THE CARIBBEAN FORESTER

This journal serves as a medium of interchange of knowledge among those interested in forestry in the islands and countries in or near the Caribbean Sea. Invitations to cooperate in this project have been sent to forestry and agricultural officials in the following places:

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Articles may be submitted in the contributor's own language and preferably should be accompanied by a short summary of the paper. Authors' names should be typed or printed clearly and the title or position of the author sent with the paper.

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FORESTRY AND FOREST RESOURCES IN MEXICO

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Not until the beginning of this century did influential citizens of Mexico and representatives of the Government take active steps to protect the Mexican forests from unnecessary and ruthless destruction. It is true that long before many far-sighted men had warned the people of the consequences of forest devastation, and often large forest fires drew the attention of the public to this important problem. But such warnings were not heeded or followed by protective measures. While the Mexican Congress concerned itself from time to time with various forest problems the legislators were unwilling to enact any drastic legislation which would favor the Mexican forest. The governments of the various states were likewise unable to promote laws to conserve the forests of the mountainous regions of the country because such laws would naturally conflict with the immediate interests of the local communities and the large landowners. Local cutting restrictions and other decrees which were actually in force under the Spanish rule, that is to say before 1810, were discarded after the liberation, but not replaced by new ordinances. The National Government did not dare to restrict by federal legislation the sovereignty of the states. Under these unfortunate circumstances the destruction of the forests by the indigenous population, in progress for centuries, was allowed to continue and even to increase as the lumbermen invaded the virgin Sierras of the North and the forested areas in the vicinity of the larger centers of population.

It is an established fact that most of the denuded and badly eroded mountains and hills so familiar to the visitor of the many famous archaeological sites throughout the country were once covered with forests. The gradual destruction of the Mexican soil by erosion, which took place after the destruction of the original forests, is paralleled on the same scale only in the countries around the Mediterranean basin and in China.

Towards the end of the nineteenth century the forest conditions of Mexico became a subject of deep concern to many patriotic citizens of Mexico. Under the leadership of Ing. Miguel A. de Quevedo a movement was started to protect the Mexican forests from further destruction and devastation. Members of a Central Committee began their work in the vicinity of Mexico City, Veracruz, and other centers of population. A forest school and a large forest nursery were established in Coyoacan near Mexico City. In 1909 a Bureau of Forestry was established within the Department of Agriculture. All this work was interrupted by the Mexican Revolution, but it was resumed again soon after. An excellent forest law was enacted in 1926. Under the presidency of General Lázaro Cárdenas the federal forest service, together with wildlife and fisheries, was administered under an autonomous department. In 1938 it again became a bureau within the Department of Agriculture.

Area, Distribution and Types of Forests

Although there is considerable known about type and composition of a great number of Mexican forests, it is still rather difficult to give a complete picture of the existing forest types and their distribution. The varied topography and the great differences in elevation result in a corresponding difference in climatic conditions and hence types of vegetation. Tropical forests cover the coastal regions on the gulf of Mexico and a narrow strip along the Pacific coast. Embedded between the western mountain range of the Sierra Madre and the mountains in the East near the Gulf coast lies the vast tableland of Mexico with an altitude of from 5000 to 8000 feet above sea-level. A sub-tropical vegetation covers the foot hills of the main mountain ranges, which unite in the southern part of the country. Coniferous forests of great commercial importance cover the mountains of the Sierras. Large areas in the west, central, and northern parts of the tableland are extremely dry, supporting only a scarce vegetation of mesquite, cactus, and agave.

Botanically, the existing trees and shrubs of Mexico are rather well known. They are described by Paul C. Standley in five volumes, published by the Smithsonian Institute in Washington. Yet the practicing forester may still find himself in great difficulty when trying to determine the scientific name of an important forest tree found in remote regions of the country. There is no doubt but that a great deal of botanical research remains to be done, especially in tropical forests, before all the existing timber trees of Mexico are adequately described.

At the present time less is known of the existing forest types. In the files of the Mexican Forest Service there are a great many valuable reports on specific forest areas of the country. Many of these reports have also been published in official bulletins. However, up to the present time no one has compiled and made this information available in a comprehensive study covering every region of the country. An attempt to outline and to map the major forest regions or "zones" of Mexico was made in 1937 by José García Martínez who, at that time, was Chief of the Statistical Office of the Department of Forestry, Game and Fish. The forest zones established by Martínez are chiefly based on the topographic features of the country. The resulting map, which is reproduced in Figure 1, gives quite a satisfactory picture of the distribution of the major forest zones since the forest type is intimately correlated with altitude.

It would take too much space to give a description of each of these major zones and of the prevailing climates and subsequent types of vegetation. Some pertinent data have been assembled in Table 1, showing the total extension of various zones of altitude and the estimated forested area within each of these zones.

According to this table only 28,471,000 hectares1/ or 14.5 per cent of the total land area of Mexico is covered by forest vegetation. The estimates of the percentage of forested areas within each zone of altitude

1/ One hectare = 2.47 acres.

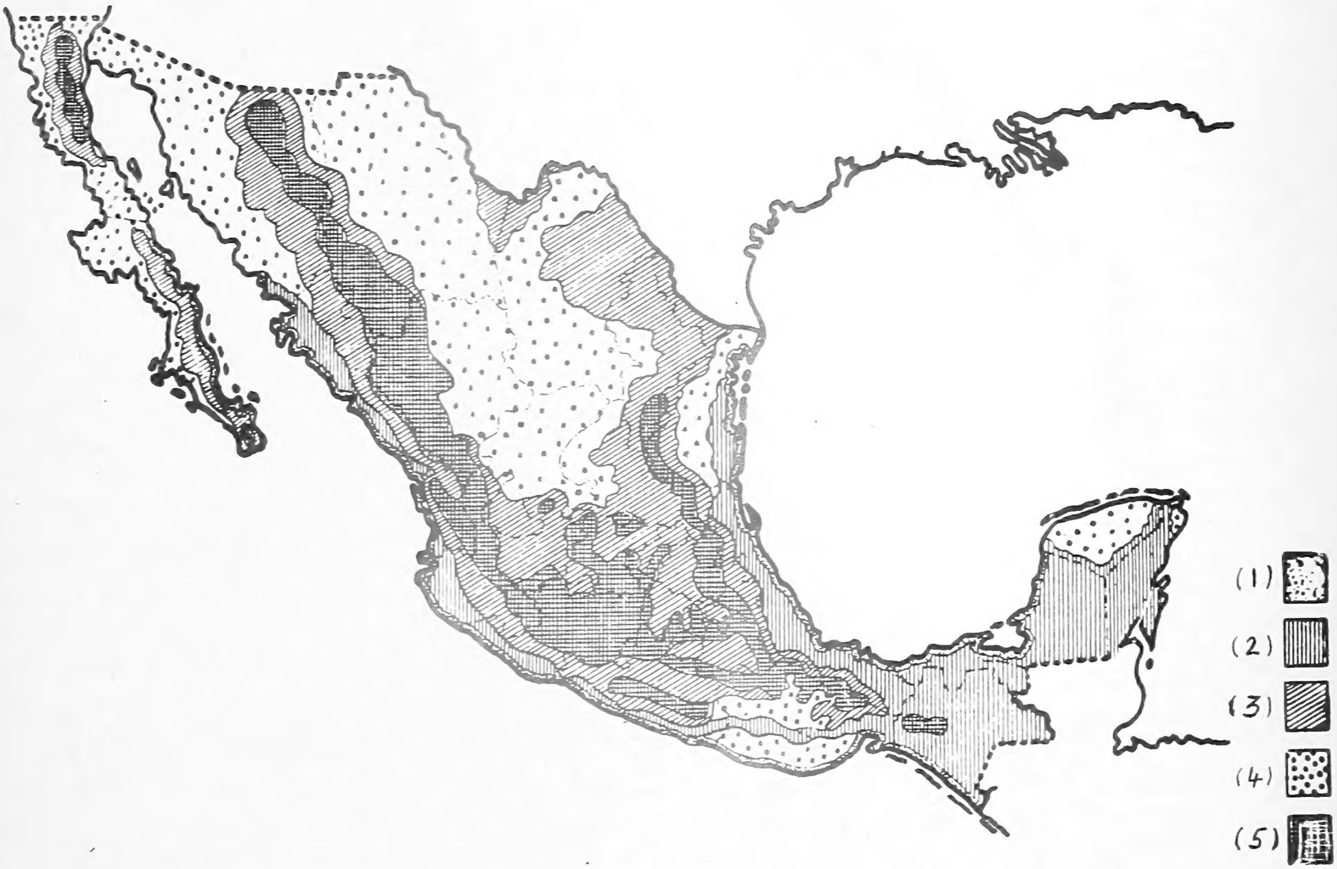

Fig. 1.—Forest Zones of Mexico.1/

(1) Mangove, palme.
(2) Mahogany, mountain mahogany, ceiba, chicle, cedar (Cedrela) and many other tropical species.
(3) Oak, copal (Elaphrium), pinon pine, senna, alder, arbutus.
(4) Agave, cactus, mesquite.
(5) Pine, white cedar, cypress, fir.

1/ Reproduction of map published in Boletín del Departamento Forestal y de Caza y Pesca, No. 8, 1937.

probably refer merely to the areas actually covered by forests and do not include arid lands sustaining only a poor vegetation which might be classified as forest land as contrasted with agricultural or tillable land. It has been estimated that of the total land area of Mexico which is 197 million hectares only 20 million hectares are agricultural land, 30 million hectares sterile land, the balance representing a type of land which could be classified as forest and range land, of which only a small portion or roughly 30 million hectares is covered by high forests. A large part of the remainder is suitable for restoration and reforestation.

Table 1.—Forested area of Mexico in different zones of altitude.

Altitude above sea-level meters	Total land area		Area covered with forest vegetation	
	million hectares	Per cent	million hectares	Per cent
Total	196.9	100.0	28.5	14.5
0-500	64.7	32.9	17.0	8.6
500-1000	32.7	16.6	4.3	2.2
1000-1500	40.6	20.6	2.6	1.3
1500-2000	38.8	19.7	3.1	1.6
2000-2500	18.9	9.6	1.1	0.6
2500-3000 and over	1.2	0.6	0.4	0.2

With a population of 17 million the forest area per head amounts to 1.54 hectares, which is rather low when compared with other Central and South American countries, but about the same as the per capita area of the commercial forest lands of the United States, and about six to eight times larger than that of Germany and France.

Forest Production

Statistics on forest production are still scarce and by no means all inclusive. The latest official statistics on wood and charcoal production are found in the September-October issue of the Boletín Forestal y de Caza, Volume 2, Number 3. According to this publication the output of wood products in the years 1937-1938 was as shown in Table 2.

The increase in the production of saw timber is partly explained by the recent construction of highways leading through heavily forested regions. The decline in hewn timber is due to the heavier tax imposed on such timber, the purpose of the tax being to discourage this kind of products, and to the reduced demand for railroad ties which resulted from the increased use of creosoted ties. The actual exploitation is probably larger than the amounts recorded in official statistics; still it represents only a small average exploitation per hectare. Ten million cubic meters per year would only amount to 0.35 cubic meters per hectare, while the productive capacity of the estimated forest area of 28 million acres may be estimated to be at least 3 cubic meters per acre. These few figures give an idea of the future potentialities of forestry in Mexico.

Table 2.—Wood production in Mexico 1933-1938.

	1933	1934	1935	1936	1937	1938
Saw timber in 1000 cu. m.	369	1419	585	600	648	477
Hewn timber in 1000 cu. m.	698	1817	387	369	317	399
Logs in 1000 cu. m.	136	380	199	61	66	250
Fuelwood in 1000 cu. m.	1447	2140	514	567	791	1111
Charcoal in 1000 tons	170	188	167	156	157	160

With the large number of forest types in Mexico it is not surprising that the country is producing a great variety of secondary forest products. Some of these products if produced in greater quantities would represent a basis for a number of important industries. At the present time the production of gum or chicle, used for the manufacture of chewing gum, is perhaps the most important one. This gum is produced by the chicozapote, Achras sapota. It comes from tropical forests, the principal producers being the State of Campeche and the Territory of Quintana Roo. The annual production for the entire country according to official statistics is as follows:

1935 - 2,069,718 kgs.
1936 - 2,760,851 kgs.
1937 - 2,577,898 kgs.

Other secondary products are dyewoods, tanning materials, rubber, naval stores, coconut and palm oils.

Accomplishments and Future Problems of Mexican Forestry

In recent years the Mexican government became fully aware of the pressing problems concerning the maintenance and conservation of the forests. The executive branch of the government, entrusted with the conservation of these forests, has undertaken an extensive campaign in all parts of the country to impress upon the average citizen the national importance of forest conservation. One of the outstanding features of this campaign is the establishment of forest nurseries by schools throughout the country. Over 1500 such nurseries were in existence in 1938. A popular magazine "Protección a la Naturaleza" has been published and freely distributed during recent years.

A large number of beautiful natural forested areas have been set aside as national parks. Up to 1938 twenty-five such parks had been definitely established and many more were being contemplated. The areas of these parks vary from several hundred to seventy thousand hectares. A great many tourists visit these parks each year. Most visitors to Mexico probably have seen the beautiful fir forest of the "Desierto de los Leones" near Mexico City, or the virgin oak forest in the National Park Alexander von Humboldt, located near the famous city of Tasco which also has been declared a national monument.

In accordance with the provisions made in the forest law, a large number of forests or partly forested areas have been declared protective forest zones. These areas have been established as a protection against erosion in steep mountainous country, as a protection for watersheds, and for artificial systems of irrigation. Protective zones also have been declared in the neighborhood of cities and other centers of population. Any exploitation of these forests is subject to the strictest regulation. The size of these protective zones varies greatly, ranging from about 20,000 to 200,000 hectares.

Much progress has been made in forest protection, especially against forest fires. More than 10,000 farmers have been organized in "defense cooperatives" throughout the country.

The enforcement of forest regulation in practice has been very effectively tied up with the collection of the forest yield tax. Cutting and shipping permits must be secured before any large quantity of wood may be cut and sold. The application of differential tariffs has greatly increased the radius of forest operations; the tax on wood cut near the centers of population is higher than for products coming from remote regions. In addition high quality products are taxed higher than defective or dead wood, the removal of which is a definite advantage to the forest. By extending the current wood operations over a larger territory, the cutting in any particular region becomes less intensive. The forest tax, therefore, is an effective factor in helping to control forest exploitation.

The distribution of the large land holdings and "haciendas" has in many ways created a new situation in regard to the administration and management of the Mexican forest. The creation of communal forests and of Ejidales forests has been greatly promoted in recent years.

It is the opinion of leading Mexican foresters that communal forests and forest cooperatives offer the best possibilities for sustained yield management and conservative forest practices, as contrasted to large scale exploitations which have been, and to a certain extent are still, carried out by large lumber companies.

The intensification and extension of forest activities throughout the country was only possible through a substantial increase in the personnel of the forest service. It was not too difficult a problem to train, in a relatively short time, a large number of forest rangers, and this has actually been done at the ranger school in Tlalpam, near Mexico City. These rangers are being placed at stations and forest delegations throughout the country. They represent a police force which sees to it that the regulations of the forest law are observed. In the enforcement of these regulations the department of forestry is assisted by the regular army.

A more difficult task is the education of technically trained forest engineers. Today young men are receiving technical training in forestry at the National School of Agriculture in Chapingo near Mexico City. The forest service seems to have in mind also a plan to send promising young men to foreign schools where they can improve and widen their technical knowledge. Most of the well trained foresters of the country are at the present time holding important positions in the federal forest service.

The extensive organization of the Mexican forest service based on progressive forest legislation, together with the patriotic spirit of the Mexican forester, promises the most successful continuation of the forestry program.

Summary

Mexico's forest history is not unlike that of many other nations in which exploitation greatly reduced the forest resource before the application of effective remedies started. Toward the end of the nineteenth century, Ing. Miguel A. de Quevedo started a protection movement. A forest school and a large forest nursery were established near Mexico City. In 1909 a Bureau of Forestry was set up within the Department of Agriculture. An excellent forest law was enacted in 1926.

There is a great variation in climate and soils throughout the length of Mexico, resulting in a corresponding wide variety of forest types. Tropical forests cover the coastal regions on the Gulf of Mexico and a narrow strip along the Pacific coast. Subtropical vegetation covers the foothills, and important coniferous forests cover the Sierras. A vast majority of the tree species have been identified but little is known concerning the character and extent of distinct forest types.

There are at present 28 million hectares of forested land and an additional 145 million hectares of non forested forest land. Present saw-timber exploitation is low enough so that if properly conducted the present forest area would be adequate for perpetual production.

A secondary product of Mexico's forests is chicle, used in chewing gum. The production, which was more than 2,500,000 kilograms in 1937, is centered in Campeche and Quintana Roo.

Mexico has recently set aside a large number of parks and protection forests. A flexible forest yield tax provides government control of the type and location of forest exploitation. Communal forests and forestry education are being encouraged.

Resumen

A principios de este siglo el gobierno mexicano empezó a tomar acción contra la destruccion innecesaria del bosque. Se inició un movimiento de

protección forestal bajo la dirección del ingeniero Sr. Miguel A. de Quevedo. Se estableció en Coyoacán cerca de Ciudad de México una escuela forestal y un vivero grande de árboles. En el 1909 se creó una Dirección de Bosques que dependía de la Secretaría de Agricultura. Bajo la presidencia del General Lázaro Cárdenas se constituyó el Departamento Forestal y de Caza y Pesca que tenía carácter autónomo, pero en el 1938 volvió éste a depender de la Secretaría de Agricultura.

Apesar de lo mucho que se sabe del tipo y composición de gran número de los bosques mexicanos, todavía es difícil dar una idea completa de los tipos forestales allí existentes y de su distribución. Las variaciones topográficas y las grandes diferencias en elevación dan como resultado una diferencia correspondiente en condiciones climáticas y por lo tanto en el tipo de vegetación. El litoral del golfo de México y una faja estrecha a lo largo del litoral Pacífico están cubiertos de bosques tropicales. Las bases de las cordilleras principales que se unen al sur del país están cubiertas de vegetación subtropical. Las montañas de las sierras están pobladas de bosques de coníferos de gran importancia comercial. Grandes áreas en el oeste, centro y parte norte de la meseta central son extremadamente secas y tienen por lo tanto solamente una escasa vegetación de mezquite, cacto y agave.

Sólo el 14.5 por ciento del área total de México o sea 28,471,000 hectáreas están cubiertas de bosques. El área por persona viene siendo de 1.54 hectáreas.

Los principales productos forestales son madera de aserrío, madera bruta, leña y carbón. Además un producto secundario importante es el chicle que se obtiene en el estado de Campeche y el territorio de Quintana Roo.

El gobierno mexicano ha emprendido recientemente una campaña extensiva para recalcarle al pueblo la importancia de los bosques. También se han establecido grandes parques nacionales. Las diferencias en los impuestos sobre aprovechamiento forestal (v.g. que sean más altos cuanto más cerca al mercado se efectúe el corte) se usan para favorecer determinadas prácticas más convenientes y racionales.

Se crearon cátedras de selvicultura, dasometría, etc. para establecer el grado de Ingeniero de Montes y también se crearon Escuelas de Guardería y en el presente se considera un plan para que los ingenieros de montes realicen estudios avanzados en el extranjero.

La organización y trabajo extenso del Servicio Forestal Mexicano, basado en una legislación forestal progresiva y el espíritu patriótico de los ingenieros de montes mexicanos promete la más próspera continuidad del programa forestal de aquella nación.

ROOFING SHINGLES IN JAMAICA[1/]

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The use of shingles as a roofing material in Jamaica has been a practice from the earliest days of the colony. The practice appears to have been introduced by the English colonists who settled in the island towards the end of the seventeenth century. Prior to this the Spaniards had employed tiles almost exclusively for their better dwellings. Most of their towns were built on the coastal plains within easy distance of the lower limestone hills, and the soil was suitable for the manufacture of tiles, to which they were accustomed. After 1655, however, the English colonists spread through the island and began to establish temselves further inland. The island abounded in valuable timbers many of which were suitable for shingles, and their master craftsmen were set to work. In the next 50 years, most of the magnificent colonial mansions were erected. Today only massive ruins remain but these pay a silent tribute to the skill of the early builders who so influenced the school of colonial architecture, and introduced the art of fashioning hand-riven shingles.

Advantages of Shingles

Coolness.--In tropical countries, it is necessary to select a roofing material which will always remain relatively cool. This is perhaps the best feature about shingles, as buildings roofed with shingles maintain an almost constant temperature sometimes many degrees lower than that outside.

Relative durability.--There are many examples on the sugar estates throughout the island where cedar shingles are still in good condition after nearly a century of constant use. This is common on the lowland houses but even in the hills, where conditions are very humid, shingles will last for 50 years or more. All these early shingles were split and dressed entirely by hand and are credited with being much more durable than sawn material.

Local materials.--Timbers suitable for shingles occur throughout the island mainly over 1,000 ft. above sea-level. Consequently there is not much distribution of the finished product from one point to another. Generally, shingles are utilized essentially for rural construction as in the towns imported shingles, galvanized iron, and tiles are the most popular roofing materials. However, in rural districts low transport costs and ready replacements when necessary are of great assistance, particularly to the peasantry who are slowly changing from the use of thatch and grass to shingles, and who are usually required to provide their own transport - by head or donkey.

1/ Acknowledgement is made to C. Swabey, the Conservator of Forests in Jamaica for valuable assistance in the preparation of this paper.

Suitability to environment.—Unfortunately, seasoning is not a very popular or widely practised operation in Jamaica. Shingles are usually manufactured only when they are required and are often used within a few weeks. Therefore, shingles produced in any district are generally best suited for use in the same district rather than in another locality where humidity and temperature, etc. may be quite different.

Disadvantages of Shingles

Fire hazard.—Fire is the bugbear of all wooden buildings. Shingles have become less popular as a result of the exaggerated advertising of merchants who are anxious to sell less inflammable roofing material. However, with ordinary elementary precautions, shingles are as safe and suitable as any other form of roofing.

Water collecting.—In the rural areas where people depend on rainfall for their water supply, roof catchment is very important. Water collected off new roofs which are made of some aromatic wood like cedar will definitely be tainted for a few weeks. As the water does not become injurious, and as the faint aroma may be removed by boiling it will be seen that this is not a serious disadvantage. In any event, tainted water is usually the result of uncovered tanks, birds perching on roofs and probably also to freshly painted roofs.

Appearance.—The rough appearance of an unfinished split shingle constitutes a serious drawback and is one of the chief reasons for the limited use of shingles in urban construction.

Wood Used for Shingles

Most straight-grained timbers are used for shingles but other desirable qualities are light weight, durability, and minimum tendency to warp and split under varying conditions of wind, temperature, and moisture. In the tropics where a heavy downpour often occurs during a blazing sun, special regard must be paid to all qualities in selecting material for use in the better buildings. The following timbers are those chiefly used for shingles:2/

Cedrela odorata L. (Meliaceae) West Indian cedar.—This tree furnishes what is undoubtedly the best shingle wood in the island. It is a large tree and the timber is light (36 lbs./cu ft.) durable, fissile and is available in large quantities. It occurs throughout the island up to 4,000 ft. Very closely allied to *C. mexicana*.

Terminalia latifolia Sw. (Combretaceae or Terminaliaceae) Broadleaf.—Next in importance to cedar. This is a tall tree reaching 80 to 100 ft. in height with a girth of 8 to 10 ft. The trunk is usually very straight with horizontal branches arranged in whorls every 15 to 20 ft. The timber is straight-grained, light (41 lbs./cu ft.), splits easily and is often used for shingles in the limestone districts where it occurs.

2/ The information here presented was obtained from "The Principal Timbers of Jamaica" by C. Swabey, B. Sc.

Calophyllum brasiliense Camb. var. antillanum Britton (Guttiferae or Clusiaceae) Santa Maria.—A lofty straight tree, 100 to 120 ft. in height with a girth of 8 to 10 ft. The wood is of medium weight (53 lbs.) fissile, and often used for shingles. The shingles are not durable and usually require some form of preservative treatment. A widely distributed forest tree in damp woodlands up to 3,000 feet.

Nectandra spp. and Ocotea spp. (Lauraceae) Sweetwoods.—The term sweetwood is rather loosely applied to several trees of different identity. The timber is usually soft, light, (approx. 35 lbs./cu.ft.) and fissile. It is not durable but is often used for shingles by the peasantry.

Mosquitoxylum jamaicensis Kr & Urb. (Anacardiaceae) Mosquito wood.—A tall tree common in the cockpit region and often used for shingles in the surrounding districts. The shingles are very durable but because of the cross grain they do not fit nor do they lie evenly.

Peltophorum brasiliense (Sw.) Urb. (Leguminosae or Caesalpiniaceae) Brazilette.—A small tree common on the dry lowlands with a first class, heavy (67 lbs./cu.ft.), durable, hard wood occasionally used for shingles. Never used where cedar, etc. are obtainable but occurs under xerophytic conditions where usually there are few other suitable timbers.

Samanea saman (Jacq.) Merril (Leguminosae or Mimosaceae) Guango. (Syn. Pithecolobium saman Benth).—A large tree common on the southern lowlands of the island. The timber is good but the tree is rarely used except as shade and for fodder in pastures. When mature it is cross-grained, and difficult to work but fairly light (44 lbs./cu. ft.) and strong. The branches are often quite large and are sometimes used for making shingles on estates.

Macrocatalpa longissima Britton (Bignoniaceae) Yokewood. (Syn. Catalpa longissima Sims).—A large tree to 80 ft. in height. It yields very good timber which has recently been tried in the production of sawn shingles. The tree is of limited distribution, being found on the dry coastal plains of the South and Southeast and along sandy river banks.

Hibiscus elatus Sw. (Malvaceae) Blue mahoe.—A fast growing, straight-stemmed tree. The wood is hard, tough, durable, and fairly light (47 lbs./cu. ft.). This timber is popular for cabinet work and is now almost unobtainable. It has been used occasionally to make first class shingles but is definitely of very limited use for this purpose, owing to its rarity.

In addition to the above recognized shingle timbers, there are many others which are used by the poorer classes for splitting rough shakes to be used on temporary "bush huts". Among these may be mentioned:

Cecropia peltata L. (Moraceae) Trumpet
Anona montana Macf. (Anonaceae) Wild sour sop or mountain sour sop
Clethra tinifolia Sw. (Ericaceae) Soapwood
Crescentia acuminata (Bignoniaceae) Calabash
Eugenia jambos L (Jambosa jambos) (Myrtaceae) Roseapple
Calyptranthes spp and Eugenia spp (Myrtaceae) Rodwood

Spondias mombin L. (Anacardiaceae) Hog Plum
Zanthoxylum martinicense (Lam.) DC. (Rutaceae) Prickly yellow
Unknown Black fig

Method of Preparation by Hand

The method usually employed is extremely wasteful. Under the Crown Lands Forest Produce Rules all green standing trees cut with the object of yielding shingles are assessed for royalty purposes on their girth measurement. This does not, however, apply to remnants, as the people are encouraged to work on these.

Usually trees are felled with a generous portion remaining on the stump. All work is done with axes. After the branches have been removed, the trunk is cut into sections 2 ft. 6 in. in length. These may be cross-cut but axes are still very generally used as they are cheaper, easier to obtain, easier to sharpen, can be used by one man, and probably more than any other reason, the men are familiar with this versatile tool which can be such a formidable weapon of offence or defence. Cross-cut saws are now being stocked by the village shops and their advantages are slowly being recognized. After cutting, the short barrel-like blocks are stood on end, and while one man holds the "froe" in place his partner drives it tangentially through the block with a series of blows The "froe" is usually native made and is an ordinary cutting implement about 12 in. long and 3 to 4 in. wide. It has a handle about 3 ft. in length providing great leverage to assist in the process of getting off the undressed shingle. No guide lines are drawn on the end of the block and the shingle splitter depends on his amazingly accurate judgement to get off the rough shakes which will dress down to half-an-inch in thickness at the larger end. The minimum shingle width is 5 in. but usually the timber is discarded as a result of cross grains when the now polygonal block is about 8 to 9 in. across. As immature trees of small girth are often cut it is obvious that the majority of the timber is wasted.

The method of "shaping" or "dressing" shingles is very primitive and full use is made of the powerful prehensile toes with which most of the peasantry are equipped. The operator sits on a low wooden horse, the main section of which consists of a hardwood scantling approximately 4 ft. long and 4 in. square. The end of this scantling is raised about 12 to 15 inches above the ground and usually is supported by an ordinary wooden cross. The end facing the operator and away from him, rests on the ground. About 9 in. from this end, a rectangular hole about 3 in. by 2 in. is made through the beam Fitting freely in this hole is a hardwood pin so designed that it protrudes for 3 to 4 inches at its lower end but is prevented from falling through the hole by a head which is extended on the side towards the operator and so rests on the top of the beam. A nail is driven into the head of the wooden pin so that the sharp point protrudes for approximately half an inch like a solitary upper tooth in the "jaw" which is formed by the main beam and the head of the pin When a shingle is pushed into this jaw, the operator grasps the lower end of the pin between his toes and pushes forward. This lowers the upper end of the pin, closes the jaw and forces the nail into the shingle which is thus held firmly in place. A drawing knife is then used to smooth off the shingle on its upper side, after which the pressure is released and the shingle is turned to present the other side.

The native shingle splitters are remarkably dextrous. A pair will split and dress up to 400 in one day when the blocks are already cut. The quantity depends on the kind of timber, cedar being easiest to work.

At this stage the shingle-splitter leaves his shingles. The next step is known as "jointing" and is done by the carpenters who are laying the shingles on the roof. Jointing consists of planing the sides of the shingles so that they are parallel and the shingles will fit closely. This is a selective operation and only about 20 per cent of the shingles will require attention.

Costs

Production.—Cost of manufacture varies considerably but is chiefly influenced by locality and type of timber used for the shingles. Splitting and dressing can usually be done for 40 to 50 shillings per M., while jointing will cost an additional 8 to 10 shillings per M.

In some districts where the shingles must be carried for some distance often over very rocky ground, the cost of "heading" must be considered. This usually works out at approximately 6 to 9 pence per 100 shingles per mile. The amount carried depends on the terrain but a good carrier will usually make bundles consisting of about 100 to 150 shingles.

Sale.—Shingles are offered for sale in two grades, No. 1 being 22 in. by 5 by 1/2 in. and over, while all shingles measuring less than this are classed as No. 2. In actual practice, with the sale of native split shingles, no such sharp distinction exists although sawn shingles are rigidly graded. Under the Crown Lands Forest Produce Rules the principal timbers are grouped in 3 classes. Of the shingle woods, cedar and mahoe are in Class 1, Braziletto in Class 2 and all others fall into Class 3. No. 1 cedar shingles, all heart, will fetch about 6 to 7 pounds per M., while broadleaf, santa maria, sweetwood, and mosquito wood shingles of the same grade are sold for 3 to 4 pounds per M. Sawn shingles are usually sold for approximately 20 per cent less than split shingles of the same grade and species. Sawn yokewood shingles were recently put on the market at 5 pounds per M., but did not compete very well against the best sawn cedar which was sold at the same price.

Local Shingle Mills

Within the past 5 years many local shingle mills have been erected. Power is almost always derived from an ancient, erratic, and usually inefficient motor-car and is conveyed by slack, wildly slapping belts to the saw table. There are however, a few mills where a small but powerful diesel engine runs all the units necessary.

One of the best small mills in the island uses a 25 horse power Ruston Hornsby engine, and by adequate belts and shafting runs a breakdown log saw, 3 saw tables, one 12 in. jointer and a small lighting plant.

The logs are purchased already cut to length and are collected by truck. On arrival at the yard, the green logs are sawn into slabs 5 in. thick. These slabs are then removed to the shingle tables where the actual shingles are turned out. These tables are constructed of good solid heavy hardwood in order to reduce vibration. A circular saw is operated so that 5 in. protrudes above the table top and the slab is drawn at an angle to the saw so that the necessary taper is given to the shingle.

It is important that the teeth be kept sharp and properly set or the shingles will have raised and torn grain. When this type of shingle is laid, water usually collects on and is absorbed through the ragged surface, thus resulting in early decay. Very few mills pay sufficient attention to these points and as a result the quality and quantity are not as satisfactory as they might be.

Summary

The use of shingles in Jamaica as a roofing material has been a practice ever since the first English colonists settled on the island near the end of the seventeenth century.

Shingle roofs are for several reasons very desirable. They are cool, keeping inside temperature below that outside. They are durable, some old roofs in Jamaica being still serviceable after nearly a century. They can be built of local materials, thus obviating the necessity of high transportation costs. On the other hand they are inflammable and have a rough appearance.

Cedrela odorata and *Terminalia latifolia* are the most important shingle woods in Jamaica. *Cedrela odorata* and *Hibiscus elatus* produce Class 1 shingles; Peltophorum brasiliense produces Class 2; and all other species produce Class 3.

The best shingles are made by primitive hand methods. Tangential pieces are split out of blocks of wood with a froe. They are then dressed with a draw knife while lying on a small timber before the seated worker. The jointing or trimming of the edges is done by the carpenters when laying the shingles. A pair of laborers can split and dress 400 shingles per day, or at a cost of 40 to 50 shillings per thousand.

Split shingles are sold in two grades, the first being 22 x 5 x 1/2 inches or over and the second grade those measuring less than this. First grade split shingles of *Cedrela odorata* will bring about 6 to 7 pounds per thousand.

