6	.985	14,760	18,300	22,700	2,500		.985
		Minimum		6.5	.796	5,770	7,180	9,770	1,500		.723
Do	Masbate	Average								24	.85
		Maximum	---	---	---	---	---	---	---		.89
		Minimum									.816
Do.[b]	Mindanao	Average								23	.669
		Maximum	---	---	---	---	---	---	---		.707
		Minimum									.636
Malasantol	Unknown	Average	5	12.1	.694	5,760	7,630	10,880	1,754	28	.646
		Maximum		18.2	.712	7,730	9,000	13,540	2,290		.712
		Minimum		5.3	.66	3,520	4,220	4,800	1,320		.608
Supa	do	Average	18	14.5	.722	10,060	11,670	13,100	1,863	46	.711
		Maximum		19.7	.808	15,500	15,800	16,850	2,280		.835
		Minimum		10.2	.625	7,040	7,730	7,810	1,475		.61
Do	Tayabas	Average								61	.813
		Maximum	---	---	---	---	---	---	---		.955
		Minimum									.70
Balacat	Lamao Forest Reserve, Bataan.	Average								9	.517
		Maximum	---	---	---	---	---	---	---		.57
		Minimum									.478
Do	Tarlac	Average	32	10.4	.589	6,050	7,600	8,270	1,271	60	.578
		Maximum		18.7	.66	8,440	11,250	11,720	1,520		.66
		Minimum		2.6	.54	4,220	4,670	4,670	1,080		.515
Macaasim	Unknown	Average	4	15.7	.79	6,260	9,650	11,010	1,825	47	.717
		Maximum		19.1	.82	8,450	11,980	13,240	2,030		.82
		Minimum		12.3	.76	3,240	6,690	7,750	1,530		.667
Calantas	Albay	Average	4	11.1	.363	5,300	7,260	8,980	1,255	19	.358
		Maximum		14.6	.37	6,320	8,160	9,300	1,340		.379
		Minimum		8.6	.355	4,220	6,320	8,670	1,160		.336
Do	Mindoro	Average								18	.527
		Maximum	---	---	---	---	---	---	---		.583
		Minimum									.492
Tindalo	Unknown	Average								10	.763
		Maximum	---	---	---	---	---	---	---		.864
		Minimum									.734
Do	Ambos Camarines.	Average	1	19.5	.808	7,180	9,140	11,200	1,570	29	.805
		Maximum		19.5	.808	7,180	9,140	11,200	1,570		.866
		Minimum		19.5	.808	7,180	9,140	11,200	1,570		.72

[a] The apparent elastic limit was used in order to compare tests of native woods with similar tests of American woods. See table of tests, pp. 83, 84.

[b] This is not the wood commonly known as dungon, but is often sold under that name.

TABLE I.—*Cross-bending strength of Philippine timber*—Continued.

Name.	Locality.		Moisture over 35 per cent. Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).[a]	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).
Tindalo	Masbate	Average	10	59	0.77	5,290	7,690	11,200	1,536
		Maximum		71.8	.813	7,460	9,480	13,240	1,710
		Minimum		50.7	.70	2,950	4,500	8,420	1,160
Amuguis	Mindoro	Average	31	46.1	.692	4,490	6,800	9,780	1,697
		Maximum		61.1	.76	9,110	9,300	12,670	2,160
		Minimum		35.7	.621	1,548	3,520	5,630	1,160
Do	Palawan	Average	8	53.9	.675	6,730	8,020	11,040	1,735
		Maximum		64.1	.753	8,000	8,850	11,680	1,840
		Minimum		49.5	.613	6,320	6,880	9,620	1,530
Acle	Tarlac	Average	41	92.5	.632	3,920	6,000	7,270	1,069
		Maximum		103	.707	5,280	7,730	8,920	1,395
		Minimum		77	.598	2,460	4,780	5,250	895
Do	Zambales	Average	6	96.8	.579	5,900	7,010	9,080	1,213
		Maximum		111	.604	7,030	8,720	11,560	1,360
		Minimum		83.6	.553	4,080	4,570	5,810	1,080
Betis	Tayabas	Average	7	38.1	.849	5,780	8,460	11,910	1,768
		Maximum		42.5	.882	7,380	10,130	13,680	2,055
		Minimum		35.1	.82	3,160	6,330	10,010	1,233
Do	Ambos Camarines.	Average	30	61.6	.725	3,670	5,620	7,450	2,035
		Maximum		100	.798	5,240	7,750	9,340	2,400
		Minimum		45	.615	2,090	2,830	3,660	1,050
Bansalaguin	Unknown	Average	18	46.2	.841	6,820	9,420	11,740	1,702
		Maximum		57.8	.883	8,440	10,550	14,150	2,050
		Minimum		40	.784	3,800	7,310	9,510	1,480
Palo Maria	Zambales	Average	24	56	.623	5,840	7,040	8,930	1,461
		Maximum		105	.708	8,790	9,500	12,450	1,680
		Minimum		36.6	.488	2,950	4,080	5,500	810
Batitinan	Unknown	Average	10	54.4	.777	4,540	6,350	9,320	1,427
		Maximum		61.2	.795	5,620	7,600	10,600	1,630
		Minimum		49.1	.76	2,540	4,080	5,900	1,200
Aranga	Ambos Camarines.	Average	--						
		Maximum		------	------	------	------	------	------
		Minimum							
Banuyo	Masbate	Average	16	82	.522	2,900	4,170	5,140	881
		Maximum		115	.572	5,070	6,880	7,390	1,120
		Minimum		47.7	.455	1,400	2,860	4,080	575
Red Lauan	Occidental Negros.	Average	15	75.8	.406	4,040	4,690	7,100	1,201
		Maximum		84	.43	4,920	5,620	7,900	1,370
		Minimum		65	.371	2,110	2,250	2,610	870
Mayapis	Laguna	Average	20	67.7	.399	4,070	5,320	6,760	1,133
		Maximum		91	.456	4,920	6,330	8,300	1,420
		Minimum		48	.343	3,510	3,510	3,510	870
Malugay	Mindoro	Average	18	57.2	.635	4,780	6,930	10,280	1,627
		Maximum		72	.713	6,680	8,570	12,700	1,920
		Minimum		48.2	.553	2,810	5,200	6,900	1,290
Sasalit	Zambales	Average	--						
		Maximum		------	------	------	------	------	------
		Minimum							
Liusin	Bataan	Average	14	60.9	.71	5,430	8,120	11,360	1,896
		Maximum		63	.73	7,720	10,200	14,150	2,180
		Minimum		57.6	.70	2,390	5,900	7,160	1,340