Recently several mills have been erected for the manufacture of sawn shingles. When efficiently run these can produce shingles cheaper than by hand, a circumstance required for their existence, because of the 20 per cent premium paid for split over sawn shingles. When these mills do not properly maintain their saws torn grain results. This increases the absorption of water by the shingles and accelerates decay.

Resumen

El uso del tejamaní para techar ha sido una práctica empleada en Jamaica desde los tiempos en que los primeros colonizadores ingleses se establecieron en la isla a fines del siglo 17.

Los techos de tejamaní son deseables por varias razones: son frescos, pues conservan una temperatura en el interior más baja que la del exterior; son duraderos, ya que algunos techos antiguos son servibles aún después de casi un siglo, y porque pueden construirse con materiales locales obviando así la necesidad de pagar costos altos de transporte. Pero por el contrario son inflamables y tienen una apariencia ordinaria.

Las principales maderas usadas en Jamaica para tejamaní son: Cedrela odorata, Terminalia latifolia, Calophyllum brasiliense var. antillanum, Nectandra spp., Ocotea spp., Mosquitoxylum jamaicense, Peltophorum brasiliense, Samanea saman, Macrocatalpa longissima, e Hibiscus elatus. Las primeras dos mencionadas son las más importantes. Cedrela odorata e Hibiscus elatus producen tejamaníes de primera clase; Peltophorum brasiliense de segunda clase; y las demás de tercera clase.

El mejor tejamaní se hace por métodos manuales primitivos. Se cortan listones tangenciales de trozos de madera, luego se desbastan con una cuchilla especial sobre un madero que el trabajador coloca delante de su asiento. El ribete de los bordes lo hacen los carpinteros al techar.

Dos trabajadores pueden cortar y desbastar 400 tejamaníes al día a un costo de 40 a 50 chelines por millar.

El tejamaní se vende de dos tamaños, el primero es de 22 x 5 x 1/2 pulgada o más, y el segundo, aquél que mide menos. El tejamaní de primer tamaño pesa de 6 a 7 libras por millar.

Recientemente se han construído molinos para la fabricación de tejamaní aserrado. Debido a que el tejamaní hecho a mano vale 20 por ciento más, es una circunstancia indispensable para la existencia de los molinos el que funcionen eficientemente produciendo tejamaní más barato. Si las sierras en los molinos no se conservan en buen estado se producen granos torcidos en la madera. Esto aumenta la absorción de agua y acelera el deterioro.

THE PINE FORESTS OF HAITI

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The pine genus belongs essentially to the temperate zone, but since it has invaded the warmer zones of the world in such places as the West Indies, Central America, and the East Indies, no consideration of tropical forestry can be quite complete without mention of this important group of trees. Furthermore, pine is of special importance to a country such as Haiti, where due to the pressure of a dense agricultural population, the greater portion of its timber resources have been removed already from the richer soils which previously supported excellent stands of hardwoods.

The one species of pine native to Haiti is Pinus occidentalis Sw., a tree scarcely heard of in northern climes but one which is destined to play an important role in forest management on the island of Hispaniola and in eastern Cuba. Two papers[1] which appeared previously in this journal have reported on the taxonomic characteristics and the range within the Dominican Republic of this species.

In Haiti, the range of the species includes most of the country, although in most sections it occurs only as scattered specimens. In the southern ranges of mountains, good stands of pine are found in large blocks. At the eastern end of the Morne la Selle range, in the section called Mornes des Commissaires is located a stand estimated to cover approximately 10,000 acres. This is contiguous with the pine forest across the border in the Bahoruco Mountains of the Dominican Republic. The Haitian tract is located on a plateau at an elevation of about 5,000 feet above sea-level, although scattered patches of pine to the north and south grow down to 2,000 feet. This is the only forest in Haiti which is traversed by a public road and when "le forêt de pins" is mentioned in the capitol, it is almost invariably with reference to this unit.

Only a few miles to the west of this area La Selle peak, the highest point of land in the Republic, attains an elevation of over 9,000 feet. It is covered to the very peak with a pine forest which has an area probably greater than 25,000 acres. West of La Selle on the main plateau and on the various ridges extending therefrom scattered individuals and patches are encountered to slightly beyond Furcy and Kenscoff.

1/ Chardón, Carlos E. Los Pinares de la República Dominicana. Caribbean Forester, 2(3): 120-130. April 1941.
Carabia, J. P. Contribuciones al Estudio de la Flora Cubana, Gymnospermae. Caribbean Forester 2(2): 94-97. January 1941.

Traveling still farther westward on the southwestern peninsula various, at present inaccessible, scattered patches in the Morne la Hotte range are found, but only near Pic Macaya are solid stands of pine found to be of any appreciable extent. Here, they ascend to 7,000 feet on the peak and occupy the sides and crests of precipitous ridges, which in combination with the very deep, intervening valleys make up a region which is very difficult to traverse and hence little known.

North of the Cul de Sac plain, which runs eastward from Port-au-Prince, many different mountain ranges occur and on all of these so far observed scattered trees of this pine have been seen. Only in the Montagnes du Nord, which come across the border between Mont Organisé and Banica and extend northwestward, are there extensive areas of pine. Although this area has been invaded to a considerable extent by agriculturalists so that the forest is very broken, there is nevertheless an area of about 100,000 acres on which pine is the dominant feature of the landscape and thus it comprises an important forest section. In addition to this, the extensive central plateau should be mentioned since its soil is very unproductive for agriculture and there remain a great many scattered pines, making it possible to develop this in the future as a solid block of pine which would probably be more profitable to the country than the present farming and grazing uses.

As is to be expected, the site conditions in the various parts of the range are extremely variable and attest to the great adaptability of the species. Within the Republic of Haiti alone, pine ranges from an elevation of about 300 feet above sea-level on the northern coastal plain at Acul Samedi to over 9,000 feet in the Morne la Selle section. Soils are derived from many parent rocks, and soil types are not the limiting factor for the distribution of the species as supposed by some previous observers. The accompanying vegetation varies greatly so that the species actually transcends several vegetation types. It is really too early for me to attempt to explain the ecological status of the species but so far the only logical explanation for the occurrence of the pine seems to be tied up very closely with fire. I would call it an igneous type and believe that it would not have been able to persist in solid stands without the occasional occurrence of a conflagration. At the same time, this would explain the scattered patches of hardwoods which are found inside the blocks of pine. The only obvious difference between the two such adjacent sites is apparently that of greater moisture in the hardwood stands.

The tree itself is a good commercial timber tree. Although the majority of the trees are small due to the fact that the stands have had no attention and have been at the mercy of unrestricted cutting and burning during the last century, there still exist many magnificent specimens. I have measured trees 48 inches d.b.h. in the Morne la Hotte range of the southwest peninsula and have found trees up to 44 inches in the more accessible Mornes des Commissaires forest. Specimens 125 feet or more in height are common, some having a clear bole for 80 feet. The species grows straight and we have had no difficulty in filling orders for masts 60 feet in length. Not much is known about the lumber but from general appearance it would seem to be similar to slash pine, P. caribaea, in quality. Recently, in cooperation with Duke University and the Tropical Forest Experiment Station, timbers were shipped to North Carolina for timber tests which will throw light on this question. At any rate, local timber purchasers prefer the native lumber to that imported from the States. In addition to its lumber, the species is a naval stores pine which makes it a dual purpose tree.

Naturally, in a country such as Haiti which has been densely populated for centuries since the early days when it was one of the most productive of colonies, it is very difficult to even estimate what the effects of man have been on these forest areas. One might suppose that their inaccessibility in the highest mountains had been an important factor in their persistence, and yet we have found at a distance of over 50 miles from Port-au-Prince on a recently constructed road remnants of masonry construction which are none other than the establishments of the French commissaires for which this section is named. These were going concerns before 1702 and being located between the present Morne la Selle and Mornes des Commissaires units must have exerted some influence on the closely adjacent pine forests. At any rate, we can safely assume that the pine is a hardy species very resistant to fire after its sapling stage and also a good reproducer. The dense reproduction in protected corners, such as in small triangles at trail intersections affords excellent evidence of the latter.

With a species of such potential value and possessing excellent silvicultural characteristics, it was a surprise to the author to find in 1939 that Haiti, a steady importer of pine lumber from the States, was doing nothing with her own pine forests, and several government contacts were made to discuss the possibility of development. Also, shortly before my visit, Mr. C. Swabey, Conservator of Forests in Jamaica, had visited the same areas and prepared a favorable report for the government. Mr. Atherton Lee, then Agricultural Advisor to the Government of Haiti, assisted in the fostering of the idea and in the winter of 1939-1940, the progressive group of workers of the Service Technique at Damien started work at Mornes des Commissaires.

The beginning was crude because it was extremely difficult to get support and a great number of people in the capitol sincerely believed that the lumber would prove to be of inferior quality and not worth transporting to town. Thanks to the aggressiveness of M. Georges Heraux, Chief of the Service Technique, they pushed on with the project even though all of the first lumber was pit-sawed and not very uniform due to the inexperience of the labor available in that section. These first boards which were brought to market did at least serve the purpose of destroying the skepticism about the qualities of the lumber and mill. This was set up early in 1941 and continued to operate under the direction of the Service Technique until October with occasional official trips being made by the writer from the Tropical Forest Experiment Station in Puerto Rico in an advisory capacity.

This was the picture previous to October of 1941, when the Mornes des Commissaires, Morne la Selle, and Cerca la Source (northern unit) forests were turned over to the newly organized Société Haitiano-Americaine de Developpement Agricole and the writer came to Haiti on an assignment as Manager of the Forestry Division of the new corporation. The Société was organized primarily for the development of rubber and other agricultural crops but Mr. T. A. Fennel, General Manager of the Corporation and previously

Agricultural Advisor to the Republic following Mr. Lee, was personally interested in the forestry project and sufficiently satisfied with the prospects to give it the benefit of the capital resources of a large enterprise. Fortunately, the Service Technique had pushed the idea of exploiting the pine forests beyond the troublesome starting point and had made rapid strides in such items as fire-control, even though this work was largely confined to the Mornes des Commissaires Unit.

I think the most significant fact about this whole project is that Latin American leaders can grasp the idea of profitable forestry and set up their own projects. Naturally, anyone entering a new field is up against many technical and organizational difficulties and where it would be impossible for the individual smaller countries to finance and await the training in technical forestry of their own students in order to make a start, they could probably help in a small way to contribute to the maintenance of a staff of experts at some centrally located point such as the Tropical Forest Experiment Station and thus obtain the maximum benefits of technical assistance for a minimum of expenditure. On the other hand, the Station should be organized so that eventually its own staff may contain several workers from the various countries whose forestry departments would be serviced by a truly international experiment station.

But, to return to the pine forests of Haiti, profiting by the opportunity to obtain sufficient capital for the necessary expansion of the work, the Forestry Division has made considerable progress in the first few months, although the organizational work remaining is so great that comparatively speaking this is just a start. Lands for the operation of forestry were secured in a lease by the Haitian Government of approximately 150,000 acres of pine forest on public lands to the Corporation in exchange for stock in the Société. The exact boundaries of this land have not yet been defined and it is a part of the contract that the Government perform this operation. From the Division standpoint, this seems advisable in taking away from landowners who may dispute actual forest boundaries any feeling that the Division is solely responsible for the settlement of the boundary, which in the event of dissatisfaction could readily be transposed into such destructive measures as incendiarism.

Since the establishment of the Forestry Division happened to be timed during difficult shipping periods, it was primarily essential that production of lumber to meet the needs of the country be given preference over all other considerations. This is being done as far as possible although the same oceanic transportation problems coupled with the scarcity of certain materials work against the rapid installation of new plants. Plans are to cut and market one million board feet during the first twelve months and push this up to three millions during the second year, the latter production equivalent to the average importations from the exterior during the past few years.

Transportation problems within the Republic constitute the most serious obstacle to be overcome and this difficulty will become increasingly more acute with the growing scarcity of rubber tires. As a long time solution to the problem a primary road system is being constructed and fire-breaks which are suitable for log transportation in good weather now are laid out in such a manner that they can later be improved to constitute the secondary road system of the forests. For the solution of the immediate problem of transportation, which can be assumed to last anywhere from one to five years, we are making plans to drop back to more simple means of transportation such as ox-carts and water. Thus, locations of new mills and sites selected for relocation of existing mills are on the sea-coast or at lower elevations where hauls to them may be made by oxen or river driving and where the transportation to market of the finished products may be accomplished by ox-cart or small coastal schooner.

The pressure for production coupled with the minimum of trained personnel makes it necessary for the time being to neglect the finer points of forest management and put the maximum amount of attention on the proper location and operation of the cutting and milling. This has entailed a large amount of preliminary reconnaissance on horse-back, on foot, and in small river boats. And, in spite of the need for rushing this type of work, it must be essentially accurate in order that present developments may fit into future management plans, which will be developed after the accumulation of sufficient factual data, with the minimum of changes possible. At the same time, mapping work has been started and although far behind present needs will be available for some areas within a relatively short time. As fast as such maps become available, preliminary developmental plans which exist now only in our minds or in the form of sketchy notes, will be written down in more permanent and quantitative records.

Training of personnel is another tremendous job which must be carried out on all phases of the work and with all classes of employees. This is too important a phase to be neglected, and since the early trained workers are expected to pass their learning on to a progressively increasing number, special pains are being taken to see that these first men obtain the correct training at the start. The forest administration system is being built around the familiar District Ranger. Local college trained men are selected for these positions and because no forestry trained men are available this type of practical, educated workers must carry the load until forestry graduates are available in the future.

Fire-control is an important factor in the satisfactory stocking of the forest since reproduction does not become fire-hardy until fifteen or twenty years of age. Due to the nature of the topography and the fact that the major portion of the fires are caused by peasants, emphasis of the fire control program has been placed on fire prevention rather than on organization for fighting fires. Agricultural police are located throughout the forest areas, who although under the direct supervision of the Forestry Division are government agents and thus have the power to arrest and take to local courts any one who is found burning without permission within or in the vicinity of the forests. This system is working very satisfactorily and where forest developments are under way and providing work to the local residents the pines have already attained a high place in the respect of the native so that there should be less and less trouble with fires as the various units reach a higher stage in development.

Presumably, control burning will be necessary in the future in order to exclude hardwood trees and brush from the pine stands. Botanical collections as a basis for an understanding of the ecology of the areas and plots to be established in the near future will provide us with the factual basis as to whether or how this will have to be carried out. The forests will be managed on the uniform silvicultural system which can easily include controlled burning. This essentially will consist of burning at the time of main fellings followed by from fifteen to twenty-five years of strict protection so that a new crop of seedlings becomes established and attains the size of large saplings with the thickened bark which gives them immunity to fire damage.

Division headquarters are being constructed at Mornes des Commissaires, about one mile above sea-level where the climate is invigorating and very healthful. At this place the temperature drops down to the freezing point just about once every year. In the vicinity, are areas of good fertile soil where northern vegetables thrive and thus, with the tropical vegetables and fruits which are brought in from the lowlands, providing a broad range of diet. All these factors are considered important in maintaining the administrative staff in good working condition.

As one side line to the management of the pine forests, this same rich soil of the high plateau is being tested for its suitability for the production of Cinchona. It is still far too early to know what the ultimate chances for success with this crop will be but it is hoped that success may be obtained as this is not only a very much needed crop at the present time but also is one which would very well complement the forestry activities in this region.

As a final point, it might be of interest to mention the financial possibilities of the pine forests. So far the lumber operations are easily able to pay their own way. Forest developments such as the road building and construction of Division headquarters are too heavy a load to be borne by present timber exploitation and are therefore capitalized but there are excellent possibilities of cancelling out all of these developmental costs within a relatively few years at which time it should be possible to proceed with the development of other forest types in the Republic.

Summary

The native pine of Haiti represents one of her most important forest resources. This tree with a wide range in the Republic is a valuable timber and naval stores species which fortunately possesses good silvicultural characteristics. Initial development was started by the Service Technique in 1939 but since October 1941, 150,000 acres have been turned over to the Société Haitiano-Americaine de Developpement Agricole, which has carried on a program primarily designed to provide for the timber needs of the country but also constituting a long range development plan with construction of roads, fire protection, mapping and the necessary investigations for setting up proper management. The first few months of operation indicate satisfactory financial possibilities.

Resumen

El pino oriundo de Haití, Pinus occidentalis, constituye uno de los recursos forestales más importantes de ese país. Este árbol, que está extensamente distribuído en la república suministra madera muy útil y trementina, y afortunadamente, posee características silvícolas favorables.

Es difícil encontrar especímenes desarrollados debido a las cortas sin distinción a que fué sometido en el pasado. Sin embargo en algunos sitios hay árboles de 44 pulgadas de d.a.p. y 125 pies de alto. Son bien formados y por consiguiente producen madera de grano recto que tiene buena demanda. Considerando estas circunstancias es un hecho sorprendente que en época tan reciente como 1939 no se estuviese explotando sistemáticamente.

En 1941, 150,000 acres de tierras forestales fueron puestas bajo la administración de la recién organizada Société Haitiano-Americaine de Developpement Agricole que está llevando a cabo un programa destinado no sólo a proveer al país de la madera que necesite sino que incluye un plan de gran alcance para construcción de carreteras, protección contra incendios, delineamiento de mapas y las investigaciones necesarias para el manejo apropiado de este recurso. Los problemas más importantes con que se confronta la Administración son aquellos propios de cualquier organización similar en un país donde la Dasonomía está en sus comienzos. Hoy existe además el problema de la transportación debido a la escasez de neumáticos y también la dificultad de adquirir equipo y maquinarias necesarias. Ha sido necesario hacer estudios y reconocimientos en gran escala rápidamente aunque con la necesaria exactitud. La labor de los primeros meses ya indica que cuando la inversión inicial se distribuya sobre las mejoras permanentes, se demostrará un beneficio o ganancia en el negocio.

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Errata

On page 75 of Vol. 3, No. 2, paragraph 2, "Calophyllum globulifera" should have been "Calophyllum brasiliense".

The headings of the tables on pages 93 and 94 of Vol. 3, No. 3 should read "Girth class in feet".

In the table of Non-American woods on page 172, Vol. 3, No. 4, Jarrah should have been classified as an Australian, rather than an Indian wood.

CREOSOTE PENETRATION IN TABONUCO WOOD AS AFFECTED BY PRELIMINARY BOILING TREATMENTS IN ORGANIC SOLVENTS

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Most Puerto Rican woods are not destined to become important on a large commercial scale but rather will be useful only for local consumption. This is explained by the fact that approximately 80 per cent of the timber resources on the island have been exploited in order that land could be made available for agricultural use.[2] In time some of the land now in agriculture may be available for reforestation. Specific information as to potential uses of the woods and proper management practices must be determined in order that species of useful qualities may be produced.

This paper deals specifically with the problems in the preservative treatment of tabonuco, Dacryodes excelsa Vahl, one of the more important Puerto Rican species. A review of the literature indicates that the preservative treatment of tropical timbers has received little or no attention. Therefore, as a part of a cooperative program of research dealing with the physical-mechanical properties of important Puerto Rican timbers being carried on by the Duke University School of Forestry and the Tropical Forest Experiment Station, a study was initiated with a two-fold purpose: (1) to ascertain correct treating schedules for tabonuco, and (2) to present some of the problems arising from attempts to force preservatives into woods of this kind.

Selected tabonuco trees in Puerto Rico were felled and bucked into four-foot lengths. The bolts were then sawn into test-specimen flitches according to recommendations of the American Society for Testing Materials. The flitches, after coding, were wired into bolt form and the ends painted with tar to prevent drying and checking during shipment. Upon receipt of the material at Duke University, the flitches were re-sawn and milled into standard test specimens used for determining strength data. The surplus stock, largely heartwood, was cut and milled into 3 inches by 23 inches material and allowed to air dry for five months before being used in this study.

1/ A thesis submitted in partial fulfillment of the requirements for the degree of Master of Forestry in the School of Forestry of Duke University. The writer wishes to acknowledge his indebtedness to Dr. E. S. Harrar for directing the experimental work. Appreciation is expressed to Professor A. E. Wackerman for his many valuable suggestions concerning the preservative treatment, and to Professor F. X. Schumacher for his advice on the statistical analysis.
2/ Gill, Tom. Tropical Forests of the Caribbean. Baltimore, Maryland, 1931.

Preliminary Study

The original proposal was to make a comparative study of oil-preservative retentions in tabonuco wood, using the Bethell and Rueping Processes. Preliminary experiments of preservative treatment were conducted by the Bethell Process, Rueping Process, and a modification of the Bethell Process using creosote as the preservative.[3] These methods of oil impregnation failed to accomplish any penetration in the heartwood although the sapwood, when present, was completely penetrated. Failure to obtain penetration of the heartwood by creosote prompted the use of chromated-zinc chloride, a water soluble salt. Negative results were obtained also with this salt using the Bethell Process and a modification of the Bethell Process.

Hunt and Garratt[4] assert that three main factors affect penetration; viz: the anatomy of the wood, the preparation of the timber, and the treating procedure. Since the preparation of the timber and the treating procedure were controlled in this study, it was thought that some anatomical feature of the heartwood was prohibiting penetration.

Microscopic examination of the wood showed that the fiber walls are exceedingly thick and possess very minute pits. Since these gross anatomical features were found to be characteristic of both heartwood and sapwood, they were not considered as factors prohibiting penetration because, as previously indicated, preliminary experiments resulted in excellent sapwood penetration but no heartwood penetration. It is quite evident that when the wood changes from sapwood to heartwood the fiber walls are infiltrated with materials that block the passage of preservatives. Practically no organic material is contained within the intercellular spaces except in the vessels which constitute only a small percentage of the total wood volume. Therefore, the infiltrated material in the fiber walls of the heartwood, as will be indicated later, apparently affects preservative penetration much more than the included material within the vessels and other cell cavities.

It was concluded, therefore, from the results of the preliminary preservative treatments and the microscopic examination of the wood, that it would be necessary to subject the wood to a pre-treatment before impregnation with a preservative was attempted.

Accordingly, this paper deals with the effects of certain boiling treatments on the penetration of a creosote preservative in tabonuco wood.

Experimental Technique

Preparation of material

Specimens 1-1/4 in. by 1-1/4 in. by 5 in. were cut and milled from the 3 in. by 3 in. by 23 in. stock and placed in a drying oven maintained at 100

3/ Anonymous. Manual of Recommended Practice. American Wood Preservers Association. 1941.

4/ Hunt, George M. and George A. Garrat. Wood Preservation. McGraw-Hill Book Co., Inc., New York and London. 1938.

degrees Centigrade. After the specimens were oven-dry, 60 of the clear heartwood pieces were chosen for this study. These were numbered consecutively with steel dies on the ends and sides, and placed in a dessicator in order to maintain the oven-dry condition until ready for use in subsequent treatments.

Boiling treatment

Four organic solvents were chosen for this phase of the study: viz: Distilled water, alcohol, kerosene, and xylene. A set of three oven-dry specimens was taken from the dessicator, their respective numbers and weights recorded, and then placed in a flask and flooded with 600 cc. of one of the solvents.

Boiling the specimens was accomplished by using a reflux condenser system as shown in Figure 1. The six liter flask was heated by an electric hot plate in order to control temperature during the boiling process since the four solvents used possessed very different boiling points.

The boiling treatment lasted 10 hours after which time the specimens were removed from the flask, weighed, and then placed in a closed container to prevent drying. This procedure was followed with each of the solvents chosen, using a new set of three oven-dry specimens for each boiling treatment.

Preservative treatment

Preservative treatment was undertaken in an experimental wood preservation plant. Figure 2 shows details of the plant construction. This plant is designed to withstand working pressures of 200 pounds per square inch. The vacuum system can effect and maintain vacuums as high as 28 inches of mercury. Heating the preservative is accomplished by means of steam heating coils located in the storage tanks, charging tank, and treating cylinder. Live steam may be forced into the treating cylinder in order to give timber steaming treatments preliminary to introduction of the preservative. Gauges, valves, and thermometers are connected to the system which permit continuous observation and control of temperatures, vacuums, and pressures for the duration of the treating procedure.

After the four sets of three specimens had received a boiling treatment in their respective solvents, they were encased between two steel end-plates along with three oven-dry specimens which served as controls. The end-plates were used to minimize end-penetration of creosote into the wood; this study being concerned only with side penetration. These 15 specimens were placed in the treating cylinder and subjected to a steaming period of 30 minutes at a steam pressure of 25 pounds per square inch. This was followed by a vacuum period of 25 to 28 inches of mercury for 30 minutes. Finally, without breaking the vacuum, creosote at a temperature of 190 degrees Fahrenheit was introduced into the cylinder and held under a pressure of 200 pounds per square inch for 90 minutes. The properties of the creosote used are presented in Table 1. The records of the preservative treating schedule used are given in Tables 2 to 5.

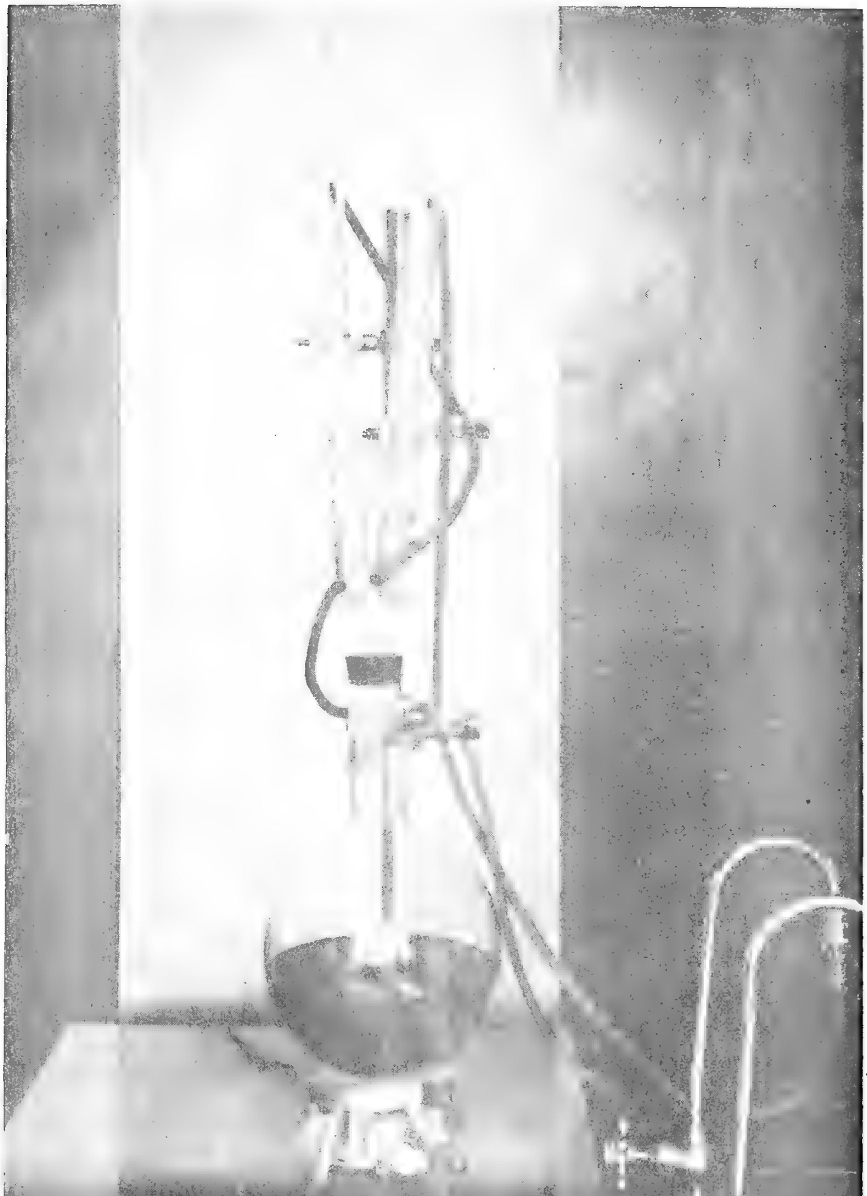

Figure 1.—Reflux Condenser System Used for the Boiling Treatment of Wood Specimens.

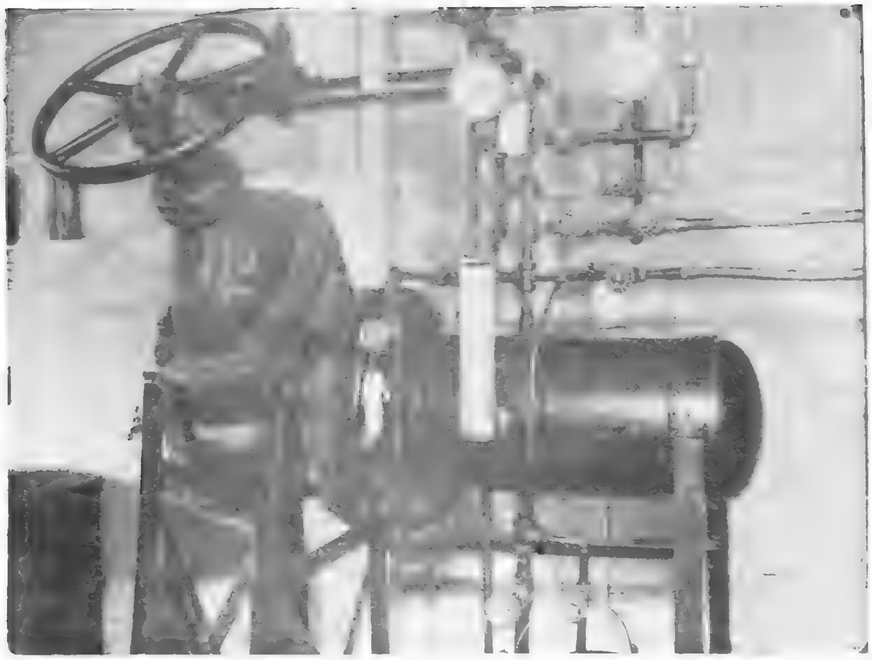

Figure 2.—Side View of the Treating Cylinder.

Table 1.—Properties of Creosote Used in Preserving Tabonuco.

Specific Gravity	Water Content	Standard Distillation of Fractions[1]	
		Up to 210°C.	Up to 235°C.
1.103	1.5	3.3%	12.6%

[1] Percentage by weight.

Measurement of preservative penetration

After the preservative treatment, a transverse sample wafer, one-quarter inch in thickness, was sawn from each specimen. These samples were representative of side penetration since they were taken from the middle of the specimens. Arranging them in columns according to their respective boiling treatments, they were photographed in order to record depth of creosote penetration. The negative was placed in a photographic enlarger and the cross-section images, showing the outline of the specimens and region of preservative penetration, are shown in Figures 3 to 6.

Table 2.—Percentage of Cross-Sectional Area of Specimens Penetrated by Creosote Preservative - First Replication.

Boiling Treatment				
Alcohol	Control	Kerosene	Water	Xylene
%	%	%	%	%
36.6	35.0	93.7	79.0	72.6
37.2	42.4	98.0	71.9	60.3
41.5	33.3	96.8	85.3	45.1

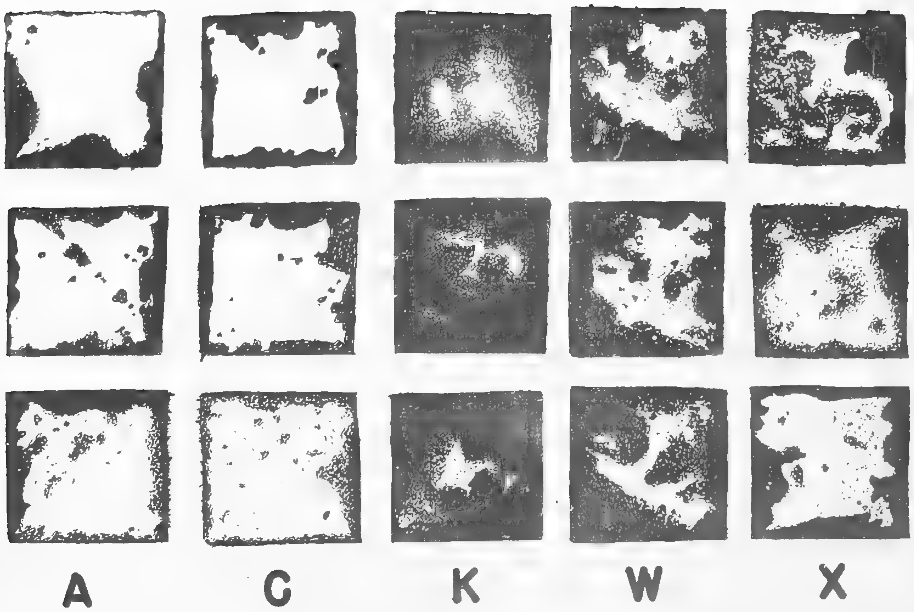

Figure 3.—Transverse Samples of First Replication Showing Regions of Preservative Penetration.

A - Pre-treated in Alcohol.
C - Oven-dry Control.
K - Pre-treated in Kerosene.
W - Pre-treated in Distilled Water.
X - Pre-treated in Xylene.

Table 3.—Percentage of Cross-Sectional Area of Specimens Penetrated by Creosote Preservative - Second Replication.