Name.	Locality.		Moisture 20 to 35 per cent. Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).	Moisture under 20 per cent. Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).	Total number of tests.	Specific gravity of dry wood, all tests.
Tindalo	Masbate	Average	3	22.5	0.785	6,370	8,160	9,050	1,273	5	18.9	0.766	5,990	8,220	8,920	1,180	18	0.772
		Maximum		24.6	.788	7,020	8,300	10,000	1,320		19.9	.808	7,450	9,770	11,020	1,370		.813
		Minimum		20.3	.784	5,340	8,080	8,080	1,180		17.7	.68	4,920	7,170	7,680	950		.68
Amuguis	Mindoro	Average	1	33.6	.75	5,620	8,590	12,050	1,760								32	.694
		Maximum		33.6	.75	5,620	8,590	12,050	1,760	---	------	------	------	------	------	------		.76
		Minimum		33.6	.75	5,620	8,590	12,050	1,760									.621
Do	Palawan	Average															8	.675
		Maximum	---	------	------	------	------	------	------	---	------	------	------	------	------	------		.753
		Minimum																.613
Acle	Tarlac	Average	5	27.9	.635	5,630	6,830	7,550	1,138	1	15.7	.684	3,660	4,920	5,400	880	20	.685
		Maximum		34.5	.67	6,330	8,870	9,750	1,210		15.7	.684	3,660	4,920	5,400	880		.707
		Minimum		21	.607	4,640	5,340	5,980	1,060		15.7	.684	3,660	4,920	5,400	880		.598
Do	Zambales	Average															6	.579
		Maximum	---	------	------	------	------	------	------	---	------	------	------	------	------	------		.604
		Minimum																.553
Betis	Tayabas	Average	13	31.8	.86	4,930	8,090	10,850	1,593								20	.856
		Maximum		34.4	.886	7,380	10,550	14,060	1,950	---	------	------	------	------	------	------		.886
		Minimum		27.1	.82	2,110	5,380	7,030	1,080									.82
Do	Ambos Camarines.	Average	1	34	.806	4,190	5,660	7,580	2,020								31	.728
		Maximum		34	.806	4,190	5,660	7,580	2,020	---	------	------	------	------	------	------		.806
		Minimum		34	.806	4,190	5,660	7,580	2,020									.615
Bansalaguin	Unknown	Average	1	33.3	.88	6,750	7,030	7,740	1,740	6	15.5	.87	8,670	11,870	14,480	2,311	25	.85
		Maximum		33.3	.88	6,750	7,030	7,740	1,740		17	.905	10,250	13,350	18,200	2,530		.905
		Minimum		33.3	.88	6,750	7,030	7,740	1,740		14.3	.85	6,330	8,780	12,400	2,100		.784
Palo Maria	Zambales	Average															24	.623
		Maximum	---	------	------	------	------	------	------	---	------	------	------	------	------	------		.708
		Minimum																.488
Batitinan	Unknown	Average								4	5	.836	6,850	8,400	9,630	1,655	14	.795
		Maximum	---	------	------	------	------	------	------		6.2	.85	8,860	11,100	12,300	1,910		.85
		Minimum									4.1	.821	4,920	5,770	7,030	1,450		.76
Aranga	Ambos Camarines.	Average	19	31.4	.826	7,970	11,070	13,440	2,061	26	5.6	.882	12,530	16,230	17,920	2,419	45	.859
		Maximum		34.8	.86	10,200	12,660	16,900	2,350		7.5	.942	16,880	21,350	24,450	2,800		.942
		Minimum		29.3	.796	4,790	8,860	10,300	1,740		2.9	.832	7,740	9,850	11,630	2,000		.796
Banuyo	Masbate	Average	1	29.3	.52	4,220	5,340	5,940	1,105	3	17	.538	4,030	5,530	6,000	1,070	20	.525
		Maximum		29.3	.52	4,220	5,340	5,940	1,105		18.9	.546	5,200	6,040	6,270	1,105		.572
		Minimum		29.3	.52	4,220	5,340	5,940	1,105		13.4	.523	2,810	5,200	5,800	1,000		.455
Red Lauan	Occidental Negros.	Average															15	.406
		Maximum	---	------	------	------	------	------	------	---	------	------	------	------	------	------		.43
		Minimum																.371
Mayapis	Laguna	Average															20	.399
		Maximum	---	------	------	------	------	------	------	---	------	------	------	------	------	------		.456
		Minimum																.343
Malugay	Mindoro	Average	7	22.4	.656	5,790	7,530	10,530	1,732	15	12	.686	7,730	11,220	13,980	1,788	40	.658
		Maximum		26.4	.693	6,900	8,080	11,740	2,150		19.8	.75	9,850	14,900	19,830	2,180		.75
		Minimum		21	.625	3,800	6,900	8,850	1,530		7.5	.62	4,090	6,810	10,040	1,480		.553
Sasalit	Zambales	Average	21	26.4	.901	9,990	11,420	14,050	2,120	18	12.4	.839	8,010	10,260	11,310	1,837	39	.872
		Maximum		30.2	.995	13,350	15,480	18,720	2,480		19.2	.87	12,650	13,980	15,820	2,270		.995
		Minimum		22	.742	7,030	7,460	8,770	1,240		9	.807	4,080	4,220	5,310	1,120		.742
Liusin	Bataan	Average															14	.71
		Maximum	---	------	------	------	------	------	------	---	------	------	------	------	------	------		.73
		Minimum																.70

[a] The apparent elastic limit was used in order to compare tests of native woods with similar tests of American woods. See table of tests, pp. 83, 84.

TABLE I.—*Cross-bending strength of Philippine timber*—Continued.

Name.	Locality.		Moisture over 35 per cent. Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).[a]	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).
Lumbayao	Basilan Island, Moro Province.	Average	2	37.1	0.545	5,620	6,460	7,790	1,160
		Maximum		38.7	.56	6,740	6,890	8,060	1,210
		Minimum		35.5	.53	4,500	6,040	7,520	1,110
Agoho	Tarlac	Average	28	45.9	.704	8,400	9,730	11,920	1,696
		Maximum		57.4	.762	11,820	13,220	15,950	2,050
		Minimum		35.4	.62	1,970	2,670	3,160	870
Do	do	Average							
		Maximum	—	—	—	—	—	—	—
		Minimum							
Do	do	Average							
		Maximum	—	—	—	—	—	—	—
		Minimum							
Mangachapuy	Albay	Average	5	51.3	.59	6,070	7,430	8,600	1,528
		Maximum		69	.622	7,880	8,290	10,320	1,710
		Minimum		36.2	.55	3,240	5,620	7,020	1,260
Do	do	Average							
		Maximum	—	—	—	—	—	—	—
		Minimum							
Dao	Mindoro	Average							
		Maximum	—	—	—	—	—	—	—
		Minimum							
Cupang	Palawan	Average	14	96.2	.285	2,460	3,090	3,580	779
		Maximum		129	.368	3,380	3,940	4,530	1,100
		Minimum		69	.259	1,410	2,250	2,550	160

Name.		Moisture 20 to 35 per cent. Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).	Moisture under 20 per cent. Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Fiber stress at true elastic limit (pounds per square inch).	Fiber stress at apparent elastic limit (pounds per square inch).	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).	Total number of tests.	Specific gravity of dry wood, all tests.
Lumbayao	Average	30	26.1	0.552	6,550	7,620	10,090	1,416	22	12.7	0.584	7,800	9,110	11,390	1,570	54	0.565
	Maximum		33.9	.603	8,870	10,000	12,180	1,630		19.5	.671	10,140	12,380	14,920	1,870		.671
	Minimum		20.5	.483	3,510	4,150	4,430	950		5.3	.53	4,220	4,220	7,810	1,340		.483
Agoho	Average															28	.704
	Maximum	—	—	—	—	—	—	—	—	—	—	—	—	—	—		.762
	Minimum																.62
Do	Average	15	26	.854	6,620	8,240	11,730	1,775								15	.854
	Maximum		34.2	.905	9,000	10,980	16,100	2,130	—	—	—	—	—	—	—		.905
	Minimum		20	.80	4,080	5,630	8,370	1,420									.80
Do	Average								4	17.6	.942	8,620	11,290	14,660	1,970	4	.942
	Maximum	—	—	—	—	—	—	—		19.7	.954	9,150	12,670	15,420	2,160		.954
	Minimum									16	.93	7,740	10,280	14,250	1,630		.93
Mangachapuy	Average															5	.59
	Maximum	—	—	—	—	—	—	—	—	—	—	—	—	—	—		.622
	Minimum																.55
Do	Average	14	30.8	.725	9,030	10,780	14,190	1,715								14	.725
	Maximum		34.8	.75	10,400	11,960	16,450	2,030	—	—	—	—	—	—	—		.75
	Minimum		23.5	.708	3,240	4,220	5,830	920									.708
Dao	Average	2	32.5	.631	6,390	7,230	8,550	1,740								2	.631
	Maximum		34	.633	6,600	8,150	9,440	1,740	—	—	—	—	—	—	—		.633
	Minimum		31	.63	6,190	6,320	7,660	1,740									.63
Cupang	Average															14	.285
	Maximum	—	—	—	—	—	—	—	—	—	—	—	—	—	—		.368
	Minimum																.259

[a] The apparent elastic limit was used in order to compare tests of native woods with similar tests of American woods. See table of tests, pp. 83, 84.