Boiling Treatment				
Alcohol	Control	Kerosene	Water	Xylene
%	%	%	%	%
41.1	45.1	44.6	32.0	29.6
38.3	55.1	42.3	27.9	30.4
35.0	48.6	46.6	29.7	33.8

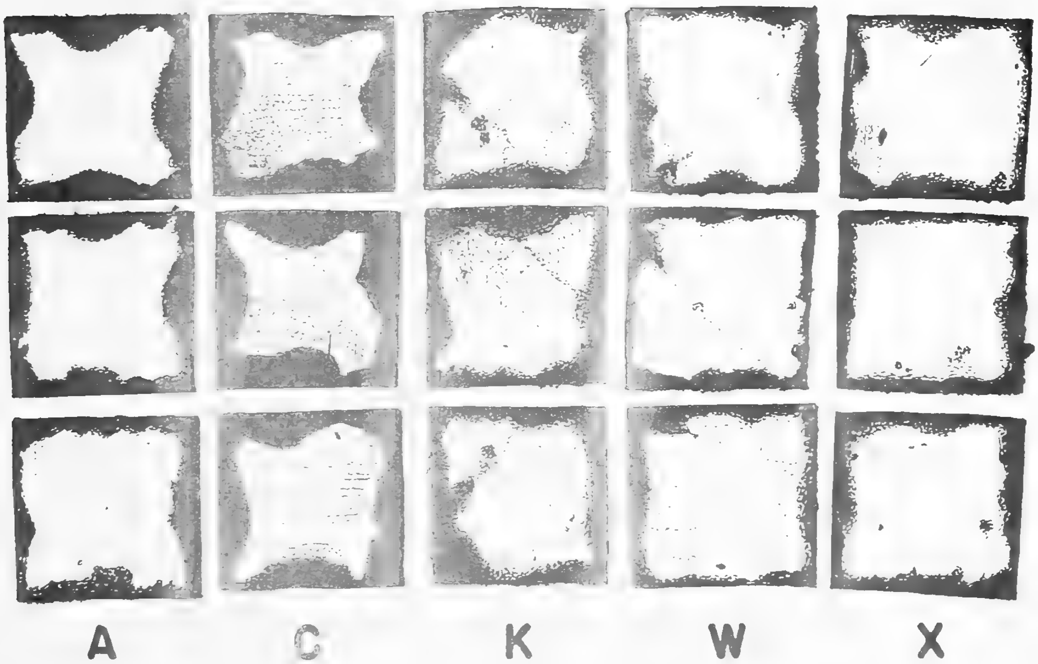

Figure 4.—Transverse Samples of Second Replication Showing Regions of Preservative Penetration.

A - Pre-treated in Alcohol.
C - Oven-dry Control.
K - Pre-treated in Kerosene.
W - Pre-treated in Distilled Water.
X - Pre-treated in Xylene.

Table 4.—Percentage of Cross-Sectional Area of Specimens Penetrated by Creosote Preservative - Third Replication.

Boiling Treatment				
Alcohol	Control	Kerosene	Water	Xylene
%	%	%	%	%
40.5	45.7	71.2	87.5	45.9
31.3	42.0	63.7	29.4	31.9
26.7	35.3	57.1	37.9	48.6

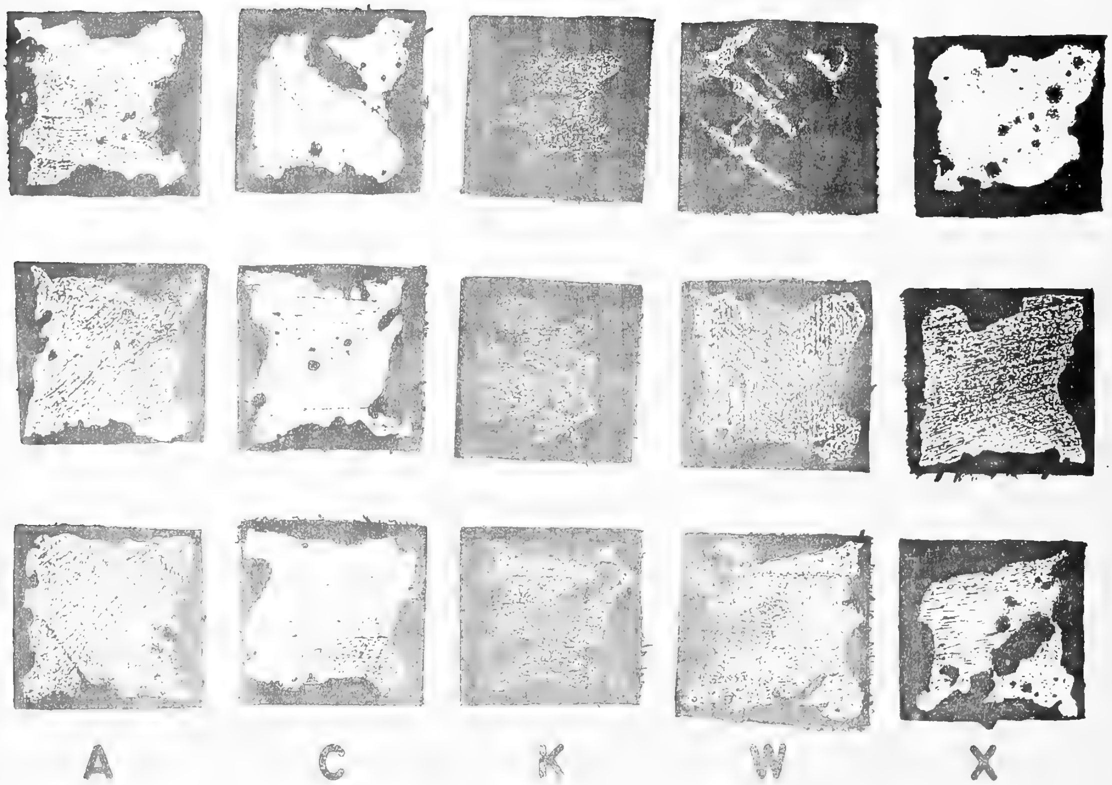

Figure 5.—Transverse Samples of Third Replication Showing Regions of Preservative Penetration.

A - Pre-treated in Alcohol.
C - Oven-dry Control.
K - Pre-treated in Kerosene.
W - Pre-treated in Distilled Water.
X - Pre-treated in Xylene.

Table 5.—Percentage of Cross-Sectional Area of Specimens Penetrated by Creosote Preservative - Fourth Replication.

Boiling Treatment				
Alcohol	Control	Kerosene	Water	Xylene
%	%	%	%	%
40.5	43.5	53.6	37.9	68.8
27.1	38.6	78.0	59.2	51.1
26.2	45.1	97.5	26.8	51.8

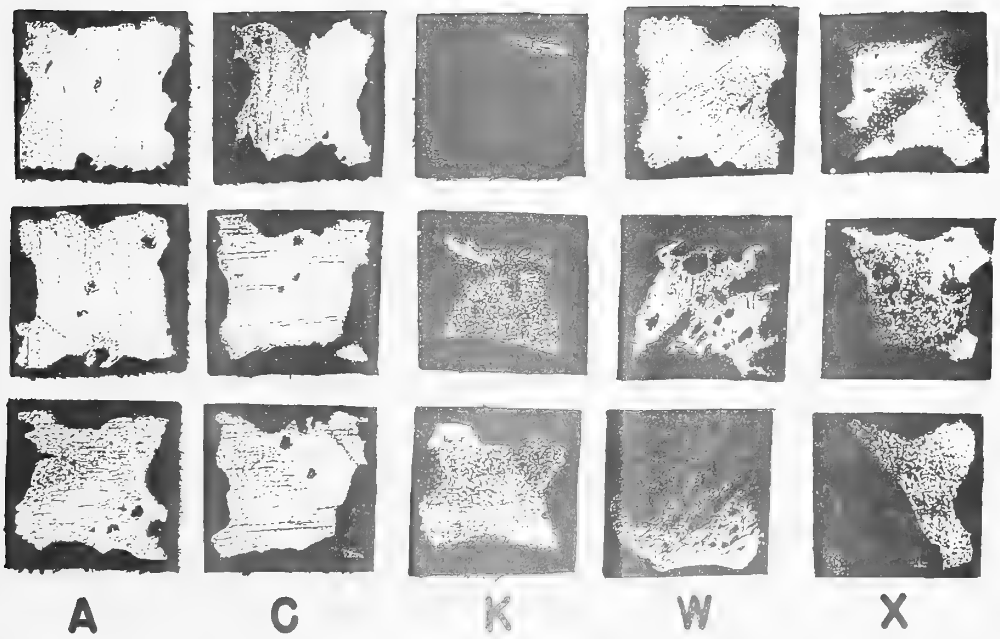

Figure 6.—Transverse Samples of Fourth Replication Showing Regions of Preservative Penetration.

A - Pre-treated in Alcohol.
C - Oven-dry Control.
K - Pre-treated in Kerosene.
W - Pre-treated in Distilled Water.
X - Pre-treated in Xylene.

The total area and the penetrated area of each specimen was determined from the tracings by using a planimeter. The percentage of creosote penetration was established for each of the fifteen specimens by dividing the value of the penetrated area by the value of the total area.

Compilation of data

Four replications of 15 specimens each supplied the data as shown in Tables 2 to 5. Each datum expresses the per cent of cross-sectional area of the specimen penetrated by the creosote. Figures 3, 4, 5, and 6 show the region of penetration for each specimen in the four replications.

Analysis of variance

An analysis of variance[5] was computed from the data in Tables 2 to 5. This was used to determine whether or not the boiling treatments had a significant effect on preservative penetration for the treatment given.

The 60 observations in Tables 2 to 5 were summed according to replication and specific boiling treatment which produced 20 values composed of three observations each. The analysis of variance is shown in Table 6.

Table 6.--Analysis of Variance Between Replications and Treatments

Source	Degrees of Freedom	Sums of Squares	Mean Squares
Replication	3	12646.224	4215.408
Treatment	4	24836.458	6209.458
Error	12	17691.646	1474.471
Total	19	55176.328	

The minimum significant difference at the one per cent level[6] is 27.65. Therefore, any boiling treatment, to have a significant effect on preservative penetration at the one per cent level, must have an average penetration per cent as great or greater than the average per cent of the oven-dry control plus 27.65. Therefore the kerosene boiling treatment, with an average penetration per cent of 70.3, is the only treatment having a significant effect on preservative penetration.

The Standard Error for the average penetration per cent of each boiling treatment was found to be ± 6.4 per cent.

5/ Fisher, R. A. Statistical Methods for Research Workers. Sixth Edition-Revised and enlarged. London, England. 1936

6/ Probability less than 1 in 100 that observed difference is due to chance.

Observations and Conclusions

From the statistical analysis of the data on percentage of creosote penetration, the kerosene boiling treatment was the only one of the four showing a significant effect at the one per cent level on preservative penetration when compared to the oven-dry control.

The average penetration percentage of the 15 specimens in each treatment gave the following values: kerosene, 70.3 per cent; distilled water, 50.4 per cent; xylene, 47.5 per cent; and alcohol, 35.2 per cent; the oven-dry control being 42.5 per cent. The standard error of each of these averages is ± 6.4 per cent. The alcohol boiling treatment indicated a retarding effect on preservative penetration as compared to the oven-dry control. Specimens that received the distilled water and xylene treatment showed a greater average penetration percentage than the control but not a significant difference, such as was the case with the kerosene boiling treatment.

The photographs of the cross-sections of the specimens clearly show that the side penetration of the preservative into the specimens was very irregular. This may be attributed largely to the effect of interlocked grain which is an anatomical characteristic of tabonuco wood.

Even though the kerosene treatment is the only one showing a significant effect on penetration, it would be impractical to apply on a commercial basis. Incising of pre-framed timber is a possibility that merits consideration since some of the refractory woods growing in the United States are treated commercially after such preparation (Hunt and Garratt).

There are specific problems brought out by this study that are deserving of further consideration. A chemical analysis of the solvents, after the boiling treatment would show what materials, if any, had been extracted from the wood. Also it would be desirable to know the effect of the boiling treatment on the cell walls and the mechanical properties of the wood.

It would also be interesting to conduct a series of service tests in Puerto Rican soils on the treated wood. Data of this sort could probably be used to indicate how much penetration of a preservative is required to render the wood safe from fungal and insect attack under local conditions.

Summary

1. Heartwood of tabonuco, Dacryodes excelsa Vahl, is very refractory and cannot be treated successfully by standard preserving methods.

2. The presence of organic material infiltrated in the cell walls was assumed to be the factor prohibiting penetration rather than gross anatomical features.

3. Pre-treatment by boiling samples of heartwood in organic solvents to extract infiltrated materials, before subjecting them to

preservative treatment showed an average percentage effect on creosote penetration for the fifteen specimens in each treatment as follows:

Kerosene	70.3 ± 6.4%
Distilled Water	50.4 ± 6.4%
Xylene	47.5 ± 6.4%
Alcohol	35.2 ± 6.4%
Oven-dry Control	42.5 ± 6.4%

4. Results in this study show that only the preliminary boiling treatment with kerosene had significant effect at the one per cent level on preservative penetration.

Resumen

Recientemente la Escuela de Técnicos Forestales de la Universidad de Duke llevó a cabo un estudio sobre la penetración de preservativos en la madera del tabonuco, Dacryodes excelsa, una de las especies de árboles más importantes de Puerto Rico.

Se encontró que los preservativos penetraban con facilidad en la albura mientras que el duramen, que contiene substancias inhibidoras, requiere un tratamiento preliminar para remover o modificar dichas substancias para que la penetración sea satisfactoria.

Se trató una ebullición preliminar en cuatro solventes: alcohol, kerosina, agua destilada y xileno. Se hirvieron especímenes en cada uno de estos líquidos por espacio de 10 horas. Después se encajaron entre dos láminas de acero para impedir que la penetración se efectuase por las extremidades y luego se sometió al tratamiento con preservativo.

El tratamiento con preservativo comenzó aplicando vapor por un período de 30 minutos a una presión de 25 libras por pulgada cuadrada. A éste siguió un período en un vacío de 25 a 28 pulgadas de mercurio por 30 minutos. Finalmente, sin destruir el vacío se introdujo creosota a una temperatura de 190 grados Fahrenheit en el cilindro y se le sometió entonces a una presión de 200 libras por pulgada cuadrada por espacio de 90 minutos.

Después de la preservación se tomó una muestra transversal que se cortó del centro de cada pedazo. El por ciento de área penetrada con respecto al área total del corte se tomó como medida indicativa de la efectividad de la penetración.

El único tratamiento que tuvo efecto significativo positivo sobre la penetración desde el punto de vista estadístico fué la kerosina. De los demás el agua destilada y el xileno tuvieron efecto positivo en la penetración mientras que el alcohol tuvo efecto negativo.

CATALOGUE DES CRYPTOGAMES VASCULAIRES DES ANTILLES FRANCAISES

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Martinique

Le présent catalogue comporte l'énumération systématique des Ptéridophytes ou Cryptogames vasculaires des Antilles françaises récoltées principalement par L'Herminier, Mazé et Duss à la Guadeloupe, par Duss et par Hahn à la Martinique, ainsi que par l'auteur entre 1934 et 1942, avec l'aide de Madame M. Stehlé et du R. P. L. Quentin, collecteur infatigable et botaniste avisé, dans l'une et l'autre de ces îles. A un petit nombre d'espèces près, dont la difficulté de rassembler la bibliographie complète en milieu tropical isolé est la raison, la totalité des plantes appartenant aux Fougères, Lycopodes et Selaginelles des Antilles françaises, figure dans le présent travail.

L'ordre suivi et la nomenclature adoptée sont ceux de Wm. R. Maxon, Curator of Plants, Smithsonian Institution, de Washington (Studies of tropical American ferns et Pteridophyta of Porto Rico and the Virgin Islands, 1926), spécialiste le plus remarquable des Ptéridophytes d'Amérique et des Antilles. Il a bien voulu étudier nos récoltes au cours de ces 8 dernières années et reviser nos déterminations, ce pourquoi nous lui adressons ici l'expression de nos plus vifs remerciments.

La dernière publication relative aux Ptéridophytes des Antilles françaises est celle du R. P. Duss (Division, Nomenclature et Habitat des Fougères et Lycopodes, Lens-le-Saunier, 1903), dans laquelle de nombreuses espèces sont désignées par des binômes aujourd'hui caducs et que les botanistes les plus récents ont classés en synonymie.

Nous nous sommes référés dans cette étude à l'Histoire des Fougères et des Lycopodiacées des Antilles (Paris, 164 p., 34 tab., 1866), par A. L. A. Fée, publication magistrale et aux monographies les plus récentes des ptéridographes des Antilles voisines, en particulier à Urban: Symbolae Antillanae, Flora Portoricensis, Vol. IV, 1903-1911, Pteridophytae p. 5-70 (1903) et p. 648-651 (1911), Pteridophyta domingensia, Vol. IX, 1925, p. 273-397 et à Domin: Pteridophyta of the Island of Dominica (Prague, 1929).

Dans notre Essai d'Ecologie et de Géographie Botanique de la Guadeloupe, tome I, Basse Terre, 1935, ainsi que dans l'Esquisse des Associations végétales de la Martinique (in Bull. Agr. Mart. 6, 193-264, 1937), nous avons cité des Fougères et végétaux alliés récoltés dans les différents secteurs, mais d'après leur répartition et leurs exigences édapho-climatiques. La publication suivante a surtout pour objet de donner une idée de la richesse en ptéridophytes des Antilles françaises, de faire connaître, sous leurs dénominations les plus récentes et les plus exactes, la plupart des espèces de notre flore et les raretés que nous y avons récoltées au cours de ces dernières années, surtout dans les secteurs de la chaine centrale des deux îles qui avaient été moins explorés. Les numéros indiqués ici sont ceux de nos collections et nous les faisons précéder du nom du collecteur. Enfin, les lettres G. et M. correspondent respectivement à la localisation en Guadeloupe et en Martinique.

Nos collections antérieures à 1938 sont déposées au Muséum d'Histoire Naturelle de Paris et celles récoltées ultérieurement figurent dans l'herbier de H. et M. Stehlé, actuellement à la Martinique. Tous les doubles des Ptéridophytes ont été adressés à l'Herbarium de la Smithsonian Institution à Washington.

L'énumération faite ci-après des Fougères et Alliées des Antilles françaises fait ressortir un total de 56 genres et 313 espèces en écartant les espèces douteuses, les variétés et les formes. Ces plantes sont réparties en 10 familles, chacune représentée par un petit nombre d'espèces à l'exception de la famille des Polypodiacées qui à elle seule groupe presque les trois-quarts des espèces énumérées: 225 réparties dans 44 genres. C'est aussi la plus représentée dans le monde ou on lui connait environ 6500 espèces. Ces chiffres montrent la richesse ptéridophytique des Antilles françaises particulièrement élevée puisque sur un total d'environ 2500 végétaux vasculaires (Phanérophytes et Ptéridophytes), le groupe des Fougères et plantes affines est représenté dans le rapport de 1 pour 7, 8 plantes, alors que Fée, dans son introduction à l'Histoire des Fougères et des Lycopodiacées des Antilles (p. IX) en 1866, indiquait pour les Tropiques et l'Equateur que les Fougères "forment environ le neuvième de la végétation totale".

Tableau Comparatif de la Richesse Pteridophytique des Antilles Françaises

Familles	Antilles françaises (H. Stehlé)		Puerto Rico (W. R. Maxon)	Dominique (K. Domin)
Désignation	Genres	Espèces	Espèces	Espèces
Ophioglossaceae	2	2	3	-
Marattiaceae	1	5	4	2
Osmundaceae	-	-	1	-
Ceratopteridaceae	-	-	1	-
Schizaeaceae	-	-	6	-
Glacheniaceae	1	6	3	2
Cyatheaceae	3	9	12	5
Polypodiaceae (y compris Dicksoniaceae)	44	225	205	140
Hymenophyllaceae	2	39	24	16
Salviniaceae	-	-	1	-
Marsileaceae	-	-	2	-
Lycopodiaceae	1	17	13	10
Psilotaceae	1	2	1	1
Selaginellaceae	1	9	9	4
Total	56	313	285	180

Il nous parait intéressant d'indiquer en un tableau comparatif les familles représentées dans notre flore, le nombre des genres et celui des especes par famille et de comparer ce dernier nombre a celui de la Dominique, île anglaise voisine située entre la Martinique et la Guadeloupe et a celui de Porto Rico, île la plus petite et la plus proche des Grandes Antilles. Dans ces deux îles voisines la connaissance des Fougeres a été très poussée grace aux remarquables monographies de Maxon (1926) et de Domin (1929).

En ce qui concerne Puerto Rico et les Antilles françaises, les chiffres indiqués ci-dessus serrent certainement de très près la réalité alors que pour la Dominique ce chiffre, bien que sensiblement inférieur à celui des Antilles françaises, doit à notre avis, être bien plus élevé. Dans Domin, il y a un nombre plus élevé d'espèces que celles consignées, d'après notre décompte dans ce tableau, mais nous n'y avons pas fait figurer naturellement celles qui, dans ce travail intitulé "The Pteridophyta of the Island of Dominica", sont citées par l'auteur lui-même comme des endémiques de Trinidad, de la Jamaïque ou même de Colombie, celles qu'il énonce comme existant aux Antilles françaises et pouvoir être trouvées un jour à la Dominique où on ne les a pas collectées encore et enfin les douteuses les variétés et formes pour pouvoir comparer avec Puerto Rico et les Antilles françaises dans des conditions égales. W. H. Hodge au début de ses Notes on Dominican Ferns (in Amer. Fern Journ. Vol. 31, No. 3-4, 1941) estime que ce grand groupe de plantes, dominant en forêts humides dans la Dominique montagneuse est représenté par environ 400 espèces. Ce chiffre nous parait très élevé car si l'on ajoute aux 180 espèces dominiquaises de Domin les 23 trouvées en outre de celles connues pour cette île, par Hodge au cours de ces 4 dernières années d'investigation nous arrivons seulement à un total de 203 espèces. Il semble donc que la Dominique ait été insuffisamment explorée mais que l'abondance des Fougères qu'elle héberge demeure notablement moins élevée que celle de Puerto Rico, de la Martinique et de la Guadeloupe. Une visite malheureusement trop courte de la Dominique en 1935 en nous rendant de Guadeloupe en Martinique, nous a semblé à première vue correspondre avec les résultats du précédent tableau comparatif.

Les chiffres indiqués ici ne sont pas intangibles; ce sont des relevés mis en lumière d'après les récoltes effectuées et les publications les plus récentes; la végétation des îles évolue, des découvertes peuvent être réalisées, les conceptions varient également. Notre intention en rédigeant ce catalogue a été surtout de faire un recensement tenu à jour des Ptéridophytes des Antilles françaises, de démontrer leur richesse floristique, de donner les noms logiques et les binômes rationnels des espèces avec la réference des ouvrages dans lesquels leur publication et description ont été données afin de combler la lacune qui sur ces points, existait dans la Flore Cryptogamique de Duss de 1903, seul traveil antérieur sur les Fougères des Antilles françaises.

Ordre I. O P H I O G L O S S A L E S

Famille 1. OPHIOGLOSSACEAE

1. OPHIOGLOSSUM (Tourn.) L.

1. Ophioglossum reticulatum L. Sp. Pl. 1063. (1753). G.: S.n. 476, n. 927 et M.S. n. 3850 et n. 4106.

2. CHEIROGLOSSA Presl.

2. Cheiroglossa palmata (L.) Presl, Abh. Böhm. Ges. Viss. V. 4:317 (1845), G. Duss n. 4308.

Ordre II. M A R A T T I A L E S

Famille 1. MARATTIACEAE

1. DANAEA J. E. Smith

1. Danaea nodosa (L.) J. E. Smith, Mém. Acad. Scienc. Turin 5:420. (1793) G. Mazé n. 64 et Duss n. 4317, n. 4319 et M. Duss n. 1690.
2. Danaea elliptica J. E. Smith, in Rees, Cycl. II. n. 2 (1808), G. Duss n. 4316, n. 4336 et M. (ex Maxon).
3. Danaea alata J. E. Smith, in Mém. Acad. Scienc. Turin 5:420. (1790), G. Duss n. 4318 et M. Duss n. 1687.
4. Danaea stenophylla Kunze, G.S. n. 534, n. 1223 et M.S. n. 3447.
5. Danaea Mazeana Underw., G.S. n. 1811.

Ordre III. F I L I C A L E S

Famille 1. SCHIZAEACEAE

1. ACTINOSTACHYS Wall.

1. Actinostachys ponnula (Sw.) Hook. Gen. Fil. pl. III, A. (1842). G. Duss n. 4348.
2. Actinostachys Germaini Fée, Hist. Foug. et Lycop. Ant. 29:123 (1866) G. Duss n. 4349.

2. ANEMIA Sw.

3. Anemia hirta (L.) Sw. Syn. Fil. 155 (1806), G. Duss n. 4306 et M. Duss n. 1689 et n. 4579.
4. Anemia adiantifolia (L.) Sw. Syn. Fil. 157. (1806). G.S. n. 89, n. 192, n. 540, n. 840, n. 1842, n. 2016, n. 2534, n. 2704 et M.S. n. 4159.

Famille 2. GLEICHENIACEAE

1. DICRANOPTERIS Bernh.

1. Dicranopteris flexuosa (Schrad.) Underw. Bull. Torrey Bot. Club 34:254. (1907). M. (ex Maxon).
2. Dicranopteris pectinata (Willd.) Underw. Bull. Torrey Bot. Club 34:260 (1907), G. Duss n. 4310, n. 4311 et M. Duss n. 1694, n. 1696.
3. Dicranopteris bifida (Willd.) Maxon, N. Amer. Fl. 16:60 (1909), G.S. n. 94, n. 653, n. 1441 et M.S. n. 3419.
4. Dicranopteris Bancroftii (Hook.) Underw. Bull. Torrey Bot. Club 34 (1907), G.S. n. 2424.
5. Dicranopteris furcata (L.) Underw. Bull. Torrey Bot. Club 34:257 (1907), G.S. n. 2415.
6. Dicranopteris farinosa (Kaulf.) Underw. Bull. Torrey Bot. Club 34:254 (1907), G. Duss n. 4312 et M. Duss n. 1693 b. Rapportée par Duss à Gleichenia subtrisperma (Fée) Duss, synonyme.

Famille 3. CYATHEACEAE

1. CYATHEA

1. Cyathea arborea (L.) J. E. Smith. Mém. Acad. Turin 5:417 (1793). G. S. n. 332 et M.S. n. 3297, n. 3309 et n. 3329.
2. Cyathea serra Willd. Spec. Plant. 5:1,491 (1810), G. Duss n. 4322, n. 4346, n. 4591 et M. Duss n. 1604. Espèce très affine de C. arborea (L.) J. E. Smith.
3. Cyathea tenera (J.Smith) Griseb. Fb. Br. W.I.I. 704 (1864), M. (ex Urban, Symb. Ant. 9:289 (1925).

2. HEMITELIA R. Br.

4. Hemitelia grandifolia (Willd.) Spreng. Syst. 4. 1. 125, (1827). G.S. n. 96, n. 98, n. 102, n. 1192, n. 1221, n. 1774 et M. Duss n. 4605.
5. Hemitelia horrida Duss, non R. Br., G. Duss n. 4155 et M. Duss n. 1605 et n. 1610, se rapporte à H. grandifolia. Il en est de même de H. obtusa Duss, G. n. 4153 et M. Duss n. 1607 et n. 1608, non Kaulf., limité à Grenade et Saint Vincent (ex Maxon).
6. Hemitelia muricata (Willd.) Fée, Gen. Fil. 350 (1850-52). G.S. n. 9, n. 321, n. 326, n. 329, n. 527, n. 827 et M.S. n. 3414 et n. 3426. Cyathea Tussacii Desv. (Syn. C. Imrayana Hook. et C. Beryi L'Herm.) n'est autre que cette espèce. Alsophila nitida Kuntze basé sur des spécimens de la Martinique s'y rapporte également. Elle est maintenue par Domin, Pterid. Dominica, 66 (1929), comme espèce valable, sous le binôme C. Imrayana Hook., qu'il considère comme très différent de C. Tussacii Desv.

Alsophila aspera R.Br. ex Duss, Foug. et Lycop. Ant. fr. 20 (1903), G. Duss n. 4157, n. 4323 et M. Duss n. 4602, se confond aussi avec H. muricata (Cf. Maxon, Stud. trop. ferns 5, in Contr. U. S. Nat. Herb. 419 (1914).

7. Hemitelia Kehautiana (Presl.) Kunze, Bot. Zeit. 2:298 (1844). G. ex Maxon et M.S. n. 3281, n. 3294, n. 3404 et n. 3422.

8. Hemitelia insignis (Fée) Christ. Index Fil. 349 (1905), G. Duss n. 4449, ne parait pas distinct de H. grandifolia (Willd.) Spreng. Cette espèce a été basée sur l'échantillon de Willdenow n. 20167 récolté en Martinique.

3. ALSOPHILA R. Br.

9. Alsophila sp. M.S. n. 3316. Spécimen stérile mais se référant au genre Alsophila str. sensu tel que le conçoit Wm. R. Maxon.

Famille 4. POLYPODIACEAE

1. ELAPHOGLOSSUM Schott.

1. Elaphoglossum piloselloides (Presl) Moore, Ind. Fil. 13 (1857). G. Duss n. 4137 et M. Duss n. 1615 et n. 4576.
2. Elaphoglossum apodum (Kaulf.) Schott, Gen. Fil. pl. 14 (1834). G. Duss n. 4321 et M. Duss n. 1621 et n. 4577.
3. Elaphoglossum undulatum (Willd.) Moore, Ind. Fil. 16. (1857), G. (ex Chris) et M. Duss n. 1616 et n. 4122.
4. Elaphoglossum perelegans (Fée) Moore, Ind. Fil. 16. (1857), G. (ex Fée et Christ).
5. Elaphoglossum erinaceum (Fée) Moore, Ind. Fil. 9 (1857), G. L'Herminier n. 7 (1862), S. n. 694 et M.S. n. 4160. Espèce affine de E. scolopendrifolium (Raddi) J. Smith, à laquelle divers auteurs l'ont rapportée.
6. Elaphoglossum cuspidatum (Willd.) Moore, Ind. Fil. 16. (1857, G. Duss n. 4339.
7. Elaphoglossum tectum (H. et B.) Moore, Ind. Fil. 15 (1857). G. (ex Christ).
8. Elaphoglossum decoratum (Kunze) Moore, Ind. Fil. 8 (1857). G. Duss n. 4152.
9. Elaphoglossum Herminieri (Bory et Fée) Moore, Ind. Fil. 16 (1857), G. Duss n. 4136, n. 4137 et M. Duss n. 1626.
10. Elaphoglossum pteropus C. Christ. Ind. 5 et 314 (1905), G. (ex Urban) et M. (ex Domin).
11. Elaphoglossum flaccidum (Fée) Moore, Ind. Fil. 356 (1862), G. Duss n. 4143 et M. Duss n. 4149.
12. Elaphoglossum petiolatum (Sw.) Urban, Symb. Ant. Fl. Port. 4:61 (1903) et 9:373 (1925). G. Duss n. 4130 et M. Duss n. 1622.
13. Elaphoglossum glabellum J. Smith, Lond. Journ. Bot. 1:197. (1842), G. S. n. 342 et M. (ex Maxon).
14. Elaphoglossum rigidum (Aubl.) Urban Symb. Ant. 9:374 (1925). G. et M. Les variétés de E. latifolium Sw. et cette espèce citée par Duss (loc. cit. p. 27) ainsi que

E. longifolium (Sw.) J. Smith pour les Antilles françaises doivent etre rapportées à cette espèce.

15. *Elaphoglossum Dussii* Underw. in Maxon, Pterid. Porto Rico in Sc. Surv. P. R. 6:398. (1925), G. S. n. 1061, n. 1448, n. 1466, n. 1808, n. 1828, n. 2418 et M.S. n. 2384. Confondu souvent avec *E. petiolatum* (Sw.) Urban.

16. *Elaphoglossum simplex* (Sw.) Schott, Gen. Fil. (1835) in Obs. sub Bolbiti, t. 14. G. (ex Fée et Hook.), Duss n. 44101, n. 4414 et M. Duss n. 1624, n. 1628 et n. 4687. La var. *martinicense* (Desv.) Urban, Symb. Ant. 4:60 (1903), G. et M. (ex Urban) n'est autre que *E. glabellum* J. Smith.

17. *Elaphoglossum Underwoodianum* Maxon, Pterid. Porto Rico 6:397. (1926), G. et M. est très voisin de *E. simplex* (Sw.) Schott.

18. *Elaphoglossum Plumieri* (Fée) Moore, Ind. Fil. 13 (1857), G.S. n. 2405 et M. Duss n. 1614. Espèce affine de *E. villosum* (Sw.) J. Smith et souvent confondue avec elle.

19. *Elaphoglossum Feei* (Bory) Moore, loc. cit. (1857), G.S. n. 652, n. 2406, n. 1211, n. 1420, n. 1767 b, n. 1782, n. 1791, n. 2406 et M. Duss n. 4135.

20. *Elaphoglossum Boryanum* (Fée) Moore, Ind. Fil. 7. (1857) G. Duss n. 4151 et M. Duss n. 1613.

21. *Elaphoglossum scolopendrifolium* (Raddi) J. Smith. in Curt. Bot. Mag. 72: 17 (1846), G. (ex Urban). Il s'agit peut-être d'une confusion avec *E. erinaceum* (Fée) Moore.