TABLE II.—*Compressive strength along the grain of Philippine timber.*

Name.	Locality.		Moisture over 35 per cent.				Moisture 20 to 35 per cent.				Moisture under 20 per cent.				Total number of tests.	Specific gravity of dry wood, all tests.
			Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Stress at rupture (pounds per square inch).	Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Stress at rupture (pounds per square inch).	Number of tests.	Moisture (per cent).	Specific gravity of dry wood.	Stress at rupture (pounds per square inch).		
Lauan	Mindanao	Average	67	52.4	0.444	3,840	40	30.5	0.44	4,040	32	12.4	0.458	6,180	139	0.448
		Maximum		73	.485	5,490		35	.47	4,550		19.4	.488	9,270		.488
		Minimum		38.4	.408	3,262		25	.40	3,470		3.3	.404	4,730		.40
Do	Zambales	Average	70	59.5	.478	4,180									70	.470
		Maximum		76	.529	4,980										.529
		Minimum		35.2	.412	3,220										.412
Almon	Occidental Negros	Average	34	57.6	.464	4,500									34	.464
		Maximum		71.6	.52	5,170										.52
		Minimum		46.1	.378	3,140										.378
Apitong	Mindanao	Average	98	53	.617	4,350	24	27.2	.711	5,740	28	14.4	.688	7,250	150	.645
		Maximum		71.8	.715	5,740		34	.825	6,770		19.4	.735	9,400		.825
		Minimum		36	.56	3,350		20	.664	4,740		7.8	.618	5,270		.56
Do	Zambales	Average	60	53.4	.679	5,010					2	15.2	.93	4,190	62	.687
		Maximum		93	.721	5,710						15.2	.93	4,220		.93
		Minimum		46.4	.588	2,810						15.2	.93	4,160		.588
Do	Occidental Negros	Average	20	93.2	.564	4,750									20	.564
		Maximum		102	.581	5,400										.581
		Minimum		83	.55	3,550										.55
Guijo	Ambos Camarines	Average	50	41.8	.675	6,070	24	28.8	.719	6,160	36	14.6	.748	7,940	110	.708
		Maximum		59.6	.73	6,610		35	.76	7,220		19.8	.82	11,400		.82
		Minimum		36	.629	5,180		23.2	.673	4,900		7.5	.68	3,980		.629
Do	Mindoro	Average	98	55.7	.697	6,070									98	.697
		Maximum		79.6	.806	7,300										.806
		Minimum		40.9	.596	3,660										.596
Molave	Near Laguna de Bay	Average	78	46.4	.772	6,680	20	29.7	.794	7,080	17	12.7	.818	8,330	115	.783
		Maximum		66	.85	8,470		34.6	.858	8,800		18.8	.88	10,300		.88
		Minimum		37	.69	4,770		20.2	.725	6,100		5.2	.728	6,800		.69
Do	Ambos Camarines	Average	50	50.5	.784	6,530									50	.784
		Maximum		61.5	.822	8,300										.822
		Minimum		40.3	.712	3,900										.712
Yacal	do	Average	34	46.7	.828	7,490	94	29.5	.832	8,340	29	13.4	.849	9,220	157	.843
		Maximum		75	.85	8,400		35	.94	9,510		18.1	.90	11,280		.94
		Minimum		38.6	.77	6,200		21.8	.76	6,250		10.7	.814	7,580		.76
Narra	Near Laguna de Bay	Average	20	77.7	.563	5,780									20	.563
		Maximum		93	.69	6,900										.59
		Minimum		66.5	.535	4,180										.535
Do	Cagayan	Average	18	55.9	.619	5,300	18	28.5	.534	5,290	24	7.5	.484	6,740	60	.54
		Maximum		75.5	.68	6,530		34.2	.77	7,060		9.7	.531	8,600		.77
		Minimum		35.5	.482	3,770		21.1	.438	4,160		4.8	.384	4,540		.384
Tanguile	Unknown	Average	18	40.5	.53	4,750	22	30.6	.485	5,030	32	13.7	.424	5,230	72	.469
		Maximum		47.4	.565	5,270		35	.52	5,450		19.9	.58	6,521		.58
		Minimum		35.2	.47	3,650		27.2	.355	3,752		8.8	.376	3,825		.355
Do	Zambales	Average	54	44.1	.46	3,980					38	9.6	.535	6,900	92	.491
		Maximum		58.6	.54	4,780						19.2	.606	8,670		.606
		Minimum		35.6	.405	3,050						1.7	.478	4,150		.405
Tanguile-balacbacan	Occidental Negros	Average	28	56.4	.509	4,620									28	.509
		Maximum		59.5	.53	4,960										.53
		Minimum		49.3	.479	3,910										.479
Sacat	Bataan	Average	14	49.8	.561	4,530									14	.561
		Maximum		53.8	.585	4,740										.585
		Minimum		46.2	.54	4,280										.54
Do	Tarlac	Average	74	53.1	.60	5,260	22	26.6	.592	5,500	38	12.4	.661	7,140	134	.616
		Maximum		89.7	.657	9,150		34.8	.677	5,910		19.7	.70	9,020		.70
		Minimum		35.2	.478	3,140		20	.485	3,990		4.2	.601	4,970		.478
Ipil	Ambos Camarines	Average	36	52.9	.796	5,650	30	25.9	.779	6,250	16	17.7	.807	6,570	82	.792
		Maximum		78.7	.872	6,390		31.7	.855	7,600		19.9	.99	8,020		.99
		Minimum		43.5	.714	4,980		21.6	.68	4,280		14.8	.713	3,650		.68

TABLE II.—*Compressive strength along the grain of Philippine timber*—Continued.

Name.	Locality.		Moisture over 35 per cent. Number of tests.	Moisture over 35 per cent. Moisture (per cent).	Moisture over 35 per cent. Specific gravity of dry wood.	Moisture over 35 per cent. Stress at rupture (pounds per square inch).	Moisture 20 to 35 per cent. Number of tests.	Moisture 20 to 35 per cent. Moisture (per cent).	Moisture 20 to 35 per cent. Specific gravity of dry wood.	Moisture 20 to 35 per cent. Stress at rupture (pounds per square inch).	Moisture under 20 per cent. Number of tests.	Moisture under 20 per cent. Moisture (per cent).	Moisture under 20 per cent. Specific gravity of dry wood.	Moisture under 20 per cent. Stress at rupture (pounds per square inch).	Total number of tests.	Specific gravity of dry wood, all tests.
Ipil	Mindoro	Average	84	60.4	0.666	5,450	4	32.5	0.77	6,030	2	19.8	0.77	6,540	90	0.673
		Maximum		89	.75	7,150		33.4	.77	6,470		19.8	.77	6,570		.77
		Minimum		37.5	.56	2,390		31.5	.77	5,530		19.8	.77	6,510		.56
Do	Palawan	Average	79	51.4	.807	8,090									79	.807
		Maximum		61.2	.867	9,470										.867
		Minimum		44.8	.75	5,350										.75
Dungon	Ambos Camarines	Average	6	44.1	.803	6,160	54	25.2	.88	6,440	48	10.7	.839	9,420	108	.858
		Maximum		58	.846	6,520		34	.985	7,970		16.4	.882	11,970		.985
		Minimum		37.1	.723	5,900		20	.788	4,050		8	.796	6,410		.723
Do	Masbate	Average	6	36.9	.825	4,540	40	29.5	.854	4,690					46	.85
		Maximum		37.5	.84	5,030		34.8	.89	6,670						.89
		Minimum		36.2	.816	3,830		25.1	.822	3,460						.816
Do[a]	Mindanao	Average	38	50.7	.669	4,000	6	32.6	.67	4,600					44	.669
		Maximum		82	.707	4,740		35	.69	5,200						.707
		Minimum		35.5	.636	3,080		29	.657	4,090						.636
Malasantol	Unknown	Average	40	64.4	.631	4,660	4	30.7	.684	4,840	10	13.5	.694	6,580	54	.646
		Maximum		86	.68	5,410		34.3	.689	5,040		17.1	.712	8,040		.712
		Minimum		37.4	.608	3,390		27.2	.679	4,660		10	.66	5,140		.608
Supa	do	Average	8	36.1	.677	6,480	42	30.2	.711	7,100	42	14.5	.713	8,700	92	.711
		Maximum		36.3	.692	7,030		33.4	.835	8,510		19.5	.808	10,340		.835
		Minimum		36	.644	5,750		26	.61	5,790		8.3	.625	7,046		.61
Do	Tayabas	Average	10	37.2	.746	5,090	112	28.3	.819	5,980					122	.813
		Maximum		41.6	.855	6,090		34.7	.955	7,700						.955
		Minimum		35.1	.70	3,770		22.5	.712	4,000						.70
Balacat	Lamao Forest Reserve, Bataan.	Average	16	52.6	.517	4,020									16	.517
		Maximum		61.6	.57	4,510										.57
		Minimum		39.5	.478	3,540										.478
Do	Tarlac	Average	40	44.7	.56	4,150	12	24.9	.588	4,650	66	9.8	.587	5,530	118	.578
		Maximum		63	.62	4,710		30.7	.66	5,320		19.2	.638	7,590		.66
		Minimum		36.8	.515	2,920		20	.561	3,770		2.2	.54	4,020		.515
Macaasim	Unknown	Average	76	63.9	.703	4,350	10	26.2	.776	5,880	6	17.1	.793	6,860	92	.717
		Maximum		81.5	.81	6,260		30.5	.78	6,600		18	.82	7,650		.82
		Minimum		35.2	.667	2,610		20	.774	4,960		15.7	.76	5,980		.667
Calantas	Albay	Average	28	77.3	.357	2,960					8	9.7	.363	4,420	36	.358
		Maximum		89.6	.379	3,450						12.8	.37	4,830		.379
		Minimum		62.9	.336	2,330						7.1	.355	3,230		.336
Do	Mindoro	Average	18	57.3	.51	3,810	12	26.3	.537	3,820	6	12.5	.557	3,520	36	.527
		Maximum		64.7	.54	4,960		32.2	.583	4,320		19.1	.573	4,360		.583
		Minimum		46	.492	3,230		23.8	.505	3,360		9.1	.531	2,890		.492
Tindalo	Unknown	Average	12	41.9	.747	7,400	8	28.8	.787	8,770					20	.763
		Maximum		44.8	.77	9,150		32.4	.864	9,680						.864
		Minimum		38.3	.734	5,620		23.6	.756	6,890						.734
Do	Ambos Camarines	Average	23	43.9	.80	7,140	26	27.4	.806	7,310	6	16.9	.819	7,710	55	.805
		Maximum		58.1	.86	8,960		32.7	.866	9,040		17.6	.83	8,650		.866
		Minimum		37	.72	5,850		22.5	.742	3,530		15.7	.802	7,040		.72
Do	Masbate	Average	20	56.7	.77	5,930	8	22	.753	6,340	8	18.6	.794	6,780	36	.772
		Maximum		70.1	.813	7,030		23	.788	7,350		19.4	.808	7,660		.813
		Minimum		50.7	.70	4,270		20.1	.68	5,150		16.9	.784	5,950		.68
Amuguis	Mindoro	Average	54	45.2	.692	5,210	6	32.9	.707	4,920					60	.693
		Maximum		57.8	.76	6,490		34.8	.75	6,140						.76
		Minimum		36	.621	2,660		30	.641	3,980						.621
Do	Palawan	Average	14	54.1	.675	5,640									14	.675
		Maximum		61.6	.753	6,150										.753
		Minimum		48.1	.613	4,660										.613
Acle	Tarlac	Average	27	84.5	.631	4,550	10	30.2	.647	5,050					37	.635
		Maximum		101	.707	5,440		34	.684	5,820						.707
		Minimum		39.2	.598	3,970		25	.607	4,400						.598

[a] This is not the wood commonly known as dungon, but is often sold under that name.

TABLE II.—*Compressive strength along the grain of Philippine timber*—Continued.