22. *Elaphoglossum lingua* (Raddi) Bracken. in Wilkes Explor. Exped. 16:74 (1854), G. Mazé n. 314, S. n. 1063 et n. 1199. Syn.: *E. brevipes* (Kunze) Moore et *E. scandens* (Bory et Fée) Moore.

2. HYMENODIUM Fée

23. *Hymenodium crinitum* (L.) Fée, Mém. Foug. 2:90 (1845). G. L'Herminier, 1862, A. Fée n. 23, Duss n. 4148 et M.S. n. 2284, n. 3333 et n. 3431.

3. RHIPIDOPTERIS Schott

24. *Rhipidopteris peltata* (Sw.) Schott, Gen. Fil. pl. 14. (1834), forme type: M.S. n. 2098, n. 3274, n. 3334, n. 3398 et n. 3441. Var. *flabellata* nov. comb. Syn.: *R. flabellata* Fée, *Acrostichum peltatum* Sw. var. *flabellatum* (H.B.K.) Duss, G. Duss n. 4147.

4. ACROSTICHUM L.

25. *Acrostichum aureum* L. Sp. Pl. 1069. (1753), G. Duss n. 4146 et M.S. n. 3310.

26. *Acrostichum danaefolium* Langsd. et Fisch. Icon. Fil. 1:5, pl. 1. (1810) G. L'Herminier n. 25 et M. (ex Maxon).

5. ANETIUM Splitg.

27. Anetium citrifolium (L.) Splitg. Tidjsch. Nat. Gesch. 7:395. (1840). G. Duss n. 4227 et M. Duss 1505.

6. VITTARIA J. Smith

28. Vittaria lineata (L.) J.E. Smith, Mém. Acad. Turin 5:413, pl. 9. (1793), G.S. n. 1194 et M. Duss n. 1553.

29. Vittaria filifolia Fée, Mém. Foug. 3:20, pl. 3. (1851-52). G. Duss n. 4266.

7. ANANTHACORUS Underw. et Maxon

30. Ananthacorus angustifolius (Sw.) Underw. et Maxon, Contr. U. S. Nat. Herb. 10:487. (1908). G. Duss n. 4225 et M.S. n. 2274.

8. PTEROPSIS Desv.

31. Pteropsis martinicensis (Christ) Maxon, Stud. trop. amer. ferns, in Contr. U.S. Nat. Herb. 3:51 (1912), M. Duss n. 250 b. Endémique rare décrite par Christ, Bot. Jahrb. Engler, 24:137 (1897) sous le binôme Drymoglossum martinicense Christ. Duss précise que, par un malheureux accident, il a perdu tous les spécimens (Foug. et Lycop. Ant. fr. 93, 1903). Nous avons recherché váinement la plante jusqu'à présent sur les rochers et les arbres de la Montagne du Vauelin, localité type.

9. HECISTOPTERIS J. Smith

32. Hecistopteris pumila (Spreng.) J. Smith, Lond. Journ. Bot. 1:193, (1842). G. (ex Urban).

10. POLYTAENIUM Desv.

33. Polytaenium Feei (Schaffn.) Maxon, Pterid. Porto Rico, Sc. Surv. P. R. 6, 405 (1926), G.S. n. 505 et M.S. n. 3448. Antrosphytum lanceolatum (L.) Kaulf. Enum. 198. (1824), non P. lanceolatum Desv., est synonyme de cette espèce.

34. Polytaenium Dussianum Benedict, in Bull. Torrey Bot. Club, 169. (1911), G.S. n. 1457 et M.S. n. 2275. C'est le correspondant insulaire de P. brasilianum (Desv.) Benedict.

11. PALTONIUM Presl.

35. Paltonium lanceolatum (L.) Presl., Epim. Bot. 156. (1851). G. Husnot n. 293, S. n. 882 et M. Hahn n. 73, Duss n. 1547.

12. COCHLIDIUM Kaulf.

36. Cochlidium seminudum (Willd.) Maxon, Pterid. Porto Rico, Sc. Surv. P. R., 6, 407 (1926), G.S. n. 357, N. 651, n. 1419 b, n. 1886 et M.S. n. 3423.

37. Cochlidium linearifolium (Desv.) Maxon, Contr. U. S. Nat. Herb., G. S. n. 341, n. 1419 a et M.S. n. 4167.

13. POLYPODIUM L.

38. Polypodium duale Maxon, Contr. U. S. Nat. Herb. 16:61. (1912). G.S. n. 324 a, n. 341 a n. 356, n. 542, n. 649, n. 650, n. 657, n. 658, n. 842, n. 891, n. 1195 et M.S. n. 3397, n. 3407 et n. 3424. Souvent désigné sous le synonyme de P. serrulatum (Sw.) Mett, binôme prêtant a confusion.

39. Polypodium trifurcatum L. Sp. Pl. 1084 (1753). G.S. n. 2407 et M.S. n. 3442.

40. Polypodium taenifolium Jenmann, Bull. Bot. Dept. Jamaica II, 4:114 (1898). G. S. n. 1122, n. 1207, n. 1469 b, n. 1470 b, n. 1784 a, n. 2413, n. 2422 et M. Duss n. 1654 a.

41. Polypodium asplenifolium L. Sp. Pl. 1. ed. 2. 1084. (1753). G.S. n. 246, n. 327, n. 524, n. 648, n. 1129, n. 1210, n. 1212, n. 1412, n. 1413, n. 1414, n. 1433, n. 1434, et M. S. n. 3313, n. 3321 a, n. 3336, n. 3416, n. 3434, n. 3443. Syn. Polypodium suspensum L. Spec. 1 ed. 2. 1084 (1753), ainsi que ses formes diverses. Considéré comme espèce distincte par certains auteurs.

42. Polypodium jubaeforme Kaulf. Flora 6: 364. (1823). G.S. n. 538, n. 656 a, n. 838, n. 1202, n. 1209, n. 1417, n. 1770, n. 1773 a, n. 1865 et M.S. n. 2100, n. 2108, n. 3291, n. 3292, n. 3335, n. 3403, n. 3410, n. 3425, et n. 3430.

43. Polypodium mollissimum Fée, Mém. Foug. II:47, pl. 12, f.2. (1866). G. Duss n. 4106 et M. Duss n. 4571.

44. Polypodium taxifolium L. Sp. Sl. 1086. (1753). G.S. n. 539, n. 839 et M.S. n. 3412.

45. Polypodium Plumula Humb. et Bonpl.; Willd. Sp. Pl. 5:178 (1810). G. S. n. 523, n. 833 et M. (ex Fée).

46. Polypodium pectinatum L. Sp. Pl. 1085. (1753) G.S. n. 346, n. 350 et M.S. n. 3321.

47. Polypodium dissimile L. Syst. Nat. ed. 10, 2:1325 (1759), G. Duss n. 4063, n. 4065 et M. (ex Maxon). Syn. P. sororium (Humb. et Bonpl.) Willd. (1810), binôme sous lequel Urban l'a désignée.

48. Polypodium piloselloides L. Sp. Pl. 1083. (1753). G.S. n. 348, n. 901, n. 1430, n. 1917 et M.S. n. 2658, n. 3283, n. 3340 a. Souvent confondue avec P. ciliatum Willd., espèce affine.

49. Polypodium polypodioides (L.) Watt, Canad. Nat. II.13:158. (1867). G.S. n. 263, n. 507, n. 508, n. 529, n. 1188 et M.S. n. 4168. Syn.: P. incanum Sw. (1788).

50. Polypodium loriceum L. Sp. Pl. 1086. (1753). G.S. n. 103, n. 1229, n. 1450, n. 2104 et M.S. n. 3327.
51. Polypodium suruchense Hook. Icon. Plant. 1:69. (1837). G. (ex Urban), M. Duss n. 1652.
52. Polypodium chnoodes Spreng. Neu. Entd. 3:6. (1822). G. Duss n. 4120 et M. Duss n. 1661.
53. Polypodium angustifolium Sw. Prodr. 130. (1788). G. Duss n. 4103.
54. Polypodium astrolepis Liebm. Dansk. Vid. Selsk. Skrift. V. I:185. (1849). G. S. n. 506, n. 1191, n. 1431 et M.S. n. 2252, n. 3314, n. 3340 b. Espèce rapportée par divers auteurs à P. lanceolatum et à P. elongatum (Pw). Mett, non Ait. (1789).
55. Polypodium exiguum Hedw. in Mag. Nat. Hist. n. ser. 2:458. (1838), G. Duss n. 4087 et M. Duss n. 1655. Espèce affine de P. heterophyllum L.)
56. Polypodium lycopodioides L. Sp. Pl. 1082. (1753). G.S. n. 507, n. 1189 et M. (ex Urban).
57. Polypodium phyllitidis L. Sp. Pl. 1083. (1753). G.S. n. 642, n. 703, n. 1449 et M.S. n. 3317.
58. Polypodium latum (Moore) Sodiro, Crypt. Vasc. Quit. 371. (1893). G. et M. (ex Maxon).
59. Polypodium crassifolium L. Sp. Pl. 1083. (1753). G.S. n. 1794 et M. Duss n. 1671.
60. Polypodium sectifrons Kunze; Mett. Abh. Senckenb. Ges. Frankfurt, 2:99. Pl. 2, f. 3,4. (1857). G. (ex Maxon).
61. Polypodium aureum L. Sp. Pl. 1087. (1753). G.S. n. 347, n. 2439 et M.S. n. 4169. Espèce polymorphe et variable dont Duss, Foug. Ant. fr. 51 (1903) retient var. areolatum (H.B.K.) Hook et Bak. et var. Mazei (Fourn.) Duss.
62. Polypodium triseriale Sw. loc. cit. G.I. n. 208, n. 210, n. 257, n. 1187, n. 1228, n. 1437, n. 1877, n. 2420.
63. Polypodium serricula Fée Gen. Fil. 238. (1852) G.S. n. 656, n. 1208, n. 1467 a et b, n. 1468 b, n. 1470 c, n. 1471, n. 1474, n. 1763, n. 1767 a, n. 1768, n. 1769, n. 1771, n. 1772, n. 1773 b, n. 1781, n. 1885, n. 2413 a et M. Duss n. 1654 et n. 1654 b.
64. Polypodium tenuiculum Fée Gen. Fil. 239 (1852), G.S. n. 655, n. 1204, n. 1206, n. 1415.
65. Polypodium glaucophyllum Kunze Dic Farnk. 227, 93. (1846). G.S. n. 97, n. 392, n. 1432, n. 2411.
66. Polypodium brasiliense Poir. in Lamk. Encycl. meth. bot. 5:525 (1808). G. S. n. 95 et M.S. n. 4170. Espèce très polymorphe avec de nombreuses formes écologignes intermédiaires.
67. Polypodium Hartii Jenman, Journ. Bot. Brit. and For., 24:272 (1886). G.S. n. 1123, n. 1469 a, n. 1470 a, n. 1472, n. 1473, n. 1484 b, n. 1793.
68. Polypodium Grisebachii Underw. in C. Christ. Ind. Fil. 53, I, (1906). G. (ex Grisebach) et M. Duss n. 1655.
69. Polypodium flabelliforme Poir. in Lamk. Encycl. 5:519 (1804). G.S. n. 1203, n. 2416.
70. Polypodium limbatum (Fée) Maxon loc. cit. G. (ex Maxon).
71. Polypodium pendulum Sw. Syn. Fil. 33 (1806). G.S. n. 1205, n. 1418.
72. Polypodium cultratum Wild. Spec. Pl. 5, 187 (1810). G.S. n. 1416 et M. (ex Plumier).

73. Polypodium induens Maxon, Bull. Torrey Bot. Club 32, 75 (1905). G.S. n. 1468 a. Espèce d'altitude des Grandes Antilles et d'Amérique Centrale, nouvelle pour les Petites Antilles.

74. Polypodium Knowltoniorum W. H. Hodge, Notes on Dominica Ferns, in Amer. Fern. Journal, 31, 105, (1941). G. Questel n. 1033.

Polypodium trichomanoides Sw. Prodr. 131 (1788).

Espèce indiquée par Duss Hieronymus et par Urban, Symb. Ant. Fl. Port. 4:53 (1903), pour la Guadeloupe et la Martinique, est une fougère de répartition géographique apparemment limitée à la Jamaïque et au Guatemala. Pour les Antilles françaises, il s'agit du P. taenifolium Jenman et de P. serricula Fée.

Polypodium laxifrons Liebm. Mex. Bregn. 52 (1849).

Espèce citée par Urban, Symb. Ant. Fl. Port. 4:54 (1903) pour la Guadeloupe et la Martinique, n'est autre que le P. asplenifolium L. Le type de P. laxifrons, décrit pour le Mexique et l'Amérique Centrale, correspond exactement avec les échantillons du P. asplenifolium des Petites Antilles. C'est aussi l'opinion de Wm. R. Maxon, Pterid. Puerto Rico 6:411 (1926).

Polypodium suspensum L. Spec. I, ed. 2:1804 (1753).

Espèces citée par Duss et par Urban, Symb. Ant. Fl. Port. 4:54 (1903) pour la Guadeloupe et la Martinique, est basée sur la planche 87 de Plumier représentant une plante martiniquaise de détermination critique, paraissant être une forme de P. asplenifolium L.

Polypodium trichomanes A. St. Hil. Voy. Distr. Diam. I. 378 (1833).

Espèce décrite par Christ, in Engl. Bot. Jahrb. 24:127 (1897), comme P. taxifolium L. var. trichomanes Christ, citée par Urban, Symb. Ant. Fl. Port. 4:54 (1903) pour la Guadeloupe et la Martinique, ne parait pas spécifiquement distincte de P. taxifolium.

Polypodium areolatum H. et B. in Willd. Spec. Plant. 5:I, 172 (1810), cité par Urban, loc. cit. 57, pour la Guadeloupe et la Martinique, considéré par Hooker et Baker, Syn. Fil. 2,347 (1847) comme var. areolatum de P. aureum L., n'est pas spécifiquement distinct de P. aureum L.

(To be concluded in the January 1943 issue.)

Summary

This catalogue contains the systematic enumeration of the pteridophytes and vascular cryptogams of the French Antilles collected chiefly by L'Herminier, Mazé and Duss in Guadeloupe, by Duss and Hahn in Martinique and also by the author, between 1934-1942, with the assistance of Mrs. Stehlé and R. P. L.

Quentin, indefatigable collector and well-informed botanist who collected them in one or the other of these islands. Except for a few species whose complete bibliography is difficult to obtain in an isolated tropical region, the majority of the plants belonging to the ferns, club mosses, and Selaginella of the French Antilles appear in this work.

The order and nomenclature adopted here is that used by William R. Maxon, Curator of Plants, Smithsonian Institution, Washington. (Studies of tropical American ferns and Pteridophyta of Puerto Rico and the Virgin Islands, 1926), the most noted specialist in the Pteridophytes of America and the Antilles. He has willingly studied our collections and revised our determinations during the last eight years for which here is expressed my most sincere acknowledgement.

Reference is made to A. L. A. Fée's "History of Ferns and Lycopodia of the Antilles" (Paris, 164 p., 34 tab., 1866), a superb publication, and also to the most recent monographs of adjacent islands specially those of Urban: Symbolae Antillanae, Flora Portoricensis, Vol. IV, 1903-1911; Pteridophytae p. 5-70 (1903) and p. 648-651 (1911), Pteridophyta dominguensia, Vol. IX, 1925, p. 273-397; and those of Domin: Pteridophyta of the Island of Dominica (Prague, 1929).

In an essay on the Ecology and Botanic Geography of Guadeloupe, Vol. 1 Basse Terre, 1935 as well as in the Outline of Plant Associations of Martinique (in Bull. Agr. Mart. 6, 193-264, 1937) the fern and allies collected in the different sections, according to their distribution and their edaphic and climatic requirements were mentioned. The object of the present paper is to present information concerning the abundance of pteridophytes in the French Antilles; to make known, under their most recent and exact denominations, the majority of the species of our flora and the rarities which have been collected during recent years, especially in those sections of the central range of both islands which have been least explored. The numbers here mentioned are those of our collections and they are preceded by the name of their respective collector. Last of all, the letters "G" and "M" stand for location at Guadeloupe and Martinique respectively.

Our collections previous to the year 1938 are found at the Museum of Natural History in Paris while those collected after 1938 appear in H. and M. Stehlé's Herbarium in Martinique. Samples of all species have been sent to the Herbarium of the Smithsonian Institute, Washington.

Resumen

Este catálogo contiene una enumeración sistemática de las Pteridofitas o Criptógamas Vasculares de las Antillas francesas coleccionadas principalmente por L'Herminier, Mazé y Duss en Guadalupe, por Duss y Hahn en Martinica, así como por el autor entre 1934 y 1942 con la ayuda de la Sra. Stehlé y del R. P.

L. Quentin, botánico y coleccionista incansable, en una u otra de éstas islas. Con excepción de un pequeño número de especies cuya bibliografía completa es difícil de conseguir en un medio ambiente tropical aislado, la totalidad de las plantas que pertenecen a los helechos, Licopodias y Selaginelas de las Antillas francesas figura en este trabajo.

El orden seguido y la nomenclatura adoptada es aquella de Wm. R. Maxon, Curador de Plantas del Smithsonian Institution de Washington (Studies of tropical American ferns and Pteridophyta of Puerto Rico and the Virgin Islands, 1926), especialista de renombre de las Pteriofitas de América y las Antillas. El ha estudiado con gusto nuestras colecciones en estos últimos ocho años y ha revisado nuestras determinaciones, por lo cual expresamos aquí nuestro más vivo agradecimiento.

Hacemos referencia en este estudio a la Historia de los Helechos y Licopodiáceas de las Antillas (París, 164 p., 34 tab., 1868), de A. L. A. Fée, publicación magistral y también a las monografías más recientes sobre las pteridofitas de las Antillas vecinas, en particular a Urban: Symbolae Antillanae, Flora Portoricensis, Vol. IV, 1903-1911, Pteridophytae p. 5-70, (1903) y p. 648-651 (1911), Pteridophyta domingensia, Vol. IX, 1925, p. 273-397 y a Domin: "Pteridophyta of the Island of Dominica" (Prague, 1929).

En nuestro ensayo sobre ecología y geografía botánica de la Guadeloupe, tomo 1, Basse Terre, 1935, así como en el Extracto de las asociaciones vegetales de la Martinica (en Bol. Agr. Mart. 6, 193-264, 1937) hemos citado los helechos y plantas afines coleccionadas en los diferentes sectores, pero según su distribución y exigencias edafo-climáticas. El presente artículo tiene por objeto sobre todo dar una idea de la riqueza en pteridofitas de las Antillas francesas, de dar a conocer con sus denominaciones más recientes y más exactas, la mayoría de las especies de nuestra flora y las rarezas vegetales que hemos colectado en el curso de estos últimos años, sobre todo en los sectores de la cadena central de las dos islas que habían sido menos exploradas. Los números que aparecen en este trabajo son los de las especies en nuestras colecciones y que preceden al nombre de su colector. En fin las letras "G" y "M" corresponden a la localización en Guadeloupe y Martinica respectivamente.

Nuestras colecciones anteriores al 1938 están depositadas en el Museo de Historia Natural de París y aquéllas recolectadas después figuran en el Herbario de H. y M. Stehlé, actualmente en la Martinica. Hemos enviado duplicados de las pteridofitas al Herbario del Smithsonian Institution en Washington.

PROBLEMAS DE SUELO EN LA PRODUCCION DE COSECHAS TROPICALES[1]

Es una creencia popular que todas las tierras donde crecen bosques vírgenes son tremendamente fértiles. Esto es una falacia total. A los ojos del lego todos los bosques parecen más o menos iguales—densos y exuberantes —y se ha creído que ésto prueba que el suelo donde crecen debe ser muy rico. Pero aquéllos que conocen el bosque saben que hay diferencias enormes en su densidad y exuberancia—muchos árboles gigantes, bien desarrollados en algunas áreas y sólo árboles relativamente pequeños en otras. Sin embargo, aún en áreas de bosque más pobre hay una densidad de vegetación mucho mayor que aquella que habita en la mayoría de los suelos de las regiones templadas. El hecho es que el suelo puede ser bastante fértil bajo condiciones forestales; es decir, mientras esté cubierto de bosque, pero de poca fertilidad si se le desmonta y planta con otro cultivo. Bajo condiciones forestales, con la lluvia abundante y el calor de los húmedos trópicos hay una rápida circulación de material nutritivo. Continuamente se están desprendiendo hojas y ramas: caen al suelo, se pudren pronto y dejan libres los materiales nutritivos que contienen—nitrógeno, fosfato, potasa, etc.—que de inmediato están listos para ser asimilados otra vez por absorción en las raíces de las plantas forestales... Este proceso es muchas veces más rápido que en los bosques de la zona templada. En esta forma una cantidad dada de material nutritivo puede rendir servicio mucho más a menudo que en la zona templada. La caída copiosa de la hoja da como resultado una capa permanente de hojarasca putrefacta y de humus en la superficie del suelo y también la presencia de una rica zona húmeda en las primeras pulgadas del suelo en sí. La circulación más rápida de alimento del suelo—absorción por la raíz, traslación a la hoja, caída y pudrición de ésta—todo se origina por medio de los procesos químicos y biológicos que se efectúan en esta capa humífera, y mucha de la aparente fertilidad del suelo forestal depende de estos procesos. Por lo tanto, bajo condiciones forestales esta capa humífera es permanente: se provee de material nutritivo con la caída de la hoja a la par que se va pudriendo o se la van llevando los micro-organismos e insectos.

Pero cuando se elimina el bosque de este suelo el ciclo forestal cerrado se rompe. La parte de desgaste del ciclo o sea la pudrición y oxidación del humus continúa y más aún se acelera debido a la exposición al sol tropical —pero la parte de provisión del ciclo cesa - no hay caída de hoja que equipare las pérdidas, desaparece el humus - el suelo queda desnudo y sólo resta a la disposición del agricultor la fertilidad innata del suelo. Las grandes diferencias que puedan existir en cuanto a la fertilidad innata se revelan entonces. Así se conoce como muchos suelos se ven desprovistos de ciertas materias nutritivas desde el mismo instante en que se eliminó el bosque; es decir, que la cantidad de material nutritivo suministrado por el ciclo cerrado no es suficiente para permitir el crecimiento vigoroso de un cultivo a menos que se le añada abono.

1/ Tomado de un artículo publicado en el número de "Tropical Agriculture" de febrero 1942. Autor H. J. Page.

CONTENTS

A FOREST POLICY FOR THE AMERICAN TROPICS

Arthur Bevan, Director
Tropical Forest Experiment Station

The history of forest exploitation in temperate North America from the days of "inexhaustibility" to the formation of organized conservation signifies the natural relationship between man and a valuable resource. The virgin forests, containing many valuable species, were exploited in such a manner that the margin between cost and sales price was as wide as possible. There was nothing malicious in this manner of exploiting forests, but as it happened, cutting methods which brought the greatest immediate profits were not compatible with what are considered good silvicultural practices. With less than 20 per cent of the original commercial forest area of the United States still uncut, conservationists, even with the support of Federal and State Governments, have been unable to balance the growth-drain budget. Only slightly more than one half of the commercial forest area which has been cut-over is classified as "fair to satisfactorily restocking".

Why has this happened? Was it the fault of the lumbermen, the economic system, or the democratic form of government? Each probably contributed to some extent, but the real blame must be placed upon the shoulders of the people who throughout the history of the country have, to a large measure, condoned or permitted the prevailing methods of forest exploitation. Only when wood shortages become acute will the public demand better silvicultural practices, thereby stopping destructive cutting of remaining stands, and bringing devastated lands back into production so that ultimately a sustained annual yield will be reached which will meet the requirements of the country for forest products.

For the present, however, the rate of depletion is being greatly accelerated by the needs of the war. Shortages of strategic materials are being alleviated by substitutes produced from wood, for when other raw materials are no longer available, there is an almost universal tendency to turn to wood. For this reason, the demand for wood and more wood is growing with each month of the war. How then, in the face of these growing demands, can our depleted forests continue to produce our needs in the future during the long period necessary to bring our cut-over lands into production? Will pressure to relieve this approaching pinch necessitate increased imports of forest products from the American tropics? Such a move is already under way, and it is expected that Inter-American lumber trade will grow rapidly.

Tropical America is a region with a very heterogeneous distribution of population. Areas of dense population, such as most of the West Indies and in the vicinity of large cities in Central America are already denuded, but a large area of forest remains at least in the countries of the mainland. Much of it is remote from civilization, some is virtually inaccessible. A certain analogy exists between the present stage of development here and that in the United States in 1800, as far as the forests are concerned. At that time a limited amount of forest exploitation in the United States had already taken place and the species and the values of some of the more important forest products were known. It is possible that we are on the threshold of another era of exploitation of virgin forests. Are the forests of Central America now to be slaughtered, or will it be possible to stem the tide of depletion?

What is the present general concept of forests and their management in the forested countries of the American tropics? That concept is largely concerned with the exploitation of valuable fancy woods for export and the discovery of other species which might be suitable for these same markets. A study of literature, descriptions of forest stands, reports of forest officers, planting programs in the tropics, clearly indicates that this policy has been the incentive for nearly all forestry programs. Forest laws in tropical American countries, where they exist, fortunately are more advanced than were those of the United States at a corresponding period of development, but pressure of circumstances still largely dictates actual practice.

In the main the tropical hardwood forests, which make up the bulk of the forest resources of these countries, are highly complex stands of many species. Species yielding valuable export woods make up only a small part of the forests, averaging perhaps one tree to the acre although sometimes occurring as occasionally as one tree to five acres. Cuttings made primarily for these species result in high-grading of the forests and in many countries where forest exploitation is "organized" such species are being cut at a depletion rate; certainly this is true where the timber is readily accessible. Under such a system logging costs are very high, damage to the remaining stand is excessive, and regeneration of the valuable species is not planned for.

We do not too often find consideration of the forest problem of the tropics of the Western Hemisphere based on the needs of the local inhabitants and their future welfare. Denuded forest lands are much more common than most people imagine. Near all heavily populated sections in this region, this type of land abuse is to be found. Despite this situation, no serious consideration has yet been given to short rotation quick-growing forest crops suitable for fuel, stakes, posts, and other materials needed for local consumption and for the improvement of the standard of living, of the peasant or peon class which makes up by far the greater portion of the population of these countries. Import statistics of lumber and wood products even in forested countries are indicative of the almost total neglect of local requirements and of attempts to solve this problem. In most of the regions lumber imports could be substantially reduced by better utilization of forest products and proper management of local cut-over forest lands, many of which are idle.

In some countries efforts are being made to maintain the forests through the planting of deforested lands with the more "valuable" species. Where successful these may eventually help to supply the foreign market, but, with the exception of teak plantations in Trinidad, very little success has been attained to date. Past plantings in Puerto Rico, may be cited as an example. Large expenditures have been made on a forest program which has centered around the planting of deforested lands. The first species tried was Spanish cedar, Cedrela sp., as this proved easy to raise in the nursery and early survival was high. However, later these plantations, largely pure in composition, wilted and died, and today as far as our knowledge goes not a single plantation of cedar exists which can really be called successful. Later, plantings were made of other fancy-wood species, such as mahogany, Swietenia sp.; teak, Tectona grandis; and maga, Montezuma speciosissima. On good sites some of these plantations are growing well. Mahogany, where planted under a light overstory, looks good, but on poor sites or on denuded abandoned and eroded lands, the areas which should first be reforested, plantations fail or are very expensive to establish.

More recently, following such failures, local species have been planted, but because previous interest was restricted to species producing high value woods, little is known of the characteristics of these trees. Studies of the normal successions on such sites and value of tree species showing promise must be determined before reforestation at reasonable cost is possible. Reforestation programs are almost certain to start from and around centers of greatest need, that is to say, centers of high population density where extensive areas are denuded. This is the plan being carried out by Mexico, and it has much of merit in it, not only from the viewpoint of supplying the greatest need first, but also for the psychological and educational effect on the people. However, to secure continued and increased public support the plantations must be successful.

If the vision of high profits in the distant future from the production of exportable fancy woods is not to "rule and ruin" the domestic forest economy of tropical America, due consideration must be given to the development of a policy which recognizes that domestic supplies are of first importance. Provision for the production of "luxury" woods should be secondary to the maintenance and management of sufficient areas of forest land under sustained yield management to supply present and prospective domestic needs. This does not necessarily mean that the production of forest products for export need be restricted to areas not producing for domestic needs. On the contrary the proper management of these lands will restore them ultimately to a more normal condition where such species can be grown one or two trees to the acre as in the virgin forest. There is evidence to indicate that the reestablishment of a forest cover will permit successful introduction of "luxury" species on sites where pure plantations have proved a failure. Such introduced dominants or emergents could be carried over as growing stock through several rotations of the understory or true canopy. The cutting of the latter will supply the local market and pay the costs of carrying the slower growing fancy woods. This would develop a system something of the order of "coppice with standards" practised in Europe with hardwood forests.

A sound forest policy should be based, in the order named, on:

1. The needs of the local population.
2. Determination of the properties and uses of the more common species for lumber and other wood products for home consumption.
3. The production of "luxury" fancy wood for export.

Such an approach should solve the problem of proper utilization and management and lead to perpetuation of the high value species rather than their elimination under present destructive high-grading methods. On permanent forest lands, a method of management such as has been suggested is more compatible with natural processes and the economy of such extended use is obvious.

Consideration should be given to the fact that areas of what most foresters would consider brush, composed of so-called inferior species, close to centers of dense population, have much greater values than forest containing high value fancy woods which is generally costly to log because the commoner species are economically inaccessible at present.

The recent cutting of a tract of pomarrosa, Jambosa jambos, in Puerto Rico close to transportation facilities illustrates the extraordinary values occasioned by proximity to market and a dense population. This stand was coppice, and about 12 years old. Largest stems were 7 inches d.b.h. This pure stand, clear cut, yielded posts, poles, stakes, charcoal and fuelwood which gave a net return of over $40 per acre per annum. This may be an extreme case but it shows definitely that where a domestic market exists it is just as important as exports. It is doubtful that much of our high forest with fancy woods will show any such return as this coppice.

Undoubtedly there will be a large area of abandoned land in tropical America following the war as certain large agricultural production programs now very necessary become less important. Many of these programs, such as the following one, result in the destruction of forest. "Several hundred acres a week in Panama and Costa Rica are being cut from the jungle and seeded to Manila fiber plants as one phase of the world-wide program recommended by the Combined Raw Materials Board to fill the United Nation's war need for rope."1/ Thus we place more land under the plantation system so familiar in the tropics with sugar, cocoa, and bananas. In times of high prices in the past large areas of forest land have been cleared for these crops which, when disease or low prices came, were abandoned. Naturally the poorer and most eroded areas were abandoned first. The sugar boom in Cuba in 1920 is an example where large areas of sugar cane were abandoned when the slump came. Imagine the forest that would exist today on these areas had a policy of reforestation been followed. With the coming of peace similar abandonments will occur when products are again procurable from lands now cut off from the world markets. Are these areas to become an impenetrable jungle of weeds, vines, and brush or will provision be made to see that a forest is restored, not only to ensure the rebuilding and protection of the soil for the future should a need for these lands arise, but to provide a supply of wood products for local use and for export? When abandoned, such areas have usually been provided with a ready means of access and can help to support the economy of the country.

The war has already caused a change in the point of view and is encouraging consideration of the home requirements of a country and its citizens. However, much more should be done and research in particular should be directed to a solution of these problems which will receive added consideration with the coming of peace. New territories will be opened up for settlement and the tropics of the Western Hemisphere are a fertile field for such purposes. We must be prepared with a new and up-to-date forest policy which will not

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1/ Victory. (Washington, D.C.) 3(38):13. September 22, 1942.

perpetuate the mistakes of the past. If provision for domestic needs is made now, first by keeping all true forest land in forest, and then by keeping them productive to the extent that at least domestic needs are met, production for export will then assume its proper role in the forest economy of tropical American countries, that of a surplus crop over and above all local needs.

Resumen

La rápida explotación de los bosques en la zona templada de Norte América a través del siglo pasado ha reducido grandemente la fuente disponible de productos forestales. La gran demanda de madera originada por la presente guerra está acelerando más aún el compás de esta explotación. Todos los indicios son de que se acerca una era de destrucción similar en los bosques tropicales del hemisferio occidental para ayudar a suplir las naciones de la zona templada donde los bosques están casi exhaustos.

El concepto general del bosque tropical en el pasado se limitaba a tomar en cuenta principalmente las maderas preciosas de exportación que se consiguen sólo aquí y allá en el bosque. De ahí que el corte continuo de los bosques con el objeto de conseguir estos pocos árboles dispersos lleva consigo la deterioración costosa y desperdiciadora del bosque.

Si el ritmo de esta explotación ha de acelerarse, el corte debe efectuarse de modo que la producción se conserve como una fuente de ingresos valiosa para el pueblo de todas las pequeñas naciones de la América latina. Estos cortes deben dar lugar también a la producción continua de productos forestales de utilidad doméstica tales como combustible, estacas y postes. En las tierras despobladas que no son útiles para la agricultura deben sembrarse árboles de crecimiento rápido especialmente cuando estas tierras se hallen cerca de los centros de población. Los árboles que producen maderas preciosas son generalmente de crecimiento lento y deben sembrarse sólo en aquellos sitios donde la demanda de combustible no es grande ya que a fin de cuentas el ingreso que producen las especies forestales de crecimiento rápido se asemeja mucho al que proviene de las maderas preciosas debido al largo período de crecimiento de éstas.