Name.	Locality.		Moisture over 35 per cent. Number of tests.	Moisture over 35 per cent. Moisture (per cent).	Moisture over 35 per cent. Specific gravity of dry wood.	Moisture over 35 per cent. Stress at rupture (pounds per square inch).	Moisture 20 to 35 per cent. Number of tests.	Moisture 20 to 35 per cent. Moisture (per cent).	Moisture 20 to 35 per cent. Specific gravity of dry wood.	Moisture 20 to 35 per cent. Stress at rupture (pounds per square inch).	Moisture under 20 per cent. Number of tests.	Moisture under 20 per cent. Moisture (per cent).	Moisture under 20 per cent. Specific gravity of dry wood.	Moisture under 20 per cent. Stress at rupture (pounds per square inch).	Total number of tests.	Specific gravity of dry wood, all tests.
Acle	Zambales	Average	12	94.9	0.579	5,330									12	0.579
		Maximum		106	.604	5,880										.604
		Minimum		81	.553	4,900										.553
Betis	Tayabas	Average	14	38.2	.854	6,540	24	31.5	0.857	6,410					38	.856
		Maximum		42.7	.882	7,540		34.8	.886	7,330						.886
		Minimum		31.6	.82	5,640		28.3	.82	5,000						.82
Do	Ambos Camarines	Average	60	59.5	.725	4,330	2	34	.806	4,410					62	.728
		Maximum		79.3	.798	4,930		34	.806	4,540						.806
		Minimum		42.8	.615	3,380		34	.806	4,290						.615
Bansalaguin	Unknown	Average	34	43	.841	6,960	2	32.8	.883	7,140	12	14.5	0.87	8,630	48	.85
		Maximum		53.6	.88	8,140		32.8	.883	7,310		16.5	.905	9,560		.905
		Minimum		35.1	.784	5,410		32.8	.883	6,980		12.1	.85	7,800		.784
Palo maria	Zambales	Average	40	50.2	.618	4,770	2	34.2	.674	5,720					42	.623
		Maximum		103	.704	6,220		35	.708	6,240						.708
		Minimum		35.1	.488	3,150		33.4	.64	5,340						.488
Batitinan	Unknown	Average	18	54.9	.777	4,650					8	5	.836	9,290	26	.795
		Maximum		61.6	.795	5,180						5.6	.85	10,640		.85
		Minimum		48.5	.76	3,950						4.4	.821	7,190		.76
Aranga	Ambos Camarines	Average					36	31.2	.826	8,020	52	4.9	.882	12,420	88	.859
		Maximum						34.5	.86	8,730		6.4	.942	14,920		.942
		Minimum						27.7	.796	6,840		3.4	.832	9,290		.796
Banuyo	Masbate	Average	30	77.9	.527	3,290	4	24.2	.50	3,990	4	15.5	.534	4,150	38	.525
		Maximum		110	.572	4,470		28	.546	4,470		17.8	.545	4,470		.572
		Minimum		35.3	.46	2,550		20.5	.455	3,400		13.3	.523	3,530		.455
Red lauan	Occidental Negros	Average	28	76.9	.406	3,850									28	.406
		Maximum		92.3	.43	4,270										.43
		Minimum		63	.371	3,040										.371
Mayapis	Laguna	Average	40	63.5	.399	3,530									40	.399
		Maximum		85.4	.456	4,080										.456
		Minimum		44.1	.343	2,780										.343
Malugay	Mindoro	Average	34	55.8	.635	5,120	18	22.1	.666	5,740	26	11.2	.683	8,080	8	.658
		Maximum		70.8	.713	6,040		35.9	.71	7,270		18.8	.75	10,930		.75
		Minimum		46.6	.553	3,960		20	.625	5,160		7.4	.62	4,830		.553
Sasalit	Zambales	Average					42	25.7	.89	9,290	34	11.3	.849	9,100	76	.872
		Maximum						31.1	.984	11,890		15.8	.995	11,180		.995
		Minimum						21.5	.742	6,600		8.7	.815	6,400		.742
Liusin	Bataan	Average	8	60.9	.71	5,220									8	.71
		Maximum		63	.73	5,640										.73
		Minimum		57.6	.70	4,860										.70
Lumbayao	Basilan Island, Moro Province.	Average					54	25.2	.551	5,480	52	12.5	.58	6,410	106	.565
		Maximum						31.5	.603	6,390		19.7	.671	8,100		.671
		Minimum						20.1	.483	4,520		5.3	.53	3,550		.483
Agoho	Tarlac	Average	56	44.2	.725	7,220									56	.725
		Maximum		56.4	.762	8,760										.762
		Minimum		35.3	.62	4,390										.62
Do	do	Average					36	27	.858	5,770					36	.858
		Maximum						34.8	.94	7,770						.94
		Minimum						20.4	.78	4,330						.78
Do	do	Average									8	18.3	.909	7,370	8	.909
		Maximum										19.6	.954	8,580		.954
		Minimum										17.6	.93	5,010		.93
Mangachapuy	Albay	Average					26	29.6	.726	7,730					26	.726
		Maximum						33.1	.75	8,280						.75
		Minimum						24.9	.51	6,950						.51
Dao	Mindoro	Average	14	46.2	.602	5,070									14	.602
		Maximum		62.7	.633	5,710										.633
		Minimum		35.4	.55	3,770										.55
Cupang	Palawan	Average	26	93	.285	2,070									26	.285
		Maximum		128	.368	2,330										.368
		Minimum		59.8	.259	1,630										.259

TABLE III.—*Shearing strength along the grain of Philippine timber.*

[Results averaged regardless of moisture content.]

Name.	Locality.		Number of tests.	Specific gravity of dry wood.	Stress at rupture (pounds per square inch).
Lauan	Mindanao	Average	142	0.446	557
		Maximum		.488	934
		Minimum		.40	326
Do	Zambales	Average	69	.478	525
		Maximum		.529	873
		Minimum		.412	292
Almon	Occidental Negros	Average	34	.464	508
		Maximum		.52	737
		Minimum		.378	324
Apitong	Mindanao	Average	150	.645	669
		Maximum		.825	1,203
		Minimum		.56	240
Do	Zambales	Average	62	.687	757
		Maximum		.93	1,212
		Minimum		.588	298
Do	Occidental Negros	Average	20	.564	753
		Maximum		.581	997
		Minimum		.55	528
Guijo	Ambos Camarines	Average	110	.708	915
		Maximum		.82	1,324
		Minimum		.629	366
Do	Mindoro	Average	98	.697	824
		Maximum		.806	1,500
		Minimum		.596	561
Molave	Near Laguna de Bay	Average	129	.784	914
		Maximum		.88	1,362
		Minimum		.69	357
Do	Ambos Camarines	Average	51	.784	839
		Maximum		.825	1,323
		Minimum		.716	403
Yacal	do	Average	150	.843	849
		Maximum		.94	1,665
		Minimum		.76	427
Narra	Near Laguna de Bay	Average	20	.563	678
		Maximum		.59	844
		Minimum		.535	456
Do	Cagayan	Average	59	.54	660
		Maximum		.77	1,225
		Minimum		.384	291
Tanguile	Unknown	Average	70	0.471	647
		Maximum		.58	928
		Minimum		.355	326
Do	Zambales	Average	86	.491	555
		Maximum		.606	1,068
		Minimum		.405	288
Tanguile-balacbacan	Occidental Negros	Average	26	.509	602
		Maximum		.53	878
		Minimum		.479	380
Sacat	Lamao Forest Reserve, Bataan.	Average	14	.561	776
		Maximum		.585	1,055
		Minimum		.54	550
Do	Tarlac	Average	132	.616	850
		Maximum		.70	1,584
		Minimum		.478	466
Ipil	Ambos Camarines	Average	79	.793	904
		Maximum		.99	1,310
		Minimum		.68	458

TABLE III.—*Shearing strength along the grain of Philippine timber*—Continued.

[Results averaged regardless of moisture content.]

Name.	Locality.		Number of tests.	Specific gravity of dry wood.	Stress at rupture (pounds per square inch).
Ipil	Mindoro	Average	90	.673	948
		Maximum		.77	1,445
		Minimum		.56	410
Do	Palawan	Average	80	.807	753
		Maximum		.867	1,226
		Minimum		.75	525
Dungon	Ambos Camarines	Average	98	.852	1,253
		Maximum		.985	1,854
		Minimum		.723	672
Do	Masbate	Average	46	.85	1,298
		Maximum		.89	1,560
		Minimum		.816	925
Do.[a]	Mindanao	Average	44	.669	855
		Maximum		.707	1,102
		Minimum		.636	563
Malasantol	Unknown	Average	54	.646	720
		Maximum		.712	1,110
		Minimum		.608	409
Supa	do	Average	86	.71	898
		Maximum		.835	1,480
		Minimum		.61	520
Do	Tayabas	Average	118	.813	852
		Maximum		.955	1,380
		Minimum		.70	293
Balacat	Lamao Forest Reserve, Bataan.	Average	16	.517	486
		Maximum		.57	638
		Minimum		.478	300
Do	Tarlac	Average	117	.578	692
		Maximum		.66	1,281
		Minimum		.515	253
Macaasim	Unknown	Average	92	.717	916
		Maximum		.82	1,390
		Minimum		.667	376
Calantas	Albay	Average	34	.358	526
		Maximum		.379	870
		Minimum		.336	289
Do	Mindoro	Average	35	.527	778
		Maximum		.583	1,049
		Minimum		.492	455
Tindalo	Unknown	Average	20	.763	1,004
		Maximum		.864	1,460
		Minimum		.734	685
Do	Ambos Camarines	Average	56	0.805	911
		Maximum		.866	1,507
		Minimum		.72	299
Do	Masbate	Average	36	.772	905
		Maximum		.813	1,226
		Minimum		.68	496
Amuguis	Mindoro	Average	60	.692	824
		Maximum		.75	1,762
		Minimum		.621	396
Do	Palawan	Average	14	.675	851
		Maximum		.753	1,107
		Minimum		.613	641

[a] This is not the wood commonly known as dungon but is often sold under that name.

TABLE III.—*Shearing strength along the grain of Philippine timber*—Continued.

[Results averaged regardless of moisture content.]

Name.	Locality.		Number of tests.	Specific gravity of dry wood.	Stress at rupture (pounds per square inch).
Acle	Tarlac	Average	36	.63	686
		Maximum		.707	1,270
		Minimum		.598	420
Do	Zambales	Average	11	.579	778
		Maximum		.604	1,190
		Minimum		.553	443
Betis	Tayabas	Average	38	.856	1,168
		Maximum		.886	1,555
		Minimum		.82	598
Do	Ambos Camarines	Average	61	.728	819
		Maximum		.806	1,243
		Minimum		.615	474
Bansalaguin	Unknown	Average	48	.85	1,098
		Maximum		.905	1,865
		Minimum		.784	695
Palo maria	Zambales	Average	46	.623	856
		Maximum		.708	1,581
		Minimum		.488	528
Batitinan	Unknown	Average	26	.795	859
		Maximum		.85	2,195
		Minimum		.76	535
Aranga	Ambos Camarines	Average	82	.863	1,038
		Maximum		.942	2,324
		Minimum		.796	355
Banuyo	Masbate	Average	38	.525	596
		Maximum		.572	1,065
		Minimum		.455	287
Red lauan	Occidental Negros	Average	28	.406	502
		Maximum		.43	761
		Minimum		.371	332
Mayapis	Laguna	Average	40	.399	472
		Maximum		.456	790
		Minimum		.343	288
Malugay	Mindoro	Average	78	.658	980
		Maximum		.75	1,885
		Minimum		.553	464
Sasalit	Zambales	Average	75	.872	1,176
		Maximum		.995	1,938
		Minimum		.742	708
Liusin	Bataan	Average	8	.71	886
		Maximum		.73	1,388
		Minimum		.70	543
Lumbayao	Basilan Island, Moro Province.	Average	104	.565	827
		Maximum		.671	1,306
		Minimum		.483	353

TABLE IV.—*Summary of mechanical tests on thirty-two species of American woods.*

[From Tables, I, II, IV, V, and VI, Circular No. 15, Division of Forestry, United States Department of Agriculture.]