La política forestal sana, que sirva para asegurar los intereses del pueblo de las pequeñas naciones de la América tropical debe basarse, según el orden mencionado, en:

1. Las necesidades de la población local.
2. La determinación de las propiedades y usos adecuados de las especies forestales más corrientes como fuente de madera y otros productos para uso local.
3. La exportación de maderas preciosas.

THE EVALUATION OF FOREST TREE SPECIES IN PUERTO RICO, AS AFFECTED BY THE LOCAL FOREST PROBLEM

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Tropical forests, most of which are composed of a complex mixture of many species of trees, present many and varied problems to the forester attempting to convert them into highly productive managed stands. One of the most important decisions which must be made is in the selection of the tree species of greatest value: those which should be favored, or if necessary introduced, in order that they may make up the managed forest. This decision should be influenced by consideration of not only the properties of the wood, rate of growth, and the complex relationship between any species and the physical and biological factors of its environment, but also of the forest problem of the region which is directly dependent upon past forest land use, and present and prospective supply and demand for forest products. In Puerto Rico the present forest problem is almost entirely a result of the manner in which forests have been exploited in the past.

Past Forest Use

As the population of Puerto Rico has steadily grown, so has the demand for forest products. The sawtimber requirements for construction lumber and for attractive furniture woods have long since exceeded the local supply. Most of the lumber now imported comes from the southern United States, and for furniture, mahogany and Spanish cedar are imported from the Dominican Republic and Central America.

With parts of the Sierra palm type as a possible exception, all of the forests of the island have been cut or culled at least once, most of them many times. In the past most of the cut-over lands suitable for agriculture were immediately put under cultivation, having been cleared primarily for that purpose. The poorer lands were either permitted to grow up immediately to second growth forest or were farmed until the soil was gone or worn-out, and then abandoned to return slowly to forest.

Until recently these second-growth forests, together with the remaining old-growth, have been sufficiently extensive to supply local needs for many small forest products, including fuel wood, fence posts, poles for house construction, stakes for vegetable crops and tobacco, small poles, hoe handles, wagon parts, and ox-yokes. These are referred to as "secondary" forest products in the United States where they are by-products of the main harvest or are generally harvested at the time of forest improvement cuttings rather than at the end of the rotation. However, on an island the size of Puerto Rico, with 1,300,000 rural inhabitants, these products are of primary importance. They have a low value per unit of volume compared with other forest products, and therefore it is imperative that Puerto Rico supply her own requirements to and obviate importation, the cost of which will approach that of the products themselves.

The great demand for these products, accompanied by the fact that they may be taken from small trees, has led to severe cutting in young stands, and naturally the more suitable tree species have suffered most. Continued forest deterioration as a result of this practice, and the clearing of nearly every acre of land that could be farmed even if for only a few years, have steadily lowered production until at present the market price of these smaller forest products is rising rapidly.

Thus, Puerto Rico's forest problem is not merely that of increasing production but, fully as important, the establishment of a forest cover on some of the worst lands of the island for their protection.

Silvicultural Measures Required

Considering the circumstances a logical objective of a forest land management policy is the improvement of existing stands and the reforestation of all cleared lands unsuited to agriculture.

The available area is sufficient to produce all of the smaller forest products such as posts and fuel, that are needed. The satisfaction of this demand is of first importance. Without a great reduction in population, attended by less demand and reduced intensity of cultivation of marginal lands, the local forests cannot produce an appreciable portion of the construction lumber, railroad ties and timbers consumed here. However, this is not intended to convey the impression that lumber and valuable furniture woods cannot or should not be produced. Our tropical climate gives us an opportunity to produce very attractive furniture woods which are in great demand on both the domestic and foreign markets. When our forests become fully productive the yield of some of them can include these high-priced products, and part of the least accessible area can be managed primarily for this purpose.

The greater part of the improvement of existing forests consists of increasing the number of trees per acre of species which will rapidly produce the desired products. In some of the better forests, trees of suitable species are already growing and merely need encouragement by protection from frequent cutting and by liberation from the domination of other less valuable individuals. However, more frequently, years of indiscriminate cutting have eliminated all of the better species except a few persistent sprouters. In such forest underplanting is often needed. A moderately dense tree canopy should be left until the young planted trees are several feet tall, the removal of the older trees being made in several light cuts similar in effect to shelterwood removal cuttings which leave sufficient shade to control weeds and vines.

Many areas of worn-out farm land throughout the island are steep and rocky and should never have been deforested. The great pressure of the large agricultural population has resulted in the cultivation of lands which elsewhere, because of their slope or low productivity, would have remained permanently in forest. When these lands are abandoned reforestation is very necessary to adequately supply the local farmers with forest products and also to protect the soil.

Regardless of the tree species or the method of reforestation practised, young trees on deforested lands require protection from the competition offered by weeds and vines. On the basis of site there are two recommended methods of weed control. On the best of the lands available it is possible to interplant the area with food crops for a few years until a canopy sufficiently dense to dominate other vegetation is formed. This method has the advantage of providing payment for the weeding with the value of the crop harvested. However, most of the lands now available for reforestation are idle because of steepness of slope or impoverished soil. On these lands intercultivation is inadvisable and therefore weeding is necessary, the cost of which must be considered an investment until the trees are harvested or at least until full site protection is provided.

Silviculturally Desirable Tree Characteristics

To be of value in the solution of Puerto Rico's forest problem, a forest tree must have some of the following characteristics. It must: (1) produce a wood satisfactory for the products needed, (2) grow rapidly, (3) be relatively insusceptible to damage or mortality as a result of epidemic attacks by pests or diseases, (4) be easily established and able to grow on poor soils, (5) be able to grow in competition with existing herbaceous vegetation, (6) if underplanted, be sufficiently tolerant of shade to grow under existing forests until dominance is attained. Considering the 500+ native and the many introduced species of the island it appears that there should be a wide choice. Several species have 1 or 2 of these characteristics, but no tree so far used, either native or exotic, has all of them to the desired degree, and it is extremely doubtful that such a species will be found. As a result any species chosen, though it may be very suitable in some respects, will also have certain disadvantages.

Suitability of the Species Now in Use

For underplanting a tree tolerant of shade must be chosen, for otherwise the survival and continued growth of the young trees would require that the canopy be kept sufficiently open to also admit dense herbaceous vegetation. When in the open, tolerant trees generally grow more slowly than those requiring full light, but in the shade they will grow with virtually no care except the gradual removal of trees dominating them. One species which has been used in underplanting is broadleaf mahogany, *Swietenia macrophylla*, a tree whose chief advantage is its valuable wood and chief disadvantage is the long wait before harvesting. Among the relatively shade-tolerant species are many natives producing useful woods, such as the laurels, (Lauraceae, particularly *Ocotea* spp.); guaraguao, *Guarea guara* Jacq.; algarrobo, *Hymenaea courbaril* L.; capá prieto, *Cerdana alliodora* R. & P.; maga, *Montezuma speciosissima* Sessé & Moc.; maricao, *Byrsonima spicata* (Cav.) DC.; and jácana, *Lucuma multiflora* A. DC.

A number of species because of their rapid growth, have been used here recently for reforestation of bare lands. Most of these are exotics, such as pino, Casuarina equisetifolia Forst.; albizzia, Albizzia procera Willd.; cassia, Sciacassia siamea Britton; and eucalyptus, Eucalyptus robusta Smith. All of these species require intercultivation or thorough weeding to make their rapid growth while young. While these species are able to grow on poor sites they are all intolerant and unsuited for underplanting in existing deteriorated stands. When raised in pure dense plantations they form a temporary forest which must be periodically replaced by planting. Cassia in block plantings has been found to stagnate after 3 or 4 years of growth.1/

Pino, cassia, and albizzia are well suited for lands where cultivation or frequent weeding during the period of establishment is possible. However, as has been stated, on the greater part of the lands which now are, or will become, available for reforestation, cultivation is difficult and unprofitable, and usually incompatible with soil conservation. To obtain the necessary amount of weeding of young trees of these species on private lands farmers must be convinced of the value of spending money to make trees grow. This is no small task in a country where people have always closely associated trees with machetes. Education is needed and will help, but encouragement by government subsidy or a government land acquisition program may be necessary. However, the forester may go a long way toward the solution of this problem merely by the use of aggressive trees which require a minimum of weeding. On many private lands it may be best to use an aggressive species even if it lacks many other desirable characteristics. If desired, other species can easily be introduced by underplanting as soon as the herbaceous vegetation has been shaded out. Then the gradual removal of the "pioneer" trees in post, stake, and fuel cuttings will transfer dominance to the young trees of the new species.

Few trees are known which are suitable for use in reforestation on the large aggregate area of land, much of it in small privately-owned tracts, where cultivation is undesirable and adequate weeding is difficult to obtain. Three species which can be used successfully under these conditions are maría, Calophyllum antillanum Britton; pomarrosa, Jambosa jambos (L.) Millsp.; and roble, Tabebuia pallida Miers. These are not extremely rapid growing but they are aggressive and will withstand adverse site conditions with a minimum of weeding. Pomarrosa, slow growing at first, makes phenomenal growth from coppice. A discussion of roble appears in the following article of this issue.

The trees in the first group named are most suitable for underplanting in existing deteriorated forests. Those in the second group are suitable for reforestation with cultivation. The third group contains species suitable for reforestation of poor sites where it is expected that the plantations will receive little care. These species and others with similar good characteristics must be used in their proper place if the objectives of Puerto Rican forestry are to be fulfilled.

1/ Betts, T. F. The Tiv Plantations - 1939 to 1941. Farm and Forest II (3), Ibadan, Nigeria.

Resumen

Una de las decisiones más importantes que hay que tomar al convertir los bosques tropicales mixtos en rodales altamente productivos utilizando métodos de selvicultura es la de seleccionar las especies que mejor se adapten a los propósitos del manejo forestal. La selección depende casi por completo del problema forestal que se confronta y que en Puerto Rico proviene del abuso ejercido en el pasado sobre las tierras forestales y además de la demanda actual y venidera de productos forestales.

El desmonte desmedido que se efectuó en el pasado para poder suplir las necesidades de una población creciente creó el problema del surgimiento de bosques deteriorados y tierras abandonadas al deslave y de la escasez de productos forestales. Así tenemos que la especie forestal que se precisa debe producir rápidamente los productos necesarios a la par que crece en localidades relativamente pobres. A pesar de la producción local, la mayor parte de la madera que se usa en Puerto Rico es importada y además muchos de los productos menores tales como postes, estacas y leña se necesitan perentoriamente. Por lo tanto el objetivo primordial del presente es el de proteger las tierras despobladas que no son útiles para la agricultura con una capa forestal y la producción de estos productos forestales menores.

Los bosques deteriorados deben mejorarse levantando plantaciones nuevas al amparo de la sombra del bosque. Las especies que se usen deben tolerar la sombra y a la vez crecer rápidamente. Las tierras despobladas que no sirven para la agricultura se dividen en dos clases; las tierras mejores en que es posible intercalar cultivos agrícolas hasta que la sombra lo impida pues de este modo no habrán gastos adicionales ya que la plantación forestal se beneficia del cuidado que se le prodiga a la cosecha agrícola, en segundo término las tierras más pobres que no pueden cultivarse ni siquiera temporalmente debido a la topografía accidentada o al suelo somero y que deben sembrarse de árboles agresivos que requieren un desyerbo mínimo.

Alguna especies que sugerimos y otras que están usándose ya para esos propósitos están incluídas en la lista que sigue. Todas estas especies tienen sus ventajas pero también sus desventajas.

Para Sembrar Bajo Sombra	Para Repoblar: Junto con cosechas agrícolas	Para Repoblar: Con menor atención
Ocotea spp.	Casuarina equisetifolia	Tabebuia pallida
Guarea guara	Albizzia procera	Calophyllum antillanum
Hymenaea courbaril	Sciacassia siamea	Jambosa jambos
Cerdana alliodora	Eucalyptus robusta	
Montezuma speciosissima		
Byrsonima spicata		
Lucuma multiflora		

ROBLE, A VALUABLE FOREST TREE IN PUERTO RICO

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The forest production of Puerto Rico is dependent upon the future management of not only Government-owned forest lands but, equally important, the large aggregate area of privately-owned non-agricultural land which has been deforested and is now unprofitably cultivated, serves as poor pasture, or is virtually idle. Because of wartime pressure for food production a portion of this land is being cleared for temporary cropping. Probably, normal submarginality of such lands has been removed because of the emergency, but following the war much of this land must be abandoned regardless of population increases, because of impoverishment of the soil.

These lands, and others which are idle because of steepness of slope or poor soil can best serve the people in forest production, but in order to interest private owners in investing in reforestation and management it is necessary that the crop yield early returns and that establishment and management costs be at a minimum. One tree species which has been found well adapted for planting on such lands because of its aggressiveness and ability to withstand adverse site conditions is roble, *Tabebuia pallida* Miers (or *T. pentaphylla* Hemsl.).

The Tree

Roble, or roble blanco, is a member of the family Bignoniaceae. Contrary to the implication in this common name, which is applied to the species throughout most of its range, it is not closely related to the robles of the Mediterranean region or the oaks (both groups belong to the genus *Quercus* in the Fagaceae). Roble is, however, in the same genus as the commercially important Central American prima vera, or white mahogany, *Tabebuia Donnell-Smithii* Rose. The natural range of roble extends from Hispaniola throughout the Lesser Antilles, and from Mexico well into northern South America.

There are 4 other species of *Tabebuia* native to Puerto Rico, but roble blanco may be distinguished from them all by the large leaflets, 7 to 15 centimeters long, which make up its 3- to 5-foliate leaves. Roble is a rather small tree, few Puerto Rican specimens exceeding 20 inches in diameter and 60 feet in height.

Distribution in Puerto Rico

Roble is found from sea-level to elevations of 3,000 feet. Scattered trees or young volunteer stands are found in all parts of the island which receive an annual rainfall above 45 or 50 inches.

Roble is commonly planted in towns, frequently in the plazas, where its abundant pink or white trumpet-shaped flowers make it very attractive during the one to several periods each year in which it is in bloom. Another important use of the tree is in fence rows. As freshly cut posts generally will sprout if promptly set, roble makes a very "durable" fence post. Robles are to be seen in fence rows in nearly all parts of the island.

Most of the roble forests are on slopes in the interior. A large group of nearly pure roble stands is to be found on the north and west slopes of the Luquillo Mountains at elevations ranging from 500 to 2,000 feet above sea-level.

Products

As has been stated, roble is not a large tree. It will probably never be important here for its sawn lumber. The wood is not highly prized like that of mahogany or cedar. However, the tree grows straight and in the forest prunes itself early, producing a good bole (see figure 1).

The wood is very useful. It is white in color, hard, heavy, and strong, and according to Britton and Wilson[1] the specific gravity is about 0.8. Record[2] states that it is easy to work, finishes smoothly, and seasons without difficulty. It is used for general construction, tool handles, fence posts, ox-carts and other similar uses.

Growth

Rapidity of growth is a primary consideration in the selection of a tree species for use in plantings on private forest lands where the owners must be convinced of the value of planting and caring for trees. To be of any practical significance, growth data must be based upon conditions in a stand or plantation where the tree is subjected to normal forest environment, including competition of neighboring trees. Many tropical trees are capable of phenomenal growth when isolated, or when in an open stand or young plantation. However, if they grow slowly when subjected to the natural competition for light and soil which exists in a forest sufficiently dense to shade out herbaceous vegetation, these species are of little value for reforestation.

An indication of the growth of roble trees and forests is found in data collected in 5 one-tenth acre growth plots established in 1938 by A. K. Thurmond, then a District Ranger in the Caribbean National Forest. The plots are in a young nearly pure roble stand in the humid northeastern Luquillo mountains. The elevation of the plots is 300 to 500 feet above sea-level, and they are located on a degraded heavy clay soil (Catalina stony clay) about 50 feet above Río Espíritu Santo. Annual precipitation averages about

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1/ Britton, N. L. and Wilson, Percy. Botany of Porto Rico and the Virgin Islands, New York Academy of Sciences, 1925.
2/ Record, S. J. Timbers of Tropical America. Yale University Press, New Haven, 1924.

Fig. 1.—A 4-inch roble left after a recent clearing, showing the good form of forest grown trees. Trees such as this one produce excellent posts and poles.

100 inches. The present stand came up when previous cultivation was discontinued. A few older trees nearby are probably the progenitors of the stand.

The plots were established to determine the effects of thinning, intercropping, and removal of wolf trees upon the growth of roble. All trees within the plots were numbered with metal tags and diameters and heights of most of them were measured. Three plots were established in a mixed stand of roble and other hardwoods; the other two are in a pure roble stand. The mixed stand was so open and heterogeneous that the three plots give no conclusive indication of the results of intercropping and the removal of wolf trees. In all three plots the openings are rapidly being filled with young robles.

The two pure roble plots in the pure roble stand are more fully stocked and represent average forest conditions in such a stand. They were established to study the effects of thinning, but at present they are of value chiefly for their record of growth. The forests in the two plots differ somewhat in density (see table 1) but this factor is of insufficient importance to produce a great difference either in their appearance or in measured growth, so the data are combined for analysis. Figure 2 shows a general view of the unthinned plot.

Table 1.—Stand per acre in thinned and control plots in a pure roble stand just after thinning and four years later.

d.b.h. inches	Unthinned				Thinned			
	1938		1942		1938		1942	
	No. trees	Basal area1/	No. trees	Basal area1/	No. trees	Basal area1/	No. trees	Basal area1/
0-0.6	760	0.22	770	0.23	410	0.12	480	0.14
1 2/	380	2.32	580	3.54	430	2.62	400	2.44
2	420	9.66	450	10.35	430	9.89	360	8.28
3	230	11.66	350	17.74	220	11.15	300	15.21
4	80	7.16	170	15.22	40	3.58	140	12.53
5	10	1.39	60	8.35	50	6.96	90	12.53
6	30	5.99	10	2.00			40	7.98
7	20	5.42	30	8.13				
8	10	3.54	20	7.08				
9			10	4.47				
10								
11	10	6.66						
12			10	7.92				
Total	1950	54.02	2460	85.03	1580	34.32	1810	59.11

1/ Basal area is the aggregate cross sectional area of all trees at 4.5 feet above the ground (at breast height).
2/ The 1-inch d.b.h. class includes trees 0.6 to 1.5 inches, d.b.h., etc.

Fig. 2.—A young pure roble stand, showing the tall narrow crowns of the trees, and the characteristic open canopy.

The preponderance of trees in the small diameter classes, as shown in table 1, indicates the youth of the stand. As mortality was evidently negligible, the increase in the number of trees in each plot during the four years equals the number of saplings entering the smallest diameter classes. It might be expected that the greater number of seedlings would have come up in the thinned plot because of the openings created by the thinning, but, as is indicated by the small basal area, both stands were sufficiently open for such reproduction. Also, under the thinned stand, areas of dense grass slowed seedling and sapling growth.

A complete study of increment cannot be based entirely upon diameter growth, for height growth is equally important, particularly where production of products, such as posts, is a major objective. Figure 3 shows the curvilinear relationship between diameter and height in all the trees in the two plots. There was surprisingly little individual variation from this curve. It will be noted that roble in this stand had grown to about one half of its maximum height by the time that it reached 4 inches d.b.h.

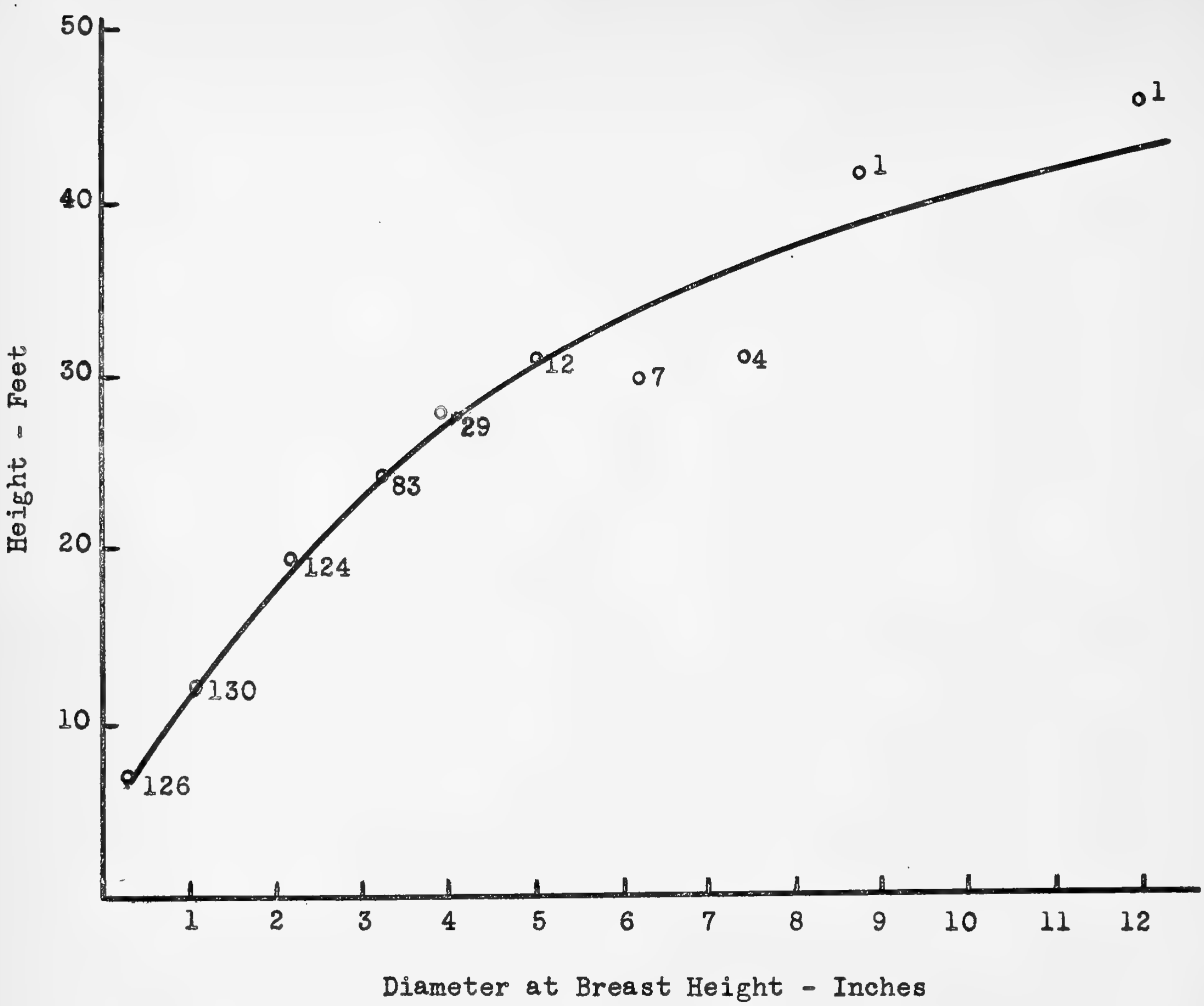

Fig. 3.—Relationship between roble diameter and height in a young pure stand, El Verde.

Information as to the increment of entire stands is valuable for many purposes, but fully as important is a knowledge of the growth of individual trees in relation to their various environments within the forest, for with such information foresters can control reproduction, both as to quantity and species, the growth of each individual tree, and tree form.

The growth of a tree in a forest is dependent upon many factors, but the most easily controlled is light (and root) competition. Analysis of the growth of trees of different diameters is one method of determining the importance of light and root competition as growth-inhibiting factors. Trees in the larger diameter classes are generally among the tallest and their crowns therefore receive an abundance of light, also they generally have well-developed root systems which give them added advantage.

The permanent tags on each tree in the plots made possible a study of the relationship between diameter and tree growth. A summary of the data shows that, as might be expected, the larger trees made the most rapid diameter growth. While those in the 1-inch d.b.h. class in 1938 averaged a growth of 0.3 inch in diameter for the 4-year period, those larger than 5 inches d.b.h. grew almost 1 inch (see figure 4). The relationship with height growth is less marked, for many small trees under openings were found to be growing well in height. Linear correlation of diameter with diameter growth and height growth gave correlation coefficients of +0.33 and +0.26 respectively.

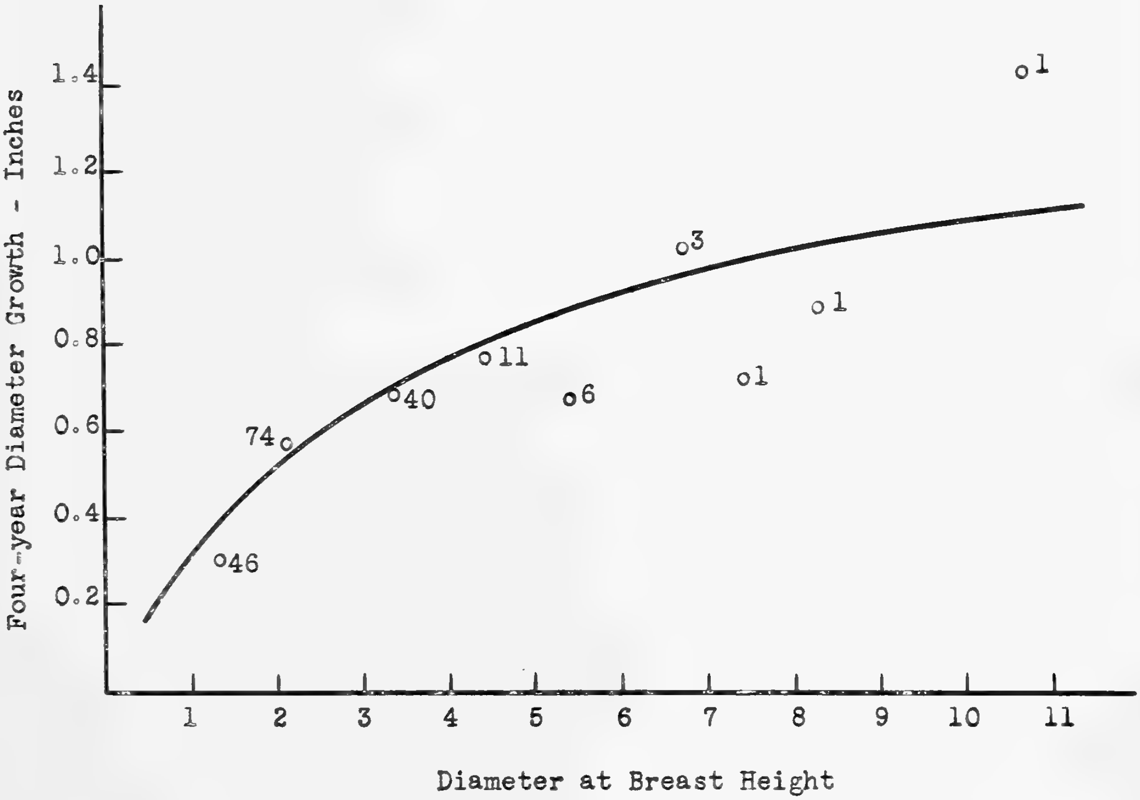

Fig. 4.—The relationship between 1938 roble diameter and four-year diameter growth in a young pure stand, El Verde.

The significance of this finding that tree diameter is related to subsequent growth, is that it indicates which part of the stand is responsible for most of the increment. However, with this information alone one might logically cut all small trees in an effort to increase growth (leaving the rapid-growing large trees). This practice might increase growth to some extent but it would be undesirable silviculturally because it makes no provision for replacement of mature trees when they are cut.

Diameter and growth in a pure stand of roble are related, chiefly because diameter and dominance, or growing space, are related. Therefore, dominance is to be considered a better index of growth than diameter. A classification of trees by the position of their crowns with respect to nearby trees (assuming this to be also a good index of relative position of the root system beneath the soil surface) has been widely used in the study of competition between trees within the forest. The four following broad classes may be used for pure stands:

Dominants - Trees with crowns extending above the general level of the crown cover and receiving full light from above and partly from the side.

Codominants - Trees with crowns forming the general level of the crown cover and receiving full light from above, but comparatively little from the side.

Intermediates - Trees with crowns extending into the crown cover formed by dominant and codominant trees; receiving a little direct light from above, but none from the side.

Suppressed - Trees with crowns entirely below the general level of the crown cover; receiving no direct light either from above or from the side.

The use of these classes as a basis for the study of individual tree growth permits a much more accurate expression of environment than does diameter. In 1942 all of the trees in the plots were classified according to this system. It would have been desirable to have the classification made at the beginning rather than at the end of the 4 years for use in growth prediction, but because of the brevity of the period it is extremely unlikely that the number of trees that changed classes was sufficient to affect the results of the study.

As has been pointed out, generally the larger trees are at the dominant end of the scale and the smaller ones are in the intermediate and suppressed classes. In fact, linear correlation between diameter and dominance is much closer than that between diameter and growth. (See table 2.)

Table 2.—Linear correlation coefficients between size and dominance of roble trees and rate of diameter and height growth.

Variables	Simple Correlations		Multiple Correlations
	Diameter	Dominance	Diameter and Dominance
Diameter growth	+0.33	+0.49	+0.50
Height growth	+0.26	+0.53	+0.53

Growth was found to be definitely related to dominance. Linear correlation of dominance with diameter and height growth gave coefficients of +0.4857 and +0.5318 respectively. These relationships are shown graphically in figure 5. Proof of the superiority of dominance over diameter as an index of future growth is found in the comparison of the various correlation coefficients in table 2. The multiple correlation coefficients shown also bring out the weakness of using diameter alone in estimating the growth of individual trees in these young stands. The correlation using both diameter and dominance is no stronger than that with dominance alone.

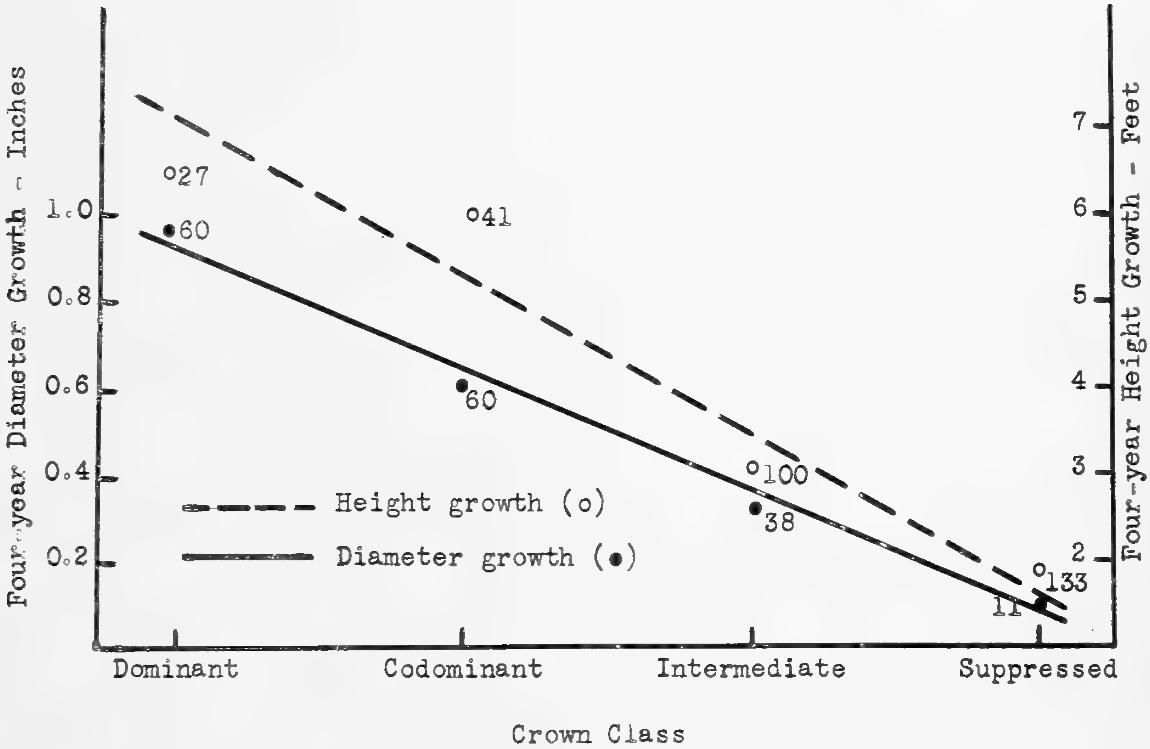

Fig. 5.—The relationship between roble diameter and height growth and position in the crown canopy in a young pure stand, El Verde.

Pests and Diseases

Roble is attacked by several insects but the only one of general importance here is a Lepidopterous shoot borer. The larvae of this insect attack roble twigs throughout the island and are responsible for crowded profuse branching in many trees. The slight zig-zag appearance of the bole of some trees is possibly the result of past attacks of shoot borer in the leader. Roble is also attacked by scales and a leafhopper, neither of which cause extensive damage.

Recently, a young roble was found dying as a result of a canker in the bole. Only two such trees are known to the writer and the pathogen has not been isolated. A witches-broom is commonly seen on robles but does not deform the merchantable part of the tree.

Roble can be considered relatively free from attacks of pests and diseases but because of the large pure stands which have recently grown up, an attack of some new pest might easily assume epidemic proportions. This vulnerability, a characteristic of all pure stands, regardless of species, provides argument for gradual conversion to a mixed forest by underplanting or favoring natural reproduction of the better species in the understory.

Tolerance of Poor Sites

The tolerance of roble for some of the poorest sites of the island is common knowledge. Good stands of roble are frequently found growing on steep slopes and ridges where the topsoil has been entirely removed by erosion following cultivation, and the soil remaining is a nearly sterile heavy clay.

Aggressiveness

Attention was attracted to roble chiefly because of its role in plant succession. The outstanding silvical characteristic of the species in Puerto Rico is its ability to invade non-forested pastures. It is a prolific seeder, isolated trees sometimes producing several large seed crops within one year. Along the edge and in the openings in most stands are young trees which have obviously come up through herbaceous vegetation, particularly where grazing has kept the grass low. Also there is unmistakeable evidence in existing young mixed forests that roble was a pioneer species in the development of the cover, having invaded a grassy or weedy deforested area and gradually attained dominance. These observations alone are of sufficient significance to justify intensive study of this tree.

Tolerance of Shade

In many different ways roble shows its intolerance of shade. In dense stands heavy seed crops may fall to the ground each year, but there is a gap in the size classes between the small saplings and poles with crowns in the lower edge of the canopy in which no young trees seem to be able to grow because of shade. Presumably sapling mortality is high under these circumstances. In more open stands this gap does not exist. The high mortality of young trees is shown by a small seedling plot established under a dense roble stand. The April 1942 seed crop had stocked the 64 square feet within the plot at the rate of more than 2,500,000 seedlings per acre. Nine months later two-thirds of them were dead, and judging by the small number of older seedlings and saplings in the vicinity it is doubtful that 5 per cent will survive for 12 months.

The intolerance of roble is shown also by its less prominent position in older, more dense forests. None of the pure roble stands are very old, few having dominant stems larger than 8 or 10 inches d.b.h. The oldest roble trees found are in mixed forests, and in many of them roble is a minor representative. These old specimens are apparently remnants of a former more open stand containing many robles. Moreover, roble is obviously not maintaining its numbers in dense stands, regardless of the number of seedlings which may start.

The Place of Roble in Forest Management

General observations supported by plot records indicate that foresters will be wise to assign roble primarily the same task on managed forest lands as that which it accomplishes so well on unmanaged lands; the reforestation of poor sites. In existing forests it is doubtful that conversion to roble would be a simple matter. As has been pointed out, roble is intolerant of shade and conversion would require destruction of the canopy to give light to the young trees. In an experimental underplanting made in a moderately dense woodlot the trees are growing well only where they were planted under scattered openings in the canopy.

Roble can be looked upon as merely a nurse crop to be replaced later with other species, or it may be desirable to perpetuate it as the major species in the stand. Whichever decision is made, no difficult silvicultural problems need be faced, provided that conversion to more intolerant species is not attempted.

Establishment

Roble can be propagated by seed or cuttings. The use of cuttings has little practical importance in forestry here at present, primarily because on a large scale it is considered more difficult than seed propagation. However, as has already been pointed out, roble fence posts, which are cuttings of a type, will generally grow if set in moist soil promptly after cutting.

Not to be overlooked in any reforestation program is an already existent supply of wilding planting stock to be found under most of the roble stands of the island. The production of these wildings by a forest is not entirely reliable as a source of planting material over a period of years, and seedlings grow more slowly in the forest than in a nursery, but by using this type of planting material the investment required for nursery maintenance is obviated. Also, wildings, because of their slow growth need not be transplanted immediately when they become of size, but may be lifted as needed and at the best season of the year. In the existing stands of the island there is a supply of wilding plants sufficient to plant thousands of acres. In many pure stands wildings are so abundant that they can be pulled nearly as rapidly as stock in a nursery. In the two small plots measured there were 1,770 saplings from 1 to 4.5 feet tall. Of these, probably 50 per cent or about 4,500 per acre would be suitable for transplanting.

Propagation by seed begins with collection. The greater part of the seed is borne in the spring, but open-grown trees sometimes flower several times during each year, so it is possible to procure at least a small amount of seed at almost any time. The seeds should be collected when the pods have turned yellow in color one or two days before they open. As the seeds are winged and light (20,000 to the pound) they are blown from the pods almost immediately after the latter have opened. The seed is relatively perishable. When stored with the natural moisture content at air temperature it loses its viability rapidly during the first few weeks but a few seeds may remain viable for 3 or 4 months.

The apparent aggressiveness of the species led to the establishment of several direct seeding plots on the island at both low and high elevations. In several plots seeds were sown about one-quarter inch below the soil surface in the center of 2-foot cleared spots. In several others they were broadcasted, some of the plots being left with dense herbaceous vegetation, and others cleaned. All of these plots failed, and led to the following conclusions:

(1) Roble seedlings are very delicate during the first month of growth.

(2) Because of this condition the seeds should not be more than just covered with soil, particularly if the soil is heavy.

(3) During the first two or three months many seedlings die from the effects of long exposure to direct sunlight. (Seeds broadcasted under dense grass had a high early survival.)

(4) Broadcasting is inferior to spot seeding because most of the broadcasted seeds lie on top of the soil, remaining dry, except under very favorable weather conditions, until they are no longer viable. Also, broadcasted seedlings, being scattered at random, are more difficult to care for than seedlings in rows of spots.

(5) If for no other reason, the success of direct seeding of roble in the field is jeopardized by the slow growth of the young seedlings during the first year. Even in a nursery the seedlings do not exceed 3 or 4 inches in height after 3 months. This slow early growth in the field might greatly prolong the period during which care is necessary.

Wherever wildings are available it is recommended that they be used for planting stock. Where the supply is inadequate it will be necessary to grow nursery stock, since direct seeding has several disadvantages.

In the nursery the seed should be sown at a depth not greater than one-quarter inch. To yield sturdy stock seeds should be spaced 4 x 2 inches apart. During the rainy season no watering is necessary. Seedlings raised under 50 per cent lath shade frames were of better color than those completely exposed, but no effect on growth was noticed, so evidently the shade is desirable but not entirely necessary. No nursery diseases of the species are known here.

After 5 or 6 months the seedlings are about 18 inches tall and may be lifted, or they may be held until they are 48 inches tall if necessitated by weather conditions. With ordinary care in lifting, wrapping of roots, and planting, mortality can be kept very low. Of 100 wildings planted on a moist site in the interior, there were 98 living 8 months later. The trees should be spaced at either 6 x 6 or 8 x 8 feet, preferably the former, in order to rapidly obtain a cover.

Data are not yet available on the growth and mortality of the planted trees during the period of their establishment in the field. However, numerous plots have been established where trees have been planted following two types of site preparation, complete clearing of herbaceous vegetation, and clearing of a circle 2 feet in radius about the tree. A series of control plots without preparation has also been established.

It is recognized that it will be necessary to keep the trees free from vines, and during their first year, also to occasionally weed them. However, observations indicate that little additional care should be necessary.

During the next few years none of the trees should be removed, regardless of the fact that some may be misshapen, for crown canopy which shades out the herbaceous vegetation beneath it is the first objective of reforestation.

Silvicultural Control of Established Forests

When the crowns of the trees meet and the canopy starts to kill the herbaceous vegetation by shading, a silvicultural policy should be formulated to guide the production of the forest, in both quantity and quality. To properly control composition and increment, such a policy must designate which species are to be favored and what cutting plan should be followed.

Much can be learned about desirable silvicultural practices by observation in existing roble forests. Nearly every significant silvical characteristic of roble stands reflects the intolerance of the species for shade. The trees may grow close together but their crowns are small and therefore the shade produced is not dense. (See figure 2.) The data here presented show that even in this relatively light environment the young robles below the canopy are making negligible growth.

Another important consideration in roble stands is the present and prospective representation of other species. In all pure stands seen there is evidence of impending invasion by other species which are more tolerant of shade and can therefore grow up under the roble and eventually replace it. Two common invaders are pomarrosa, *Jambosa jambos* (L.) Millsp. and the laurels (Lauraceae).

If pure roble is to be perpetuated, the stand must be selectively cut frequently to keep it sufficiently open to permit growth of the reproduction. All other species should be gradually removed from the stand. However, overcutting must be carefully avoided, for it may set the stand back several years. An example is shown in the thinned plot data presented in table 1. It was recorded that 55 posts were removed from one plot for comparison with the other, a control. Unfortunately, details of the cutting policy are lacking, except that the "best" trees were left. A comparison of the stand table of the reserve stand with that in the control plot in 1938 indicates that many of the trees removed were large, for only those below 6 inches d.b.h. were left, while in the other stand there were several up to 8 inches d.b.h. Table 1 shows that 510 saplings entered the unthinned stand (grew to 4.5 feet in height) from below during the 4 years, but in the thinned stand the increase was only

230. This is because parts of the thinned plot were so open that herbaceous vegetation invaded and slowed tree reproduction.

Overcutting also sets back the aggregate increment of the dominant class. In this same thinned plot the 4-year basal area increment was 72.2 per cent as compared to only 57.4 per cent in the unthinned stand. However, the higher increment per cent of the thinned stand is of little significance as it was calculated from a smaller base (1938 basal area) and the actual square foot basal area increment of the two stands was about the same.

The close relationship between the dominance and growth of roble trees, regardless of their size, must be borne in mind when cuttings are made. Thinnings which remove the subordinate trees to increase the growth of the dominants will have little beneficial effect because such cuttings do not materially change the environment of the already dominant trees. In fact, if the other extreme was used (i.e. the removal of the dominants, releasing the now slow-growing subordinates and making them dominant) it would produce accelerated growth in these new dominant trees which would approach that of dominants in the uncut stand. However, because quality as well as quantity production is desired neither extreme is satisfactory. Consideration of the potential value of each tree, both dominants and subordinates, is necessary. If among the dominant trees there are some of excellent form which are capable of large value increment they should be left until they produce a 6- to 10-inch bole for small lumber or large posts, regardless of the number or quality of the trees beneath them. Other dominants will increase only very slowly in value because they are as large as is needed, or because, due to crook or other abnormalities, they are suitable only for fuel. These should be cut to give the growing space to more promising trees, even though they be much smaller at present. Subordinate trees which show little promise because of poor form should also be cut. This policy is flexible and can be followed both in light cuttings in open stands and heavier cuttings in dense stands. In open stands it may be impossible to remove all undesirable trees in one cutting without unduly exposing the site to invasion by herbaceous growth. In such forests only a few of the worst trees should be removed in each cutting. Likewise in very dense stands it may be desirable to take a few trees of good form in addition to those of low value in order to open up the stand sufficiently to provide for reproduction.

If it is considered desirable to establish other species in the stand, two methods may be used: (1) the encouragement of other species already invading, or (2) underplanting other species.

Conclusions

Thus roble can admirably serve in the reforestation of idle lands, at present an all-important phase of forest land management in Puerto Rico. Early growth of the seedlings is slow but planting stock is readily available in existing woodlands and little care is necessary. When the stand is a few years old forest conditions are established, and any of a great number of species may be introduced into the stand if desired, while the gradual harvesting of the roble will provide early income. On the other hand, the maintenance of a nearly pure roble stand will provide a continuous high yield of excellent small poles, house posts, tool handles, and similar products. It is necessary to prevent the invasion of other species but this can be accomplished by occasionally cutting the saplings of other species.

In a country such as Puerto Rico, where the biggest immediate job confronting foresters is that of providing an abundant cheap supply of small wood products and fuel, and where it is necessary to reforest large areas of private lands where little control or care of the trees is possible, aggressive species such as roble must be used if early success is to be achieved.

Summary

One of the greatest problems which must be faced before forest production in Puerto Rico can reach the maximum compatible with other land uses is the reforestation of cleared lands which have been, or will be, virtually abandoned because of impoverishment or loss of soil. To accomplish this objective the forester must find various means of making reforestation and forest management attractive to private owners. One way is in the use of trees which can be cheaply established and which will grow rapidly on the type of land available for forest. A species which has been found well adapted is roble, Tabebuia pallida Miers (or T. pentaphylla Hemsl.).

Roble is found throughout tropical America. In Puerto Rico it grows in most parts of the island, but chiefly in the mountainous interior. The hard, heavy, strong wood is used in general construction, tool handles, oxcarts and similar uses.

The growth rate of open-grown trees is not extremely rapid, but in the forest, growth compares well with other species. The trees grow straight and have few branches. The larger dominant trees were found to grow about an inch in diameter and 7 feet in height in four years. The growth of the subordinate trees is in proportion to the amount of light they receive, with the suppressed trees making very little growth. While there is a definite correlation between diameter and diameter growth that between dominance (amount of light received) and diameter growth is much stronger. By classifying a tree as dominant, codominant, intermediate, or suppressed it is possible to predict its growth from the data presented.

One of the outstanding characteristics of roble is its tolerance of adverse site conditions. Good stands are often seen on ridges where the topsoil has been largely removed by erosion.

The aggressiveness of the species is one of its best characteristics for reforestation purposes. It competes well with grass and weeds and is often the first tree to naturally appear on abandoned land. Undisturbed areas surrounding roble forests frequently contain many saplings which are a result of the large amounts of wind-blown seeds produced.

Roble is definitely intolerant of shade and forms a temporary forest type. Young pure forests are gradually invaded by other species, as roble

seedlings do not grow well under the shade of the parent stands. In old stands the species is generally a minor representative.

If roble is to be used in reforestation it must be planted. Direct seeding has been unsuccessful because the seedlings are delicate for several months, and early growth is slow. Propagation in the nursery is not difficult, but large amounts of planting stock can be obtained from existing forests. Wild stock 18 to 36 inches in height is plentiful in moist pure roble forests, and it transplants well during the wet season.

The planted trees need early protection from the competition offered by herbaceous vegetation. The cutting of weeds in a circle 3 or 4 feet in diameter around each tree is necessary during the first year.

When the stands have grown to the point where a canopy is produced the poorer specimens should gradually be removed in charcoal or post cuttings - but always leaving the stand sufficiently dense to prevent invasion by grass. Seedlings of other species, which will begin to appear in the forest floor should be encouraged if they are of value. These other species will gradually replace the roble unless they are cut back and unless the stand is kept sufficiently open for the growth of roble saplings. However the development of a mixed forest will provide a wider variety of products.

As roble is a small tree from which little lumber is produced, the main products for which the species is used do not require trees larger than 8 or 10 inches in diameter. Therefore all trees of this size can be considered mature, but cuttings should always be selective, leaving sufficient stems to preserve forest conditions.

Thus roble, a species which does not produce a valuable furniture wood for export, is important in Puerto Rico because of its usefulness in reforestation, because a supply of wild planting stock is already available in existing stands, because the species is aggressive and able to withstand adverse site conditions, and because the wood is useful for the many wood products required by our own huge agricultural population. The species has certain limitations as do all trees when considered for use under the wide variety of conditions existing in Puerto Rico, but such species, the products of which are primarily of value for local consumption, must be grown in part of our forests if they are to be of greatest service to our people.

Resumen

Uno de los problemas más grandes que es preciso allanar para que la producción forestal en Puerto Rico alcance un grado máximo, compatible con otros aprovechamientos del terreno es la repoblación forestal de las tierras despobladas que han sido o serán virtualmente abandonadas debido al empobrecimiento o deslave del terreno. Para lograr este objetivo el forestal debe buscar los medios para hacer que esta repoblación y manejo forestal halague a los terratenientes. Uno de estos medios es usando árboles que puedan establecerse económicamente y que crezcan rápidamente en las tierras disponibles para

bosques. Se ha determinado que el roble, Tabebuia pallida Miers (o T. pentaphylla Hemsl.) es una de las especies que se adaptan a estas condiciones.

El roble se encuentra a través de toda la América tropical. En Puerto Rico crece en casi toda la isla pero principalmente en la región montañosa del interior. La madera es dura, pesada y se usa en construcciones en general, mangos, carros de bueyes, y demás usos similares.

El índice de crecimiento de los árboles de roble dispersos no es extremadamente rápido, pero su crecimiento en el bosque sí puede muy bien compararse con el de otras especies. Los árboles crecen rectos y desarrollan pocas ramas. Se determinó que la mayor parte de los árboles dominantes crecen a razón de 1 pulgada en diámetro y 7 pies en altura en cuatro años. El crecimiento de los árboles subordinados está en proporción a la cantidad de luz que reciben, siendo los árboles oprimidos los que crecen muy poco. A pesar de que existe una correlación definida entre el diámetro y el aumento progresivo en diámetro, la correlación que existe entre la dominación (que depende de la cantidad de luz recibida) y el crecimiento en diámetro es mucho mayor. Si clasificamos un árbol en dominante, codominante, intermedio u oprimido podemos predecir su crecimiento de acuerdo con los datos incluídos en el texto.

Una de las características más sobresalientes del roble es su habilidad para tolerar localidades adversas. A menudo observamos rodales buenos aun en cuchillas que han perdido las capas superiores del suelo por deslave.

La agresividad de la especie constituye una de sus mejores características para fines de repoblación forestal. A menudo es de las primeras en surgir espontáneamente en terrenos abandonados y compite bien con las malas yerbas. Debido a la enorme cantidad de semilla que produce y que el viento esparce por todos lados, las tierras adyacentes a los bosques de roble se ven frecuentemente pobladas de numerosos arbolitos.

Se sabe positivamente que el roble no tolera la sombra por lo cual forma un tipo forestal temporero. Los rodales jóvenes van siendo invadidos gradualmente por otras especies ya que los arbolitos de roble no pueden desarrollarse debidamente bajo la sombra de los árboles madres y por lo general en los bosques más viejos esta especie abunda menos.

Si el roble ha de usarse en repoblación forestal debe recurrirse al uso de arbolitos. La siembra directa no ha dado buenos resultados porque las plantitas son muy delicadas durante los primeros meses y su crecimiento inicial es lento. La propagación en los viveros no es difícil pero pueden obtenerse grandes cantidades de material de siembra de los bosques ya existentes. Arbolitos silvestres de 18 a 36 pulgadas de alto abundan en la mayoría de los rodales puros de roble y trasplantan bien durante la época de lluvias.

Durante el primer año los plantones deben protegerse contra la competencia de la vegetación herbácea, manteniendo un círculo de 3 ó 4 pies de diámetro limpio de yerbas alrededor de cada arbolito.

Cuando el rodal empieza a cerrar los ejemplares más pobres deben cortarse gradualmente para postes o carbón, pero dejando suficiente sombra para mantener a raya las malas yerbas. Deben estimularse aquellas especies de valor que aparezcan bajo el roble. Estas irán reemplazándolo gradualmente a menos que no se corten con miras de perpetuar el roble y se mantenga el rodal suficientemente abierto para permitir el crecimiento de éste. Sin embargo un bosque mixto nos proveerá de mayor variedad de productos.

Como el roble es un árbol que proporciona poca madera, los principales productos para los cuales se usa no requieren árboles de más de 8 ó 10 pulgadas de diámetro. Por lo tanto todos los árboles de ese tamaño pueden considerarse listos para la corta, que debe ser siempre selectiva pero dejando suficientes árboles para conservar así las condiciones forestales.

Por lo tanto, el roble, una especie que no suministra madera de valor para exportar, es importante en Puerto Rico por su utilidad en repoblación forestal porque el material de siembra está disponible en los rodales existentes, porque es agresivo y puede soportar localidades adversas y proporciona además numerosos productos necesarios a la enorme población agrícola de la isla. La especie, como todos los árboles, tiene ciertas limitaciones cuando su uso se considera bajo la inmensa variedad de condiciones existentes en Puerto Rico pero las especies cuyos productos son de valor principalmente para el consumo local, deben cultivarse en nuestros bosques si es que han de rendir el mayor provecho a nuestro pueblo.

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LATIN-AMERICAN FOREST RESOURCE SURVEY ORGANIZED

In November 1942 Mr. Bevan, Director of the Tropical Forest Experiment Station was called to Washington on detail to organize a Latin-American Forest Resource Survey to be conducted by the U. S. Forest Service. The objective of the survey is the determination of the character, extent, and availability of the forest resources of certain Latin-American countries. The preliminary organization has been completed, and Mr. Bevan is now in the field starting two crews.

In the party are several well known foresters and botanists, including William R. Barbour, formerly Forest Supervisor of the Caribbean National Forest in Puerto Rico; L. R. Holdridge, formerly in charge of the Forest Management Division of the Tropical Forest Experiment Station and recently Forest Manager for Société Haitiano-Americaine de Developpement Agricole; Elbert L. Little Jr., a dendrologist in the Washington Office of the Forest Service; and José Marrero, Principal Biological Aide of the Tropical Forest Experiment Station.

COMMENTS ON THE SILVICULTURE OF CEDRELA

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Mr. Beard's summary of silvicultural troubles with Spanish cedar in Trinidad in the April issue was read with extreme interest not only because the material was well organized but also due to its treatment of a silvicultural subject of such vital interest to all Caribbean foresters. Reading the article has set my mind working once more on this extremely thought provoking problem and in my mind's eye I see again the hundreds of acres of Spanish cedar graveyards and infirmaries which are scattered through the West Indies.

Sitting here in the high mountains of Haiti with a heavy jacket on for warmth may or may not be conducive to the proper mental attitude for considering a tropical tree, but I would like to make a few notes and theorize a bit on the cedar question. I recognize only two species in the West Indies, Cedrela odorata L. and C. mexicana Roem., and although herbarium specimens might puzzle me, the two can readily be distinguished as trees even at some distance by the combination of a greater number of leaflets per leaf and smoother bark of C. mexicana. These characters must be accorded however, with the relative size or age of the tree. The two are so similar that silvicultural practices for one should fit the other.

Although I personally recommended discontinuation of planting of Cedrela in Puerto Rico, I am firmly convinced that the tree can be grown satisfactorily. But to do this, we will have to stop making plantations and make plantings instead, and discard all the meters and test-tubes for the time being in favor of some good logic and common sense until the problem is narrowed down sufficiently that such instruments may be employed with success. This statement implies no criticism of Trinidad's efforts as their forestry work is exceptionally sound and for 99 trees out of 100, their investigations, as carried out on Cedrela, would have cracked the problem. It just shows that Spanish cedar is the one tree in a hundred for which some radically new approach is necessary.

Let us forget for a moment our own respective islands or countries and look at the whole of the western hemisphere. Surprisingly, we find Cedrela (consider it one species or several depending on your school of thought), widely scattered, extending over a range far surpassing most other tropical American trees. This means that the tree is not very particular about macroclimatic factors or soil types. We have a wide range of conditions in which to plant the tree and correspondingly, plenty of space in each island or country where it should be possible to grow it successfully. But, when we make a plantation within the limits of this range we are almost certain to have a complete failure on our hands, a condition quite perplexing and very inconsiderate of the foresters. Maybe we had better look more closely at the tree in its natural habitat.

Cedrela is a prolific seeder with light, winged seeds readily transported by the wind over considerably distances. The seeds have a high germinative capacity, they germinate rapidly, the tree gets away fast and continues to grow as rapidly as most of its associates. With a horse of this color, in every race for the roof following the crash of a forest giant in natural woods, we ought to have one or more cedars place or be in the running for a long while. But we don't find that condition existing when we cruise natural forest. We might assume then that Cedrela, within the broad limits of its range, can only work up enthusiasm for survival and growth when it finds certain conditions together in particular spots. This theory of a happy combination of certain conditions or factors would seem to explain why only scattered trees are found in natural forest, why plantations as a whole are failures, and why research, in running down any one factor at a time, would give insignificant results. Also, there is a clue indicated for further probing, namely, that the factors for success which must be determined will be those which are not widespread and which could occur in different soil types and under different macroclimatic conditions. The need for a set of special site factors in combination is further borne out by observations in young plantations, where a tremendous difference in growth of individuals is observed up to the time when the whole plantation fails.

This all reminds me of something which may seem far-fetched, namely, black-snakes in southern Connecticut. In walking through the woods at random, I would suddenly become conscious that right before me was a certain combination of conditions which I immediately associated in my mind with a black-snake. There was the flat ledge on a sunny slope surrounded by brush and with plenty of loose rocks and crevices for a fast snake getaway, which, out of all the territory through which you could find the snakes, represented the particular spots where they were located. Isn't that just like Cedrela?

Now, to press the analogy beyond its limit, suppose we took a big square section of country in which we knew the black-snakes thrived, and then we tied out hundreds or thousands of snakes in geometrical lines. A few snakes would be happy and thrive because they happened to be located on the right spots but the majority, although all right for a while, would become increasingly morose and weakened until an epizootic or vermin, supposing there were such, would start spreading through the whole area. We all can imagine that such an affair would spread so thoroughly that no snake would be left healthy. But, whether or not such a fantasy has any connection with trees, we still continue to space out Cedrela evenly across the country.

My own recommendation would be to forget all about plantations of the tree and try instead to bring to maturity 5 trees per acre in every forest plantation within the range of Cedrela whose component species would not be incompatible with it. To produce an average of 5 mature trees, about 25 trees per acre should be planted a day or two before the other species are filled in, and these 25 seedlings should be planted on the most likely spots for their success. In subsequent examinations of the plantation, any cedar developing signs of disease or unthriftiness should be cut down immediately so as to remove it as a source of infection for the remaining thrifty trees. At best, the results of such a system would be a far cry from the always hoped for solid crops of Cedrela but, at any rate, one twentieth of a loaf would be better than none at all.

The only difficult part of such a system seems to be that of selecting the right spots, but with the pooling of our present knowledge, it really isn't very difficult to start, and the results of successive years of experience would give us an exact set of criteria. To begin with, we have to think back to all the thrifty cedars we have seen and combine that knowledge with the results of research in order to set up the specifications to be searched for before planting the trees.

I would look for a spot in full sunlight, where the soil is porous or well aerated, where the tree could, so to speak, keep its toes wet and its ankles dry, and where there is a rich soil or the topography is such that nutrients can be washed down to the growing tree. I have seen a planted tree in such a spot that reached 10 inches d.b.h. in 10 years time. Consider for a moment how well this combination explains the distribution of Cedrela in natural forest; it is only here and there that one can find such a set of conditions and yet they could occur over a wide range of forest types, soil types, geological types, etc. This probably would have been observed long ago in plantations if it were not for the fact that cedar is a sensitive tree and the buildup of insects and diseases on the hundreds of unthrifty trees was too much for the properly located trees to resist. At any rate, it is the only set of factors which I can connect consistently with thrifty cedars in all the places where they have been seen. Trinidad foresters have always pointed out the contrast between their unthrifty cedar plantations and the healthy individuals which came up in the hedge-rows along the highways. Yet the plantations would not qualify as to the above conditions whereas the cedars in the hedges usually bordered the road ditch which gave the proper moisture relation, if the soil itself were not porous then the proximity to the bank gave sufficient aeration, ditches or hedges make good catch-alls of rubbish for tree food whether thrown, blown or swept and, of course, there was plenty of sunlight. It is interesting to note the frequency of the bank-cedar combination in areas of heavy clay soil. In such areas in Puerto Rico, good cedar trees are almost invariably found on a bank of some sort, whether a road-fill bank, a trail bank, or a stream bank. In the case of the road or trail fill it is understandable that the soil would be more porous but with stream or other natural banks, there is probably sufficient movement and instability of the soil to give a satisfactory aeration equivalent to that of a soil porous by nature.

The full sunlight will be easy to find but I have mentioned that because of Hypsipyla grandella. It would seem silviculturally wise to plant under a shelter-wood to reduce the insect damage, but a glance at the color of the leaves coupled with the knowledge that the tree is deciduous would indicate the desirability of full sunlight. The combination of good thrifty trees and only a few per acre should eliminate the shoot-borer.

As for water and nutrients, by simply considering the fast growth of the tree as well as its thin, freely transpiring leaves, we can understand why the tree must take up plenty of water and nourishment through its roots. Sand culture studies of small seedlings might not be able to throw much light on the quantitative needs of a large tree.

But why the tree wants to be able to reach down to sufficient water while in leaf and yet have its roots well aerated is hard to explain. Evidently it is just the "nature of the beast". This, however, would be deduced from the Trinidad notes. The rotting roots indicate lack of aeration and this is further seconded by the tree's efforts to balance this by taking in more air through the bark, viz. the enlarged lenticels. In selecting a planting spot in a wet or humid type, it would not be necessary to put the tree on a bank above running water. A normally dry-ditch bank would provide the desired drainage-aeration relation and during drier periods there would be considerably more moisture available at the bottom of the ditch than in the ground above.

Well, anyway, I agree fully with Mr. Whitney's previous article in the Caribbean Forester, namely, "Isn't Research Fun?". I have thoroughly enjoyed developing these thoughts on cedar and whether or not the proposed system is the real solution, it should come much closer to the silvicultural truth than the previous pure plantation methods. Madame Cedrela is a temperamental lady, but we should be able to win her heartwood before too long.

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TRINIDAD LANDS ADVISORY COMMITTEE PROVES SUCCESSFUL

In a recent article "The Lands Advisory Committee of Trinidad" in the Empire Forestry Journal, R. L. Brooks, Trinidad's Conservator of Forests, describes a method of bettering and strengthening the land policies of various government agencies through the formation of a committee consisting of their directors. The success of this committee in improving land policies, as reported by Mr. Brooks, should be of considerable interest to members of government agencies in other countries.

The Trinidad committee is made up of representatives of all interests of land use and development, the Director of Agriculture, the Inspector of Mines, the Director of Works and Transport, and Sub-Intendant of Crown Lands, and the Conservator of Forests. As three members are also in the legislative Council, the committee has a strong influence.

One of the first recommendations of the committee greatly accelerated progress on the soil and vegetational survey being conducted by the Soil Department of the Imperial College of Tropical Agriculture. Another led to steps to prevent further clearing of steep unstable lands in the Northern Range. Other recommendations indicate that through such a committee greater recognition and appreciation of the relative importance of the various forms of land use, including forest, can be obtained.

LADY-BEETLES DON'T BEHAVE

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(A paper presented before a Joint Meeting of the Zoology and Forestry Sections of the Sociedad Americana de Ciencias Agrícolas.)

The misbehavior of lady-beetles, in eating what they want to, and not necessarily what the person responsible for their introduction from abroad wants them to, once again has been illustrated in Puerto Rico. That big, glossy-black hemispherical lady-beetle with a big red spot on each elytron, Chilocorus cacti L., ostensibly introduced into Puerto Rico to feed on the scale-insects infesting bamboo, may eat bamboo scales in captivity and under force of circumstance, but free and able to do its own choosing, finds the scales on papaya much more to its liking. Of all the lady-beetles ever introduced into Puerto Rico, just at present it is very much the most in evidence, having repeatedly been collected in cane fields, where there is nothing in particular for it to feed upon, and often noted as great aggregations of larvae or pupae on scale-infested papaya trees. Despite the desirability of the scales on papaya as food for these beetles, the naked trunk of the papaya offers no protection from the attack of lizards, and many a promising colony of lady-beetles has been wiped out by a single lizard living in or on a particular papaya.

Hardly a fence-post in Puerto Rico but serves a a look-out post for the big, crested brown lizard, Anolis cristatelus Dumeril & Bibron, and, from the standpoint of this lizard, the smooth, unbranched trunk of a papaya is almost as good as a fence-post as a base for foraging for insects. Adult scale-insects are immobile, as well as being too small to attract the notice of this lizard, and the crawling young are much too minute; but the lady-beetles and their larvae which feed on scale-insects are of a suitable size and move quite fast enough to attract the attention of the lizard, but not so fast as to escape capture.

Much better from the standpoint of protection against lizards is the common red-leaved hedging plant, Acalypha wilkesiana, which is also often heavily infested with the same grey scale, Pseudoparlatoria ostreata Cockerell, that occurs on papaya. Extensively planted on the grounds of the Agricultural Experiment Station at Río Piedras, a close examination of the bushes will show that, extensively infested with the scale-insects, they are harboring thousands of lady-beetles feeding on these scale-insects, and by their bushiness, protect the lady-beetles from lizard attack. Eventually, of course, when all the desirable scales have been eaten and are no longer available, the lady-beetles may go back to eating those on bamboo, but for the present they are doing very nicely on Acalypha.

A much earlier parallel instance was the introduction of Cryptolaemus montrouzieri Mulsant, ostensibly to control the mealy-bugs of sugar cane. In captivity in Puerto Rico, these beetles fed upon and thrived eating sugar cane mealybugs, but free and in the open, they were much too clever to seek out mealybugs snugly hidden under cane leaf-sheaths when an abundance of naked and unprotected mealybugs and fat green soft scale-insects awaited them on many another host. Not until an outbreak of Pulvinaria iceryi Guerin occurred on sugar-cane many years after their introduction were they ever seen in a cane field, and due to their fondness for this particular kind of soft green scale they promptly disappeared as soon as this outbreak was brought under control. Much more abundant in Puerto Rico, however, previous to the introduction of Cryptolaemus, was another soft green scale, Pulvinaria psidii Maskell, especially on trees of bucare, Erythrina glauca. These scales were so abundant on the avenues of bucare trees to the Experiment Station and to the cemetery of Rio Piedras as to cause a premature shedding of the leaves in early winter, and for months the trunks and branches would be naked and ghostly with the thick whitish festoons of excretions of the scales. The introduction of Cryptolaemus changed all that, and a few years later hardly a scale was to be found on this host. Now and then one still finds it on palo de muñeca, Rauwolfia tetraphylla, but almost invariably accompanied by Cryptolaemus. Now that these fat green scales have almost disappeared, Cryptolaemus beetles often feed on exposed mealybugs, but never yet have been found trying to get under the leaf-sheaths of sugar-cane to eat the mealybugs ensconced there.