Kind of wood.	Specific gravity of dry wood.	Fiber stress at relative (apparent) elastic limit (pounds per square inch).	Modulus of rupture (pounds per square inch).	Modulus of elasticity (1,000 pounds per square inch).	Stress at rupture compression along the grain (pounds per square inch).	Stress at rupture shearing along the grain; not reduced for moisture (pounds per square inch).
Reduced to 15 per cent moisture.						
Longleaf pine	0.61	8,500	10,900	1,890	6,900	700
Cuban pine	.63	9,500	11,900	2,300	7,900	700
Shortleaf pine	.51	7,200	9,200	1,600	5,900	700
Loblolly pine	.53	8,200	10,100	1,950	6,500	700
Reduced to 12 per cent moisture.						
White pine	.38	6,400	7,900	1,390	5,400	400
Red pine	.50	7,700	9,100	1,620	6,700	500
Spruce pine	.44	8,400	10,000	1,640	7,300	800
Bald cypress	.46	6,600	7,900	1,290	6,000	500
White cedar	.37	5,800	6,300	910	5,200	400
Douglas spruce[a] (Oregon pine)	.51	6,400	7,900	1,680	5,700	500
White oak	.80	9,600	13,100	2 090	8,500	1,000
Overcup oak	.74	7,500	11,300	1,620	7,300	1,000
Post oak	.80	8,400	12,300	2,030	7,100	1,100
Cow oak	.74	7,600	11,500	1,610	7,400	900
Red oak	.73	9,200	11,400	1,970	7,200	1,100
Texan oak	.73	9,400	13,100	1,860	8,100	900
Yellow oak	.72	8,100	10,800	1,740	7,300	1,100
Water oak	.73	8,800	12,400	2,000	7,800	1.100
Willow oak	.72	7,400	10,400	1,750	7,200	900
Spanish oak	.73	8,600	12,000	1,930	7,700	900
Shagbark hickory	.81	11,200	16,000	2,390	9,500	1,100
Mockernut hickory	.85	11,700	15,200	2,320	10,100	1,100
Water hickory	.73	9,800	12,500	2,080	8,400	1,000
Bitternut hickory	.77	11,100	15,000	2,280	9,600	1,000
Nutmeg hickory	.78	9,300	12,500	1,940	8,800	1,100
Pecan hickory	.78	11,500	15,300	2,530	9,100	1,200
Pignut hickory	.89	12,600	18,700	2,730	10,900	1,200
White elm	.54	7,300	10,300	1,540	6,500	800
Cedar elm	.74	8,000	13,500	1,700	8,000	1,300
White ash	.62	7,900	10,800	1,640	7,200	1,100
Green ash	.62	8,900	11,600	2,050	8,000	1,000
Sweet gum	.59	7,800	9,500	1,700	7,100	800

[a] Actual tests on "dry" material not reduced for moisture.

TABLE V.[a]—*Comparison of selected Philippine, Borneo, and American woods.*

Name.	Locality	Compression along the grain.		Cross-bending.			
		Average per cent moisture.	Average stress at rupture (pounds per square inch).	Average per cent moisture.	Average modulus of rupture (pounds per square inch).	Average modulus of elasticity (1,000 pounds per square inch).	Average specific gravity of dry wood.
Aranga	Philippine Islands	4.9	12,420	5.6	17,920	2,419	0.859
Billian (Borneo ironwood).	Borneo	22.5	11,290	22.5	19,660	2,384	.96
Pignut hickory	United States	12	10,900	12	18,700	2,730	.78
Dungon	Philippine Islands	10.7	9,420	11.6	17,110	2,209	.857
Yacal	do	13.4	9,220	15.6	15,690	2,583	.843
Merabau (Borneo ipil)	Borneo	21	9,035	21	18,830	2,505	.965
White oak	United States	12	8,500	12	13,100	2,090	.80
Molave	Philippine Islands	12.7	8,330	10.4	8,580	1,614	.785
Guijo	do	14.6	7,940	13.7	15,150	2,158	.708
Selangan batu (Borneo yacal).	Borneo	27.6	7,420	27.6	12,325	2,027	.689
Apitong	Philippine Islands	14.4	7,250	14	11,620	2,144	.645
Longleaf pine	United States	15	6,900	15	10,900	1,890	.61
Ipil	Philippine Islands	17.7	6,570	18.1	6,980	1,383	.792
Lauan	do	12.4	6,180	10.4	9,760	1,653	.446
Oregon pine	United States	12	5,700	12	7,900	1,680	.51
California redwood	do	13.3	5,560	12.3	9,110	1,320	.445

[a] Table VI of the original report.

Appendix II.

BIBLIOGRAPHY OF THE FORESTS AND FOREST PRODUCTS OF THE PHILIPPINES.

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Appendix K. K. Report of the Military Governor in the Philippines. (1900.) (This appendix contains the first annual report of Capt. Geo. P. Ahern, who on April 14, 1900, was assigned the task of organizing a forest service for the Philippines.)

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DIRECTOR OF FORESTRY
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LEGEND
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