It is fortunate for the survival of all of these introduced lady-beetles that they can eat some other kinds of scale-insect or mealybug than the particular one that they prefer, for too great specialization in food has most unfortunate results. Rodolia (Vedalia) cardinalis Mulsant feeds only on cottony cushion scale, Pulvinaria iceryi Maskell, and absolutely on not another insect present in Puerto Rico. It is altogether too effective in the control of this pest, and for the past year we have been unable to find the beetle at all, or even the scale in sufficient numbers to support even a very modest-sized colony of lady-beetles. Locally the lady-beetle has actually been almost starved out of existence by its own restricted diet. Eventually, a flare-up in cottony cushion scale may be anticipated. If any Rodolia beetles have survived by that time, of course they will bring this outbreak of cottony cushion scale under prompt control, but if none survive the present scarcity of their sole host, the only method of natural control will be to re-introduce the lady-beetle.

CATALOGUE DES CRYPTOGAMES VASCULAIRES DES ANTILLES FRANCAISES

H. Stehlé
Ingénieur Agricole et d'Agronomie Coloniale
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(Continued from previous number)

14. ADIANTUM (Tourn.) L.

75. Adiantum macrophyllum Sw. Prodr. 135 (1788). G. Duss n. 4350 et M. Duss n. 1711.
76. Adiantum phyllitidis J. Smith, in Hook. Lond. Journ. Bot. 1:197. (1842). G. (ex Christensen).
77. Adiantum obliquum Willd. Sp. Pl. 5:429 (1810). G. Duss n. 4253 et M. Duss n. 1710.
78. Adiantum petiolatum Desv. Ges. Naturf. Tround. Berlin Mag. 5:326 (1811), G. Duss n. 4256 et M. Duss n. 1712.
79. Adiantum pulverulentum L. Sp. Pl. 1096 (1753). G. Duss n. 4391 et M. Duss n. 4613.
80. Adiantum villosum L. Syst. Nat. ed. 10, 2:1328 (1759). G. Duss n. 4331 et M.S. n. 3401.
81. Adiantum latifolium Lamk. Encycl. I:43 (1783). G. S. n. 644, n. 1092, n. 1196, n. 1796, n. 1914 et M.S. n. 3308. Espèce rapportée par Urban, Symb. Ant. Fl. Port. Ric. 4:45 (1903) à A. denticulatum Sw.
82. Adiantum tetraphyllum Humb. et Bonpl.; Willd. Sp. Pl. 5:441 (1810), G. Duss n. 4327 et M. S. n. 2101, n. 2653 et n. 3263.
83. Adiantum cristatum L. Syst. Nat. ed. 10, 2:1328. (1759), G. Duss n. 4351 et M. Duss n. 1720.
84. Adiantum crenatum Willd. Spec. 5:446 (1810), G. (ex Fée) et M. (ex Plumier).
85. Adiantum concinnum Humb. et Bonpl.; Willd. Sp. Pl. 5:451 (1810), G. et M. (introduit).
86. Adiantum nigrescens Fée, Gen. Fil. 117 (1850-52), G. (ex Urban) et M. Duss n. 1709.
87. Adiantum Capillus - Veneris L. Sp. Pl. 1096 (1753), G. et M. S. n. 4164. (introduit).
88. Adiantum fragile Sw. Prodr. 135 (1788), G. Duss n. 4250, et M. S. n. 2093 et n. 2095.
89. Adiantum tenerum Sw. Prodr. 135 (1788), G.S. n. 1495, n. 2015 et M. Duss n. 1722, forma reducta, G.S. n. 1095.

15. DORYOPTERIS J. Smith

90. Doryopteris pedata (L.) Fée, Gen. Fil. 133 (1852), G. Duss n. 4188 et M. Duss n. 1552.

16. HYPOLEPIS Bernh.

91. Hypolepis repens (L.) Presl. Tent. Pter. 162 (1836), G. L'Herminier 1862, Duss n. 4235 et M. Hahn n. 61, Duss n. 1708. Forme monstrueuse, M. Duss n. 4679.

17. CHEILANTHES Sw.

92. Cheilanthes microphylla Sw. Syn. Fil. 127 (1806), G.S. n. 1798.
93. Cheilanthes elongata Willd. ex Kunze Enum. 213 (1824), G. (ex Urban). Considéré par Duss, Foug. et Lycop. Ant. fr. 65 comme var. elongata Willd. de C. microphylla Sw., G. Duss n. 4132 et n. 4231.

18. ADIANTOPSIS Fée

94. Adiantopsis radiata (L.) Fée, Gen. Fil. 145 (1852), G.S. n. 512, N. 812, et M. Duss n. 1706.

19. ANISOSORUS Trev.

95. Anisosorus hirsutus (L.) Underw. et Maxon, in Maxon, Pterid. Puerto Rico, Sc. Surv. P. R. 6:429 (1926), G.S. n. 87 et M. Hahn n. 17, Duss n. 1545.

20. HISTIOPTERIS (Ag.) J. Smith

96. Histiopteris incisa (Thumb.) J. Smith, Hist. Fil. 295 (1875), G. Husnot n. 292, S. n. 646 et n. 2423.

21. PTERIS (Tourn.) L.

97. Pteris longifolia L. Sp. Pl. 1074 (1753), G. ex Maxon et M. Duss n. 4128.
98. Pteris grandifolia L. Sp. Pl. 1073. (1753), G.S. n. 1466.
99. Pteris arborea L. Sp. Pl. I ed. 2, 1073 (1753), M. (ex Urban).
100. Pteris pungens Willd. Sp. Pl. 5:387. (1810). G. Duss n. 4192 et M. et Duss n. 1539. Espèce considérée parfois comme une simple variété de P. biauritum L., var. pungens (Willd. Spec. Pl. 5:380 (1810), M. (Plumier, Descr. 13:9 et Fil. 13:11.
101. Pteris quadriaurita Retz. Obs. Bot. 6:38 (1791). G.S. n. 2438 et M. (ex Maxon). Espèce de synonymie abondante et de relation confuse; elle a été rapportée par Kuhn, in Engl. Bot. Jahrb. 24:99 (1897) a P. biaurita L. dans une var. repandula (Link) Kuhn, adoptée par Urban, in Symb. Ant. Fl. Port. 4:48 (1903). P. repandula Link., Fil. Hort. Borol. 56 (1841) est un synonyme de P. quadriaurita Retz.
102. Pteris biaurita L. Sp. Pl. 1076. (1753), G. Duss n. 4193 et M. Duss n. 4585.
103. Pteris crassipes Agardh, Recens. Pterid. 59 (1839), M. (ex Maxon). Litobrochia Agardhii Fée, Foug. Ant. 25 (1866), de Guadeloupe et Martinique indiquée par Urban comme species dubia est probablement synonyme de cette espèce.
104. Pteris altissima Poir. in Lamk. Encycl. 5:722. (1804), G. et M. (ex Maxon). Pteris Kunzeana Agardh, Roc. Pter. 62 (1839) citée pour Guadeloupe par Urban n'est pas spécifiquement distinct de P. altissima Poir.
105. Pteris vittata L. Sp. Pl. (1753), G.S. n. 104, n. 645 et M.S. n. 4162.

106. Pteris multifida Poir. Encycl. 5:714 (1804), G.S. n. 2616. Espèce asiatique naturalisée, citée également par Jenman, Ferns Br. West Ind. and Guy. 119 (1909) pour la Martinique.

22. HEMIONITIS L.

107. Hemionitis palmata L. Sp. Pl. 1077. (1753), G.S. n. 88 et M.S. n. 4163.

23. PITYROGRAMMA Link.

108. Pityrogramma sulphurea (Sw.) Maxon, Contr. U. S. Nat. Herb. 17:173 (1913), G. Duss n. 4376.
109. Pityrogramma chrysophylla (Sw.) Link, Handb. Gewächs. 3:19 (1833), G.S. n. 248 et M.S. n. 2281. Var. Plumieriana Domin, Gen. Pityr. Clav. 6 (1928), a laquelle appartient Ceropteris Herminieri Link. est répandue aux Antilles françaises.
110. Pityrogramma calomelanos (L.) Link, Handb. Gewächs 3:20 (1833), G.S. n. 92, n. 105, n. 352, n. 2437 et M.S. n. 4165. Var. distans (Link.) Urban, Symb. Ant.Pterid. doming. 9:339 (1925), G. (ex Urban).
111. Pityrogramma tartarea (Cav.) Maxon, Contr. U.S. Nat. Herb. 17:173 (1913), G. Duss n. 4173 et M. Duss n. 1507.
112. Pityrogramma Schaffneri (Fée) Weatherby in Contr. Gray Herb. 114:25 (1936), G, et M. (ex Maxon).
113. Pityrogramma caribaea Domin, Gen. Pityr. Clav. 6, 7 (1928) existe également aux Antilles françaises (ex Domin) comme à la Dominique: G. Mazé et M. Sieber n. 237.

24. DIPLAZIUM Sw.

114. Diplazium plantaginifolium (L.) Urban, Symb. Ant. Fl. Porto R. 4:31 (1903), G.S. n. 1217, n. 1451 et M. Duss n. 1640.
115. Diplazium flavescens (Mett.) Christ, Farnkr. 217. (1897), G. (ex Urban).
116. Diplazium centripetale (Baker) Maxon, Pterid. Puerto Rico, Sc. Surv. P. R. 6:441 (1926), G. ex Fée et M. Duss n. 1646. Espèce homologue et souvent référée à D. coltidifolium Kunze, localisée au Nord d l'Amérique du Sud.
117. Diplazium arboreum (Willd.) Presl, Tent. Pterid. 114 (1836), G. Duss n. 4207 et M. Duss n. 4690.
118. Diplazium striatum (L.) Presl. Tent. Pterid. 114 (1836), G.S. n. 528, n. 828, n. 1190, n. 1452, n. 2425 et M. Duss n. 1631. Var. truncatum (Presl.) Hieron. in Hedwigia 59:328 (1917), G. et M. (ex Urban). Dáprés C. Christ. ne différe pas du type.
119. Diplazium L'Herminieri Hieron. in Urban, Symb. Ant. Fl. Porter. Add. et Corr. 4:648 (1911), G. (ex Hieronymus).
120. Diplazium Shepherdii (Spreng.) Link. Hort. Borol. 2:70 (1833). Cité pour la Guadeloupe et la Martinique par Urban, Symb. Ant. Fl. Porter. 4:32 (1903) et Pterid. doming. 9:325 (1925); considéré par Presl, Grisebach, Hooker et Baker ainsi que par Duss, G. n. 4218 et M. n. 1645, comme une espèce distincte de D. arboreum (Willd.) Presl, mais par

Hieronymus et par Maxon, Pterid. Porto Rico, Sc. Surv. P.R. 6:442 (1926), comme synonyme de cette dernière.

121. Diplazium trinitense Domin, Pterid. Dominica, 155 (1929), G. Mazé n. 420 623 (1881-32), est intermédiaire entre D. arboreum (Willd.) Presl et D. caracasanum Kunze.

25. ATHYRIUM Roth.

122. Athyrium conchatum Fée, Gen. Fil. 186 (1850-52). Cité par Kuhn pour la Guadeloupe ex Urban, Symb. Ant. 4, 31, parait être une des espèces énumérées de Diplazium, probablement D. l'Herminieri Hieron.

26. HEMIDICTYUM Presl.

123. Hemidictyum marginatum (L.) Presl. Tent. Pterid. III, pl. 3, f. 24 (1836), G.S. n. 93, n. 1776 et M.S. n. 3439.

27. ASPLENIUM L.

124. Asplenium serratum L. Sp. Pl. 1079 (1753), G. Duss n. 4203 et M. Duss n. 1641.

125. Asplenium dentatum L. Sp. Pl. 1080 (1753), G. Duss n. 4223.

126. Asplenium formosum Willd. Sp. Pl. 5:329 (1810), G. Duss n. 4202 et M.S. n. 2092.

127. Asplenium pumilum Sw. Prodr. 129 (1788), G. Duss n. 4201 et M. Duss n. 1639.

128. Asplenium cirrhatum Rich. ex Willd. Spec. Pl. 5:321 (1810), G. Duss n. 4002.

129. Asplenium Serra Langsd. et Fisch. Icon. Fil. 16, pl. 19 (1810), G.S. n. 90, n. 1440 et n. 1460.

130. Asplenium lactum Sw. Syn. Fil. 79, 271 (1806), G. Duss n. 4199 et M. Duss n. 1635. Espèce affine de A. resectum Smith, a laquelle Duss l'a rapportée.

131. Asplenium obtusifolium L. Sp. Pl. 1080 (1753), G. Duss n. 4205 et M. Duss n. 1636 b. Les plantes des Antilles françaises se classent dans la var. aquaticum basée sur A. aquaticum Kl. et Karst. de Colombie.

132. Asplenium pseudoerectum Hieron. Hedwigia 60:239 (1918), G.S. n. 1224, n. 1439 et M. Duss n. 4601. Les échantillons de Guadeloupe et de Martinique se rapportant à cette espèce ont souvent été identifiés avec A. pteropus Kaulf. Enum. Fil. 170 (1824), espece localisée au continent Sud-Américain, en particulier par Urban, Symb. Ant. 4, 34 (1903) et 9:328 (1925), Krug et Duss l'avaient considéreé comme la var. pterotus de l'A. lunulatum Sw., espèce continentale.

133. Asplenium abscissum Willd. Sp. Pl. 5:321 (1810), G.S. n. 1461 a et M. Duss n. 1637 b.

134. Asplenium salicifolium L. Sp. Pl. 1080 (1753), G.S. n. 245, n. 325; n. 334, n. 359, n. 536, n. 836, n. 1193, n. 1461 b, et M. Duss n. 1648, Hahn n. 21.

135. Asplenium harpeodes Kunze, in Linnaea 18:329 (1844), G. Duss n. 4214 et M. Duss n. 1647.

136. Asplenium auritum Sw. Journ. Bot. Schrad. 1800:52 (1801), G.S. n. 349 et M.S. n. 3267, n. 3300 et n. 3324, var. rigidum (Sw.) Hook. Spec. Fil. 3 (1860), G.S. n. 889, n. 1227 et n. 1230.

137. Asplenium fragrans Sw. Prodr. Fil. 130 (1788), G. Duss n. 4382 et M. (ex Duss).

138. Asplenium radicans L. Syst. Nat. ed. 10, 2:1323 (1759), G.S. n. 1462. Espèce parfois confondue avec A. flabellatum Kunze in Linnaea 9, 71 (1835).

139. Asplenium cristatum Lamk. Encycl. 2:310 (1786), G. Duss n. 4334 et M.S. n. 2094. Espèce souvent désignée par son synonyme A. cicutarium Sw. Prodr. 130 (1788).

140. Asplenium cuneatum Lamk. Encycl. 2:309 (1786)., G. Duss n. 4222 et M. Duss n. 1649.

Asplenium auriculatum Sw. in Vet. Acad. Handl. Stockh. 38:68 (1817).

Indiqué pour la Guadeloupe et la Martinique par Urban, Symb. Ant. 4:35 (1903), ainsi que A. Samanae Brause, Repert. Nov. Sp. Fedde, 18:247 (1922), ne paraissent que des variations de A. salicifolium L., espèce très polymorphe. Les petites formes de cette dernière espèce rencontrées aux Antilles françaises et à Puerto Rico devront être comparées, d'après Maxon, Pterid. Puerto Rico, Sc. Surv. P. R. 6, 450, avec A. hastatum Kl. et A. semicordatum Sw. D'apres Domin, Pterid. Dominica, 164 (1929), cette comparaison permettrait de conclure que les seuls spécimens de Mazé: n. 246, 317, 734, 781, de 1882,-85, de Guadeloupe représentent distinctement A. semicordatum Raddi, du Brésil et sont identiques à A. pimpinellifolium Fée et Schaffn.

28. STRUTHIOPTERIS Scop.

141. Struthiopteris polypodioides (Sw.) Trev. Atti Inst. Ven. 3. 14:571 (1869), M.S. n. 2106.

142. Struthiopteris exaltata (Fée) Broadhurst, Bull. Torrey Bot. Club, 39:264 (1912). G. L'Herminier 1863, Mazé n. 276 et M. Hahn n. 76.

143. Struthiopteris Plumieri (Desv.) Broadhurst, Bull. Torrey Bot. Club, 39 (1912), G. Mazé n. 861, Duss n. 4169 et M. S. n. 3312. Espèce basée sur Lomaria Plumieri Desv., non Hook et Bak. et souvent confondue avec L. divergens Kunze. La désignation de Blechum divergens (Kunze) Mett., pour les Petites Antilles, en particulier, in Urb. Symb. Ant. 4:40, 19 (1903) et 9:336 (1925), parait s'appliquer à cette espèce.

144. Struthiopteris L'Herminieri (Bory) Broadhurst, Bull. Torrey Bot. Club, 39:267 (1912) G. L'Herminier n. 99 ter, Mazé n. 95, n. 100, S.n. 1214 et M. (ex Broadhurst).

145. Struthiopteris violacea (Fée) Broadhurst, Bull. Torrey Bot. Club, 39:379 (1912), G. L'Herminier 1862, Mazé n. 86 et M. (ex Broad.)

146. Struthiopteris striata (Sw.) Broadhurst, Bull. Torrey Bot. Club, 39:375 (1912), G. L'Herminier 1862, S. n. 1116 et M.S. n. 4163.

29. BLECHNUM L.

147. Blechnum indicum Burn. Fl. Ind. 231 (1768). G. Duss n. 4379 et M. Duss n. 1901. Espèce souvent désignée par son synonyme Bl. serrulatum L. Cl. Rich. (1792).

148. Blechnum occidentale L. Sp. Pl. 1077 (1753), G.S. n. 345, n. 1213, n. 1913, n. 1920, n. 2417 et M.S. n. 3265.

149. Blechnum unilaterale Sw. Ges. Naturf. Freund. Berlin Mag. 4:79, pl. 3, f. I (1810). M. Duss n. 1702.

150. Blechnum fraxineum Willd. Spec. Pl. 5:413 (1810), M. Duss n. 1703. Espèce assez affine de Blechnum occidentale L.; citée par Domin, Pterid. Dominica, 186 (1929) pour la Guadeloupe (ex Duss) sous le synonyme de B. longifolium H.B.K., cela par erreur car Duss, Foug. Ant. fr. 88 (1903) précise bien qu'il ne l'a pas trouvée dans cette Ile.

30. SALPICHLAENA J. Smith

151. Salpichlaena volubilis (Kaulf.) J. Smith, Journ. Bot. Hook, 4:168 (1841), G.S. n. 640, n. 1215 et M. Duss n. 1700.

31. STENOCHLAENA J. Smith

152. Stenochlaena sorbifolia (L.) J. Smith, Journ. Bot. Hook. 4:149 (1841), G.S. n. 518, n. 519, n. 532, n. 818, n. 819, n. 832, n. 1447 et M. Duss n. 1611.

32. POLYBOTRYA Humb. et Bonpl.

153. Polybotrya cervina (L.) Kaulf. Enum. Fil. 55 (1824), G. Duss n. 4140 et M.S. n. 3437.

33. NEUROCALLIS Fée

154. Neurocallis praestantissima (Bory) Fée, Hist. Acrost., 89, t. 52 et Hist. Foug. et Lyc. Ant. 8 (1866), G.S. n. 520, n. 820 et M. Hahn 1868 s.n., Duss n. 1510.

34. LEPTOCHILUS Kaulf.

155. Leptochilus nitianaefolius (Sw.) C. Christ. Bot. Tidsskr. 26:285 (1904) G. Duss n. 4145 et M. Duss n. 1699. Espèce désignée récemment par Alston sous le nom de Bolbitis nicotianaefolia (Sw.) Alston.

156. Leptochilus cladorrhizans (Spreng) Maxon, Pterid. Puerto Rico, Sc. Surv. P. R., 6:460 (1926), G. et M. (ex Maxon).

157. Leptochilus alienus (Sw.) C. Christ. in Bot. Tidsskr. 26:285 (1904), G. Duss n. 4144 et M. Duss n. 1705.

35. CYCLOPELTIS J. Smith

158. Cyclopeltis semicordata (Sw.) J. Smith in Curtis, Bot. Mag. 72:36 (1846), G. Duss n. 4358.

36. POLYSTICHUM Roth.

159. Polystichum rhizophyllum (Sw.) Presl. Tent. Pterid. 82 (1836), G. (ex Maxon).

160. Polystichum andiantiforme (Forst.) J. Smith, Hist. Fil. 220 (1875). Signalé par Urban: Symb. Ant. 4, 25 (1903), pour la Guadeloupe d'après Fée, dans une variété.

37. DRYOPTERIS Adams.

161. Dryopteris opposita (Vahl) Urban, Symb. Ant. Fl. Portor. 4:14 (1903), G.S. n. 2432 et M.S. n. 3418.
162. Dryopteris panamensis (Presl.) C. Christ. in Viol. Selsk. Skr. 7:4, 292, fig. 19 (1907) est cité par Urban (1925) pour la Guadeloupe; très voisin de D. opposita (Vahl) Urban.
163. Dryopteris sancta (L.) Kuntze, Rev. Gen. Pl. 2:813 (1891), G.S. n. 467, n. 1446, n. 1762, n. 1862, n. 2065 et M. (ex Maxon).
164. Dryopteris concinna (Willd.) Kuntze, Rev. Gen. Pl. 2:812 (1891), G. (ex C. Christ).
165. Dryopteris consanguinea (Fée) C. Christ. Ind. Fil. G. Duss n. 4126 et M. Duss n. 1584. Le type de l'Aspidium consanguineum Fée (1866), base de l'espèce est de Guadeloupe.
166. Dryopteris Linkiana (Presl) Maxon, Journ. Wash. Acad. Sci. 14:199 (1924), G.S. n. 1453, n. 2430, n. 2433 et M. Kohaut in Sieber, Herb. Mart. Suppl. n. 65. Parmi les nombreux synonymes de cette espèce, il convient de remarquer: Phegopteris Duchassaingiana Fée (1866) et D. diplazioides (Desv.) Urban (1903) non Kuntze (1891).
167. Dryopteris gracilis (Hedw.) Domin, Pterid. Dominica, 210 (1929), G. Husnot n. 391. Syn.: D. consimilis (Fée) C. Christ.
168. Dryopteris Germaniana (Fée) C. Christ. Ind. Fil. 267 (1905), G. Duss n. 4067 et M. Duss n. 1560. Le type de cette espèce est un échantillon de Germain, collaborateur d l'Herminier, de la Guadeloupe.
169. Dryopteris Sprengelii (Kaulf.) Kuntze, Rev. Gen. Pl. 2:813 (1891), G.S. n. 1444 et M.S. n. 1039, n. 3276, n. 3277, n. 3280 et n. 3286. Espèce rapportée à Dryopteris Balbisii Urban, non Polypodium Balbisii Spreng. L'échantillon type est de la Martinique.
170. Dryopteris limbata (Sw.) Kuntze, Rev. Gen. 2:813 (1891), G. (ex Domin), M. (ex Krug).
171. Dryopteris decussata (L.) Urban, Symb. Ant. 4:19 (1903), G.S. n. 514 et M.S. n. 3293, n. 3435 et n. 3444.
172. Dryopteris gongylodes (Schkuhr) Kuntze, Rev. Gen. Pl. 2:811 (1891), G.S. n. 323, n. 639, n. 643 et M. Duss n. 1587.
173. Dryopteris dentata (Forsk) C. Christ. Dansk. Vidensk. Skrift. 8. Naturv. Afd. 6:24 (1920), G.S. n. 2431, n. 2435, n. 2436 et M.S. n. 3272, n. 3302, n. 3305 et n. 3307.
Espèce souvent désignée par D. parasitica Kuntze (1891), synonyme invalidé, non Polypodium parasiticum L. (1753). Récemment dénommée par Alston: D. quadrangularis (Fée) Alston, in Pterid. St. Kitts, Journ. Bot. 75:253 (1937). W. H. Hodge, in Notes of Dominica Ferns, Amer. Fern. Journ. 31:3-4, 121 (1941) a démontré l'invalidité de ce binome et la grande variabilité de D. dentata (Forsk.) C. Christ.

174. Dryopteris patens (Sw.) Kuntze, Rev. Gen. Pl. 2:813 (1891), G.S. n. 100 et M. Duss n. 4583.

175. Dryopteris Sloanei (Bak.) Kuntze, Rev. Gen. Pl. 2:813 (1891), G. Duss n. 4061.

176. Dryopteris normalis C. Christ. Ark. för Bot. 9:31 (1910), M.S. n. 2254.

177. Dryopteris Poiteana (Bory) Urban, Symb. Ant. Fl. Portor. 4:20 (1923), G. S. n. 209 et M. Duss n. 4118. Var. Rivoirei (Fée) Domin de cette espèce (Goniopteris Rivoirei Fée, 1850), G. Mazé n. 1065, M.Mme Richard-Rivoire n. 164.

178. Dryopteris subtetragona (Link) Maxon, Pterid. Puerto Rico, Sc. Surv. P. R. 6:473 (1926), G.S. n. 641, n. 1198, n. 2529 et M.S. n. 2096 et n. 3270. C'est l'espèce désignée par Urban, Symb. Ant. Fl. Portor. 4:20 (1903) par D. tetragena (Sw.) Urban (1903), non Kuntze (1891) et qui est basée sur Polypodium tetragonum Sw. (1788), non Nephrodium tetragonum Presl (1825). Var. guadalupensis nov. (Goniopteris guadalupensis Fée) existe à la Martinique et à la Guadeloupe.

179. Dryopteris domingensis (Spreng.) Maxon, Pterid. Puerto Rico, Sc. Surv. P.R. 6:474 (1926), G. Duss n. 4059 et M. Duss n. 4389. Espèce souvent désignée par son synonyme: D. scolependrioides C. Christ. (1905), non Kuntze (1891).

180. Dryopteris reptans (Gmel.) C. Christ. Ind. Fil. 288. (1905), G. l'Herminier 1862, in herb. Fée n. 128. L'espèce de Guadeloupe se réfère à la var. tenera C. Christ. in Vid. Selsk. Skr. 7:10, 219. (1913).

181. Dryopteris guadalupensis (Fée) Kuntze, Rev. Gen. Pl. 2:812. (1891), G. S. n. 1454 et M.S. n. 3323. Espèce désignée aussi sous le nom de D. nephrodioides Klotzsch. forma guadalupensis (Fée) C. Christ., basée sur Nephrodium guadalupense Fée, Mém. Foug. II:89, pl. 24, f.3 (1866).

182. Dryopteris hastata (Fée) Urban, Symb. Ant., Fl. Portor. 4:21 (1903), G. Duss n. 4115 et M. Duss n. 4146.

183. Dryopteris megalodus (Schkuhr) Urban, Symb. Ant., Fl. Portor. 4:21 (1903) G. Duss n. 4110 et M. Duss n. 1585.

184. Dryopteris leptocladia (Fée) Maxon, Pterid. Puerto Rico, Sc. Surv. P. R. 6, 476 (1926), G. Duss n. 4116 et M. Duss n. 4117.

185. Dryopteris pyramidata (Fée) Maxon, Contr. U.S. Nat. Herb. 10:489 (1908), G. Duss n. 4115 et M. (ex Maxon).

186. Dryopteris serrata (Cav.) C. Christ. Ind. Fil. 291. (1905), G. Duss n. 1612.

187. Dryopteris reticulata (L.) Urban, Symb. Ant. Fl. Portor. 4:22 (1903), G.S. n. 511, n. 526, n. 654, n. 811, n. 826, n. 1066, n. 1096, n. 1876, n. 1919 et M.S. n. 3264 et n. 3315.

188. Dryopteris meridionalis (Poir.) C. Christ. in Vid. Selsk. Skr. 8:46 (1920), G. (type ex Christ.) et M. (ex Christ.)

189. Dryopteris excelsa (Desv.) C. Christ. Ind. Fil. 264 (1905) et in Vid. Selsk. Skr. 8:54 (1920), G. et M. (ex Christensen).

190. Dryopteris subincisa (Willd.) Urban, Symb. Ant. Fl. Portor. 4:19 (1903); G. et M. S. n. 3325. L'Alsophila martinicensis Spreng. Neu. Entd. 3:7 (1822), n'est autre que cette espèce, ainsi que le Phegopteris martinicensis Fourn. Mex. Pl. 5:90. (1872).

191. Dryopteris macrotheca (Fée) C. Christ. Ind. Suppl. 35 (1913), G. (ex Urban).
192. Dryopteris effusa (Sw.) Urban, Symb. Ant. Fl. Portor. 4:16 (1903), G. et M. (ex Urban).
193. Dryopteris protensa (Afz.) C. Christ. var. funesta (Kunze) C. Christ. Ind. 286 (1905), G. et M. (ex Urban).
194. Dryopteris l'Herminieri (Kunze) C. Christ. Ind. Fil. 275 (1905). G.S. n. 1220, n. 2109 et M.S. n. 3402, n. 3408 et n. 3420. Le type de cette fougère est de la Guadeloupe. Elle a été rapportée par divers auteurs et par Urban, Symb. Ant. 4:13 (1903) à D. trichophora (Fée) Kuntze, à considérer comme synonyme.
195. Dryopteris extensa (Bl.) Kuntze, loc. cit., M.S. n. 3260.
196. Dryopteris pubescens (L.) Kuntze, Rev. Gen. Pl. 2:813. (1891). Var. sericea (Mett.) Urban, Symb. Ant. Fl. Portor. 4:15 (1903), M. Duss n. 4690. Var. muscosa (Vahl) Urban, Symb. Ant. Fl. Portor. 4:16 (1903), G. et M.S. n. 3282.
197. Dryopteris retundata (Willd.) C. Christ. Ind. Fil. 289 (1905), G.S. n. 1104, n. 1463, n. 1887 et M. Hahn n. 37, S. n. 3303 et n. 3436.
198. Dryopteris glandulosa (Desv.) C. Christ. Mon. Dryopt. I:171 (1913), non Kuntze, G.S. n. 530, n. 830, n. 1200, n. 1442, n. 1455 et M.S. n. 2105, n. 3417 et n. 3438.
199. Dryopteris mollicella Maxon in Proc. Biol. Soc. Wash. 36:49 (1923). G. S. n. 1443, n. 1857, n. 2427 et n. 2434. Espèce considérée jusqu'à présent comme endémique de la Dominique (Cft. Domin, Pterid. Dominica, 199 (1929).
200. Dryopteris rustica (Fée) C. Christ. Ind. Fil. 290 (1905). G. S. n. 1759, n. 2426, n. 2428, n. 2434 a, et M. Duss n. 4580. D. dominicensis C. Christ doit être considéré comme synonyme de cette espèce (W. H. Hodge) Notes on Dominica Ferns, in Amer. Fern. Journ. 31, 3-4, 122 (1941).
201. Dryopteris hydrophila (Fée) C. Christ. Ind. Fil. 271 (1905). G. S. n. 1445 et M. S. n. 2429. Espèce rare basée sur Phegopteris hydrophila Fée (1866) de Guadeloupe.
202. Dryopteris deltoidea (Sw.) Kuntze, Rev. Gen. Pl. 2:812 (1891), G. (ex Hooker).
203. Dryopteris asplenioides (Sw.) Kuntze, Rev. Gen. Pl. 2:812 (1891). Var. subpinnata (Mett.) Urban, Symb. Ant. Fl. Portor. 4:18 (1903), G. et M. Forma exindusiata (Kuhn) Urban, Symb. Ant. Fl. Portor. 4:18 (1903), G. var. pinnata (Mett.) Urban, Symb. Ant. Fl. Portor. 4:18 (1903), G. (ex Urban).

38. TECTARIA Cav.

204. Tectaria plantaginea (Jacq.) Maxon, Contrib. U.S. Nat. Herb. 10:494 (1908), G.S. n. 85, n. 1218 et M.S. n. 3304.
205. Tectaria heracleifolia (Willd.) Underw. Bull. Torrey Bot. Club. 33:200 (1906), G. Duss n. 4049 a et M. Duss n. 4683.
206. Tectaria martinicensis (Spreng.) Copel. Philippine Journ. Sci. Bot. 2:410 (1907) G. et M. S. n. 2253, n. 3306 et n. 3400.

207. Tectaria trifoliata (L.) Cav. Descr. Pl. 249 (1802), G.S. n. 86, n. 1060, n. 1197 et M.S. n. 3301. L'Aspidium Plumierii Presl, cité par Urban, Symb. Ant. Fl. Portor. 4:23 est Tectaria Plumierii Copel. Philippine Journ. Sci. Bot. 2:410 (1907), espèce considérée par Urban comme distincte d'Aspidium trifoliatum (L.) Sw. = T. trifoliata (L.) Cav., mais placée par Maxon, Pterid. Puerto Rico, Sc. Surv. P. R. 6:482 (1926), comme synonyme invalidé de cette dernière.

39. OLEANDRA Cav.

208. Oleandra articulata (Sw.) Presl. Tent. Pterid. 78 (1836), G. L'Herminier n. 162, Duss n. 4161 et M. Duss n. 4587.

40. NEPHROLEPIS Schott.

209. Nephrolepis cordifolia (L.) Presl. Tent. Pterid. 79 (1836), M.S. n. 3396. Espèce nouvelle pour les Antilles françaises.

210. Nephrolepis exaltata (L.) Schott, Gen. Fil. pl. 3 (1834), G. et M. (ex Urban).

211. Nephrolepis rivularis (Vahl) Mett.; King, Bot. Jahrb, Engler 24:122 (1897), G.S. n. 101, n. 358, n. 1435 et M.S. n. 3298 et n. 3330.

212. Nephrolepis biserrata (Sw.) Schott, Gen. Fil. pl. 3 (1834), G.S. n. 504, n. 2059 et M.S. n. 3271, n. 3278 et n. 3851.

213. Nephrolepis Duffii Hort., G.S. n. 344, et M. S. n. 4171.
Cultivée et subspontanée; considérée comme une forme ornementale de N. cordifolia (L.) Presl, par Bailey, Cyclop. 2:2132.

41. ODONTOSORIA (Presl) Fée

214. Odontosoria flexuosa (Spreng.) Maxon, Stud. trop. amer. ferns, in Contr. U. S. Nat. Mus. 17, 2:163 (1913), G. Duss n. 4238 et M. Sieber n. 23 (type) et Duss n. 4238. C'est l'espèce rapportée par Urban, Symb. Ant. 4:29 (1903) a O. aculeata (L.) Smith, qui est localisée aux Grandes Antilles et nettement distincte.

42. LINDSAEA Dryand.

215. Lindsaea montana Fée, Mém. Foug. II:17, pl. 6, fig. 2 (1866), G.S. n. 521, n. 821, n. 1219 et n. 2419.
Indiqué par Urban, Symb. Ant. 4:31 (1903) sous le nom de L. quadrangularis Raddi, à réserver pour les fougères voisines du continent américain.

216. Lindsaea lancea (L.) Bedd. Ferns Br. Ind. Suppl. 6 (1876), G. Duss n. 4240, n. 4241 et M. Duss n. 1707. Syn. Lindsaea trapeziformis Dry. (1797).

217. Lindsaea L'Herminieri Fée, Hist. Foug. et Lycop. Ant. 15, t. 6, fig. 1 (1866), G. L'Herminier 1862, A. Fée n. 43, Duss n. 4237.

43. SACCOLOMA Kaulf.

218. Saccoloma domingense (Spreng.) Prantl, Arb. Bot. Gart. Breslau I:21 (1892), G.S. n. 1216 et M. (ex Maxon).
219. Saccoloma inaequale (Kunze) Mett. Ann. Sci. Nat. 4, Bot. 15:80 (1861), G.S. n. 1465 Var. Galeottii (Fée) Hieron. in Urban, Symb. Ant. Pterid. Doming. 9:318 (1925), G. (ex Fée) et M. (ex Urban).
220. Saccoloma Imrayana Kunze, Hook. Gen. Fil. t. 58B, nom. nud. (1839), Kunze, Farrnkr. 1:86 (1842) et Mett. Ann. Sci. Nat. 4 (1861), G. Duss n. 4176.

44. DENNSTAEDTIA Bernh.

221. Dennstaedtia ordinata (Kaulf.) Moore, Ind. Fil. 306 (1857), G. Duss n. 4179 et M.S. n. 2102. Espèce désignée par Urban, Symb. Ant. 4:30 sous le nom de D. dissecta (Sw.) Moore, basé sur Dicksonia dissecta Sw. appliqué primitivement à des espèces jamaïquaises et synonyme de D. cornuta (Kaulf.) Moore, du continent Centre et Sud-américain.
222. Dennstaedtia Plumieri Hook. Spec. Fil. 1, 72 (1844). G. Duss n. 4342 et M. Duss n. 1680.
223. Dennstaedtia adiantoides (Humb. et Bonpl.) Moore, Ind. Fil. 97 (1857), G. Duss n. 4841.
224. Dennstaedtia cicutaria (Sw.) Moore, Ind. Fil. 97 (1857), G. Duss n. 4184 et M. Duss n. 1686. Espece souvent confondue avec D. ordinata (Kaulf.) Moore.
225. Dennstaedtia incisa (Fée) Kuhn in Linnaea 34:146 (1869), G.S. n. 1464 et M. Duss n. 1685. Espèce basée sur Dicksonia incisa (Fée), Hist. Foug. et Lycop., Ant. 14, t. 25, f. I. (1866) sur une plante de Guadeloupe: L'Herminier 1862, A. Fée n. 172 et considérée par Baker et par Duss comme une simple varieté de D. cicutaria (Sw.) Moore.

Famille 5. HYMENOPHYLLACEAE

1. TRICHOMANES L.

1. Trichomanes sphenoides Kunze, Linnaea 9:102 (1834); Farrnkr. I:215, pl. 88 (1846) G. Duss n. 4419 et M. Duss n. 4704.
2. Trichomanes punctatum Poir. in Lamk. Encycl. 8:64 (1808), G.S. n. 659 et M. Duss n. 4689.
3. Trichomanes pusillum Sw. Prodr. 136 (1788); Fl. Ind. Occ. 3:1729 (1806), G. Duss n. 4420 et M. Duss n. 4160, n. 4578 et n. 4609.
4. Trichomanes Kraussii Hook et Grev. Icon. Fil. 2: pl. 149 (1831). G.S. n. 503 et M. Duss n. 1560.
5. Trichomanes membranaceum L. Sp. Pl. 1097 (1753), G.S. n. 513, n. 515, n. 522, n. 813, n. 815, n. 822 et M.S. n. 3427.
6. Trichomanes Hookeri Presl, Abh. Böhm. Ges. Wiss. 5:3:108 et Hymen, 16. (1843), G.S. n. 662 et M. Duss n. 1636. Souvent désigné sous le binôme de T. muscoides Hook et Grev. (1830), non

Sw. (1801). La var. angustifrons (Fée) Duss (et non angustifolium Fée comme le rapporte par erreur Domin, Pterid. Dominica, p. 47) est synonyme de T. pusillum Sw.

7. Trichomanes pinnatum Hedw. Fil. Gen. Sp. pl. 4. f. I. (1799), G. Duss n. 4287 et M. Duss n. 1528.

Trichomanes Kaulfussii Hook. et Grev. Icon. t. 10 (1830) cité par Duss, Foug. Ant. fr. 16 (1903), comme espèce différente de T. pinnatum Hedw. est synonyme de cette dernière.

8. Trichomanes polypodioides L. Sp. Pl. 1098 (1753), G. Duss n. 4286 et M. Duss n. 1524. Espèce souvent désignée par son synonyme T. sinuosum L. Cl. Rich. in Willd. Sp. Pl. 5.I:502 (1810), en particulier par Lamk. Illustr. t. 871, f.I; Griseb. Flor. 654; Hook. et Grev. Icon. t. 13; Hook. et Bak. Syn. Fil. 2 ed. 78; Duss, Foug. et Lycop. Ant. fr. 16 (1903) et Urban, Symb. Ant. 4:6 (1903).

9. Trichomanes holopterum Kunze, Farrnkr. I:185, pl. 77, f.2 (1845), G. Duss n. 4275 et M. (ex Maxon). Rapporté par Duss sous le synonyme de T. Bancroftii. Le T. L'Herminieri Fée, Hist. Foug. et Lyc. Ant. 107, t.29, fig. 1 (1866) est la var. L'Herminieri (Fée) Domin, Pterid. Dominica, 49. (1929) de T. holopterum, G. (ex Fée).

10. Trichomanes accedens Presl, Epim. 14 (1849), G. (ex Van den Bosch), et M. (ex Fée). Var. procerum (Fée) Domin, Pterid. Dominica 53 (1929), G. L'Herminier.

11. Trichomanes crispum L. Sp. Pl. 1097 (1753), G.S. n. 1459 et M. Duss n. 1522. Forma remotum Fée, Hist. Foug. et Lycop. Ant. 105 (1866), G. L'Herminier n. 192, 1862.

12. Trichomanes pellucens Kunze in Linnaea 9:104 (1834), M. (ex Urban). Syn.: T. fastigiatum Sieber (1843).

13. Trichomanes alatum Sw. Journ. Bot. Schrad. 1800: 2, 97 (1801) et Fl. Ind. occ. 3:1732. (1806), G.S. n. 91, n. 354, n. 535, n. 835, n. 1775, n. 2051, n. 2067 et M.S. n. 3320 et n. 3415. Domin, Pterid. Dominica, 51 (1929) distingue plusieurs variétés dont var. ptilodes (V. d.B.) Dom., M. et var. attenuatum (Hook) Dom. G.

14. Trichomanes crinitum Sw. Prodr. 136 (1788) et Flor. Ind. Occ. 3:1730, G. Duss n. 4293.

15. Trichomanes rigidum Sw. Prodr. 137 (1788), G.S. n. 1422 a, n. 1779 et M. Duss 1529.

Trichomanes Krugii Christ. Bot. Jahrb. Engler 24:90 (1897), décrit dans Duss Foug. Ant. fr. 14 (1903) pour la Martinique, Duss n. 4677, comme espèce distincte de T. rigidum Sw. n'en est pas spécifiquement distinct.

16. Trichomanes radicans Sw. Journ. Bot. Schrad. 1800:97 (1801), et Fl. Ind. Occ. 3:1736 (1806), G. Duss n. 4289 et M. Duss n. 1537.

17. Trichomanes hymenophylloides v.d.B. Nederl. Kruidk. Arch. 5:209 (1863). G.S. n. 1421 d et M.S. n. 2103. Confondu par Hook. et Grev. Icon. Fil. 2:pl. 206 (1831) par Duss, Foug. Ant. fr. 13 (1903) et par Urban, Symb. Ant. 4:7 (1903), avec T. pyxidiforum L. Spec. Pl. I ed. 2, 1098 (1753), espèce distincte.

18. Trichomanes elegans L. Cl. Rich. in Act. Sec. Hist. Nat. Paris I:114 (1792), G.S. n. 523, n. 823, n. 1225, n. 1888 b, et M. Duss n. 1530. T. anceps Hook. (1846) est synonyme. Duss a rapporté ses échantillons à T. Prieurei Kunze, espèce affine continentale.

19. Trichomanes osmundioides Sw. Prodr. (1788) et DC. ex Poir. Encycl. 8:65 (1808), G.S. n. 1888 c et M.S. n. 3421.

20. Trichomanes trigonum (Desv.) Kaulf. Enum. Fil. (1824), G.S. n. 1458, n. 2421 et M.S. n. 3406 et n. 3411. Syn. T. Kaulfussii Hook. et Grev. (1831).

2. HYMENOPHYLLUM J.E. Smith

21. Hymenophyllum delicatissimum Fée, Cryp. vasc. Brésil 2:83, t. 105, fig. I (1872-73), G. (ex Fée).

22. Hymenophyllum crispum H.B.K. Nov. Gen. et Spec. I:26 (1815), G. (ex Maxon).

23. Hymenophyllum macrothecum Fée, Mém. Foug. Ant. II:115, pl. 31, f.2 (1866), G. Duss n. 4402. Syn. H. vincentinum Baker (1891).

24. Hymenophyllum Francavillei v.d.B. in Nederl. Kruidk. Arch. 4:411 (1859) G. Duss n. 4272 et M.S. n. 2248.

25. Hymenophyllum interruptum Kunze in Linnaea 9:107 (1834), G. Duss n. 4270 et M. Duss n. 4374.

26. Hymenophyllum L'Herminieri Mett. ap. Kuhn, in Linnae 35:392 (1868), G. (ex Mattennius).

27. Hymenophyllum polyanthos Sw. Journ. Bot. Schrad. 1800:102 (1801), G.S. n. 324, n. 1201, n. 1421c, n. 1780a, n. 1786, n. 1790 et M.S. n. 3273a et n. 3228.
Espèce variable, polymorphe et de synonymie abondante et délicate, pour laquelle H. clavatum Sw. (1800) et H. polyanthos var. clavatum (Sw.) Hook. (1846) sont des synonymes. Duss, Foug. et Lycop. Ant. fr. 6. 1903 cite en outre une var. Blumeanum Spreng. de cette espèce et H. Mazei Fournier et Mazé qui ne sont que des formes écologiques de H. polyanthos Sw.

28. Hymenophyllum Kohautianum Presl. Hymenoph. 32 et 56 (1843), G. et M. (ex Urban). Espèce très affine de P. polyanthos Sw. et désignée aussi comme var. Sieberianum Presl, de H. decurrens Sieber.

29. Hymenophyllum lineare Sw. Journ. Bot. Schrad. 1800:100 (1801) et Fl. Ind. Occ. 3:1749 (1806), G.S. n. 1422 b, n. 1778 et n. 1780 b. H. catherinae Hook. (1867) considéré par Duss, Foug. et Lycop. Ant. fr. 7 comme espèce distincte n'est pas spécifiquement différent de H. lineare Sw. Var. Dussii Christ, in Duss, Foug. et Lycop. Ant. fr. 9 (1903), G. Duss n. 4267, type et M. Duss n. 1519 a.

30. Hymenophyllum lanatum Fée Mém. Foug. Ant. 116, t. 31, fig. 3 (1866), G. Duss n. 4247 et n. 4364.

31. Hymenophyllum ciliatum Sw. Journ. Bot. Schrad. 1800:2,100 (1801) et Fl. Ind. Occ. 3:1755 (1806), G.S. n. 1222 et M. Duss n. 1516.

32. Hymenophyllum sericeum Sw. in Journ. Bot. Schrad. 1809:2, 99 (1801), G. Duss n. 4266 et M. Duss n. 1517.

33. Hymenophyllum hirsutum (L.) Sw. in Journ. Bot. Schrad. 1800:2, 99 (1801) et Fl. Ind. Occ. 3:1746 (1806), G. Duss n. 4267 et M. Duss n. 1519 a.

34. Hymenophyllum hirtellum Sw. Syn. Fil. 149, G.S. n. 328, n. 1421 b, n. 1888a, n. 2412 et M. Duss n. 1514.

35. Hymenophyllum latifrons v.d.B. Hymen. 67 (1859), G. Duss n. 4247, n. 4265, n. 4361 et M. Duss n. 1519. Considéré par Duss (Foug. Ant. fr. 10, 1903) comme H. hirsutum Sw. var. latifrons Hook. et Bak. mais démontre distinct par W. H. Hodge (1941).

36. Hymenophyllum gratum Fée, Hist. Foug. et Lycop. Ant. 3118, t.30, fig. I (1866). G.S. n. 2052 et M.S. n. 2097, n. 2107a, n. 2655 et n. 3405.

37. Hymenophyllum fucoides Sw. Fl. Ind. Occ. 3:1747 (1806), G.S. n. 531, n. 831, n. 1521 a, n. 1780 b, n. 2107 b et M. Duss n. 1512, n. 1515, n. 1518 et n. 4603.

38. Hymenophyllum Plumieri Hook. et Grev. Ic. Fil. (1831), M.S. n. 3273 b et n. 3446. Espèce parfois confondue à tort avec H. ciliatum Sw.

39. Hymenophyllum ectocarpon Fée, Hist. Foug. et Lycop. Ant. 115, t. 31, f. I, G. (ex Fée). Considéré par Duss, Foug. et Lycop. Ant. fr. 7 (1903) comme synonyme de H. fucoides Sw. auquel il est étroitement allié, mais différent de ce dernier ainsi que l'a montré W. H. Hodge in Notes on Dominica Ferns, Amer. Fer. Journ. 31, 3-4, 125 (1941).

Ordre IV. S A L V I N I A L E S

Famille 1. MARSILEACEAE

MARSILEA L.

1. Marsilea Berteroi A. Br. Monatsb. Preuss. Akad. Wiss. Berlin 1870:747 (1870). Indiqué avec doute par Urban, Symb. Ant. 4:65 pour la Martinique d'après un échantillon de Plée probablement de Puerto Rico. Nous avons recherché en vain cette espèce à la Martinique, à la Guadeloupe et dans les dépendances au voisinage des lagunes, des marécages et du littoral, au cours de ces 8 dernières années.

Ordre V. L Y C O P O D I A L E S

Famille 1. LYCOPODIACEAE

1. LYCOPODIUM L.

1. Lycopodium reflexum Lamk. Encycl. 3:653 (1789), G. Duss, n. 2748 et M. S. n. 3279. Considéré par Duss, Lycop. 8 (1903) comme var. reflexum de L. rigidum Sw. et comme synonyme de L. Sieberianum Spring; espèces nettement distinctes.

2. Lycopodium rigidum Gmel. Syst. 2:1289 (1791), Cond. in Dill. t.57, Fig. 4, G. (ex Urban).

3. Lycopodium Sieberianum Spring. in Bot. Zeit. I:153 (1838) et Monogr. Lycop. I:23 (1842), G.S. n. 330, n. 1801, n. 2410, n. 2414 et M.S. n. 1054, n. 2656 et n. 3289.

4. Lycopodium setaceum Lamk. Encycl. 3:653 (1789), G.S. n. 516, n. 816, n. 1186 et M.S. n. 2099, n. 2381, n. 2386, n. 3275, n. 3409 et n. 3445. C'est l'espèce rapportée par Urban et par Duss à L. verticillatum L. f., le correspondant de L. setaceum pour les régions tropicales d'Asie et d'Afrique.

5. Lycopodium Wilsoni Underw. et Lloyd, Bull. Torrey Bot. Club, 33:III (1906), G. (ex Maxon).

6. Lycopodium funiforme Cham. ex Bory, in Brogn. Hist. Vég. Foss 2:10, 18, pl. 7, fig. 9 (1837), G. Duss n. 3744 et M. Duss n. 1601. Syn. L. colubrinum l'Herm.

7 Lycopodium tenuicaule Underw. et Lloyd. Bull. Torrey Bot. Club, 33:113 (1906), G.S. n. 543, n. 843, n. 1183, n. 1425, n. 1426, n. 1427 et n. 1785.

8. Lycopodium mollicomum Spring in Mart. Flor. Brasil. I, I:113, 1840 et Monogr. Lycop. I, 42 (1849), M. Duss n. 1589.

9. Lycopodium linifolium L. Sp. Pl. 1100 (1753), G.S. n. 510, n. 660, n. 810 et M.S. n. 2380 et n. 3284.

10. Lycopodium guatemalense Maxon in Contr. U.S. Nat. Herb. 17:177, t.9, fig.a (1913), G. Duss n. 3976.

11. Lycopodium dichotomum Jacq. Enum. Stirp. Vind. 314 (1762), G.S. n. 339, n. 1184, n. 1185, n. 1226, n. 1438, n. 1977 et M.S. n. 1053, n. 3318 et n. 3319 b.

Lycopodium mexicanum Herter in Engl. Jahrb. 43, Beibl. 98:49 (1909), M. (ex Urban) n'est considéré par Maxon que comme synonyme de L. dichotomum Jacq.

12. Lycopodium taxifolium Sw. Prodr. 138 (1783) et Fl. Ind. Occ. 3:1753 (1806), type G.S. n. 661, n. 1423, n. 1428, n. 1792, n. 1800, n. 2062 et M.S. n. 2659, n. 3295, n. 3319 a, n. 3332, n. 3432 et n. 3433. Var. passerinoides (H.B.K.) Bak. Fern. All. 16 (1887). Syn.: L. passerinoides H.B.K. Nov. Gen. I:41 (1815), L. Schwendenerii Herter, Bot. Jahrb. Engler 43: Beibl. 98:50 (1909) et Urostachys Schwendenerii Herter, Report. Nov. Spec. Fedde 19:162 (1923). G.S. n. 1424 et M. Duss n. 4167.

13. Lycopodium guadalupeanum Spring, Mem. Acad. Sci. Belg. 15, 6:68 (1842), errore typogr. sub. L. aqualupiano, G.S. n. 1783, n. 2409 et M. Duss n. 1588.

14. Lycopodium meridionale Underw. et Lloyd, Torrey Bot. Club. 33:121 (1906), G.S. n. 883 et n. 1866. Espèce primitivement rapportée par Duss et par Urban a L. carolinianum L. Pl. I, ed. 2, 1104 (1753).

Lycopodium curvatum Sw. Journ. Bot. Schrad. 1800, 2:116 (1801.) Indiqué par Fée et par Urban pour la Guadeloupe où nous ne l'avons pas trouvé. Pout être confondu avec L. cernuum L., duquel Grisebach Fl. Brit. 647. (1864) ne fait qu'une; variété; la plupart des spécimens des Petites Antilles rapportés a cette espèce serait, d'après Maxon, L. tortum Sieber et le L. curvatum Sw. serait endémique de P. Rico.

15. Lycopodium cernuum L. Sp. Pl. 1103 (1753); G.S. n. 340, n. 517, n. 817, n. 890, n. 1059, n. 1429, n. 1795 et M.S. n. 3269. La Var. Dussii Christ de cette espèce, ex Duss, Lycop. Ant. fr. 6 (1903), G. Duss n. 3639, n. 4105 et M. Duss n. 4166, n'est autre que L. tortum Sieber.

16. Lycopodium tortum Sieber, ex Underw. et Lloyd, in Bull. Torrey Bot. Club 33:118 (1906), G.S. n. 331, n. 332, n. 333, n. 336, n. 1895 et M.S. n. 3285.

17. Lycopodium clavatum L. Sp. Pl. ed. 2, 1564 (1753), forme type: G.S. n. 335 et M.S. n. 3290. Var. montanum nov. G.S. n. 537, n. 544, n. 837, n. 844, n. 1902, n. 2408 et M.S. n. 3288.

Famille 2. PSILOTACEAE

1. PSILOTUM Sw.

1. Psilotum nudum (L.) Griseb. Abh. Ges. Wiss. Götting. 7:278 (1857), G.S. n. 338, n. 663 et M.S. n. 2251, n. 3266, n. 3268 et n. 3299.

2. Psilotum complanatum Sw. Syn.Fil. 188, 414, t.4, fig.5 (1806) M. (ex Fée).

Famille 3. SELAGINELLACEAE

1. SELAGINELLA Beauv.

1. Selaginella ovifolia Baker, Journ. Bot. Brit. et Fern. 22:90 (1884), G. et M. (ex Urban et ex Maxon).

2. Selaginella flabellata (L.) Spring. in Bot. Zeit. 1:198 (1838) et Mon. Lycop. 2:174 (1849), G.S. n. 337, n. 343, n. 353, n. 1182 et M.S. n. 3337.

3. Selaginella rotundifolia Spring, in Bull. Acad. Sci. Brux. 10:139 (1843) et Mon. Lycop. 2:85 (1849), G.S. n. 355, n. 541, n. 841, n. 2064, n. 2644 et M.S. n. 3262 et n. 3399.

4. Selaginella portoricensis A. Br. in Ann. Sc. Nat. 5, Bot. 3:288 (1865), M. (ex Urban).

5. Selaginella albonitens Spring, in Bull. Acad. Sc. Brux. 10:139 (1843) et Mon. Lycop. 2:80 (1849), G. et M. (ex Maxon).

6. Selaginella substipitata Spring, Mon. Lycop. 2. 198 (1849), G. Duss n. 4078, n. 4084, n. 4086 et M.S. n. 2250, n. 3287 et n. 3338.

7. Selaginella Mortensii Spring, Mon. Lycop. 2 (1849), G. Duss n. 3752 et M. Duss n. 3969.

8. Selaginella Willdenovii (Desv.) Baker, Bot. Jahrb. Engler 24 (1897), M.S. n. 3261.

9. Selaginella didymostachya (Desv.) Spring. Enum. in Bull. Acad. Brux. 10:144 (1843) et Mon. Lycop. 2:130 (1849), G. (ex Urban).

Selaginella serpens (Desv.) Spring. Enum. in Bull. Acad. Brux. 10:228 (1843) et Mon. Lycop. 2:102 (1849), décrit par Duss (Lycop. Ant. fr. 14, 1903) pour la Guadeloupe et la Martinique, est en réalité confinée à la Jamaïque et a Saint Domingue.

Selaginella porelloides (Lamk.) Spring. Mon. Lycop. 2:97 (1849). Décrit par Duss (Lycop. Ant. fr. 14, 1903) pour la Guadeloupe et la Martinique, est synonyme de S. Mayerhoffii Hieron. var. Nectouocii Hieron, in Hedwigia 58:298 (1917), endémique d'Haïti.

(For summary see previous issue)

CONTENTS

HEADQUARTERS OFFICE AND LABORATORY BUILDING COMPLETED

Ralph A. Shull
Senior Administrative Assistant
Tropical Forest Experiment Station

We are pleased to announce the completion of the Headquarters Office and Laboratory building of the Tropical Forest Experiment Station. The building, which was designed by W. E. Groben, Consulting Architect for the U. S. Forest Service, is a two-story, concrete structure, painted white, with Spanish-type tile roof. It has approximately 10,000 square feet of office and laboratory space which will not only accommodate the present staff but will provide for expansion in all phases of forest research for some years to come. The building is planned so that wings can be added without affecting the present structure.

When Congress appropriated funds in July 1939 for the organization of a Research Station within the tropics, to be administered by the Forest Service, U. S. Department of Agriculture, it was decided to locate the Station on an area provided by the University of Puerto Rico within the grounds of their Agricultural Experiment Station in Río Piedras.

The Insular Department of Agriculture and Commerce and the University of Puerto Rico, jointly sponsored a Federal Works Project for the construction of the building, and it has been the writer's responsibility to see that the building, other structural improvements upon the grounds, and the landscaping were properly and successfully carried to completion. The building and other facilities are shown in the photographs on the following two pages.

On the first floor are located the offices of the Administrative Assistant's Division, the Statistics Division, and three large laboratories with appurtenant offices. On the second floor are located the office of the Director, the Library, and the offices of the Chiefs of the Divisions of Forest Management, Forest Economics and Forest Influences, a herbarium room, and a photographic dark room. A large storage room for supplies and equipment is provided in a basement.

The Library, occupying the central section, is paneled and shelved with laurel sabino, Magnolia splendens Urban, and has a total of approximately 500 lineal feet of shelf space with further room for book-stacks as the need arises.

The building, surrounded by five and one-quarter acres of grounds, is situated on a small hill overlooking the harbor of San Juan to the North and an extensive vista of the island to the West. The area is entirely surrounded by a road making it self-contained. The building is located on the highest point of this hill, and an asphalted access road has been constructed to the rear forming a circle, in the center of which is a 20-car parking lot.

Other improvements which have been constructed upon the grounds are a concrete eight-car garage, a lumber drying shed, a nursery shade shed, and a half-acre experimental nursery.

Top: Tropical Forest Experiment Station's new office and laboratory building.
Bottom: A close-up of the entrance feature.

Top: Rear view of the building showing entrance road which forms a circle behind the building, with a 20-car parking area in the center.

Bottom: Showing garage on left, lumber drying shed on right, nursery shade shed immediately behind it, and nursery beds to the right of the shade shed. The relationship of this area to the headquarters building can be seen from the cars in the parking area in both pictures.

A SEED STORAGE STUDY OF SOME TROPICAL HARDWOODS

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One of the first and foremost phases of forestry work has always been the reforestation of cleared non-agricultural lands. Among the numerous factors which contribute to the success or failure of forest tree plantings is the quality of the nursery stock planted. To provide high quality stock tropical forest nurserymen must have access to an adequate supply of good seed for scheduled sowings during a period of weeks or months which will produce a continuous supply of seedlings of the proper size during the entire planting season.

Obviously when continuous production is required during several weeks or months seed must be continually collected throughout the sowing period or during part of the period. Fortunately some tropical tree species produce more than one seed crop annually, or the crop is produced over a long period during each year. Fresh seed of these species is frequently available on the trees when needed.

Other species fruit less frequently, some during a brief period each year, and some producing seed at irregular intervals and in varying amounts. With such species it is necessary to collect large amounts of the seed when available and to store it until needed. The rapid loss of viability of some seeds in the warm moist tropical climates presents a difficulty which must be removed if stock production is to be concurrent with the best planting season or if it is to be possible to send seeds great distances for introduction elsewhere. The collection of large amounts of perishable seed for sowing at a later date is clearly a hazardous practice unless successful storage methods are known.

The Problem in Puerto Rico

In the past it has been the custom in Puerto Rico to import during the spring large amounts of Spanish cedar, *Cedrela mexicana*, from Guadeloupe and broadleaved mahogany, *Swietenia macrophylla* and *S. candollei*, from Panama and Venezuela respectively, to be sown during the balance of the year. Although the seed was of good quality and it had been possible to protect it from insects and rodents during storage, the cost of the seed made it imperative that the best practical storage methods be determined.

Algarrobo, *Hymenaea courbaril*, seed is produced once a year, consistently, and in good amounts. The seed of this species was known to retain

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1/ This study was designed by Messrs. Philip C. Wakeley and L. R. Holdridge and was carried out under the supervision of the latter. The Caribbean National Forest provided nursery beds and the necessary labor. The writer is responsible for the analysis of the data.

its viability well in storage during short periods, but conclusive information on storage beyond six months was lacking. Accordingly a study was made to determine the effect of storage under various circumstances upon the viability of the seeds of these species. It was recognized that there are many factors which affect viability during storage, such as length of period, temperature, humidity, seed moisture content, and sealing of storage containers. The study was designed to show results after various storage periods up to 2 years, and to test the relative effect of sealed and unsealed containers and of room and refrigerated temperatures upon loss of viability. Because of a lack of equipment it was impossible to include a study of moisture relationships.

The Seeds and General Storage Practice

The fruits of *Swietenia macrophylla* are large, ellipsoid, brown, woody capsules about 6 inches long, containing about 40 seeds. The seeds are about 3 inches long by 3/4 inch thick, most of the length being made by the long membranous wing. There are about 900 seeds (including the wings) to the pound.

The fruits of *Cedrela mexicana* are ellipsoid, dark brown, dehiscent capsules, 1-1/2 to 2 inches in length. The seeds have the same general outline of those of mahogany but are considerably smaller, about 1 inch long. There are about 14,000 seeds (including the wings) to the pound.

The fruits of *Hymenaea courbaril* are rough, oblong, dark brown, woody legumes about 4 inches long. The seeds are large and heavy, oblong to ovoid, and leguminous and are enclosed by a hard testa. They are reddish brown, and are found in a mealy pulp within the pod. There are about 120 seeds per pound.

Usually when the pods are received they are laid out in the sun in trays or screens to dry. The dehiscent capsules of mahogany and cedar are easily opened when dry but in the case of *Hymenaea courbaril* the thick walled capsules must be opened by force. If the seeds are not to be sown immediately they are stored in tin cans, wooden boxes or sacks. The tin cans are preferable as they protect against losses through rodent damage.

Experimental Procedure

Seeds which were all from the same lot, were counted and grouped for the various treatments. No attempt was made to modify the natural moisture content, so all treatments of each species can be considered comparable regarding this factor. Seeds to be stored unsealed were placed in small muslin sacks while those sealed were placed in quart fruit jars with a rubber sealing ring. Seeds stored at room temperature were placed in a wooden office building at Rio Piedras where the temperature average is 77° F., minimum 54° F., and maximum 98° F.; and where the average relative humidity is approximately 80 per cent. The refrigerated temperature was that of a commercial cold storage plant, ranging between 35° and 40° F.

Eight storage periods were used, ranging from 2 weeks to 2 years. Each treatment included 100 seeds (4 blocks of 25). On the date that storage was begun (0 days) 400 seeds were germinated to provide a basis for determination of subsequent losses in viability.

Sowings were made in randomized blocks in the nursery. All seeds were sown in drills, the cedar being covered with sand, and the other species with earth.

Results

Spanish Cedar

There are two obvious characteristics of the cedar germination data as shown in Table 1. One is the rapid loss of viability during storage at room temperature, and the other is the great fluctuation in the germination percentages, particularly after the longer periods of refrigerated storage.

Table 1.—Germination by blocks and storage treatments - Spanish cedar.

Storage Period	Room Temperature: Blocks of 25 seeds 1	2	3	4	Average Percent	Refrigerated: Blocks of 25 seeds 1	2	3	4	Average Percent	Total Average
	No.	No.	No.	No.	%	No.	No.	No.	No.	%	%
Open Storage											
0 days[1]	13	15	12	14	54	10	8	10	10	38	46.0
2 weeks	9	7	13	13	42	9	20	12	14	55	48.5
1 month	5	9	7	4	25	2	8	9	3	22	23.5
2 months	2	5	3	2	12	13	11	11	6	41	26.5
4 months	0	0	0	0	0	7	12	6	6	31	15.5
6 months	0	0	0	0	0	2	1	0	1	4	2.0
8 months	0	0	0	0	0	8	13	8	12	41	20.5
1 year	0	0	0	0	0	2	2	2	7	13	6.5
2 years	0	0	0	0	0	0	1	0	0	1	0.5
Total	29	36	35	33		53	76	58	59		
Sealed Storage											
0 days[1]	9	7	9	10	35	9	8	13	14	44	39.5
2 weeks	11	18	16	12	57	12	19	16	9	56	56.5
1 month	4	7	9	4	24	4	11	4	1	20	22.0
2 months	5	7	5	5	22	17	12	12	9	50	36.0
4 months	0	0	2	0	2	9	8	12	5	34	18.0
6 months	0	0	0	0	0	0	4	2	1	7	3.5
8 months	0	0	0	0	0	12	11	13	9	45	22.5
1 year	0	0	0	0	0	3	2	0	6	11	5.5
2 years	0	0	0	0	0	0	3	2	5	10	5.0
Total	29	39	41	31		66	78	74	59		

1/ This period, corresponding to a check, involves no treatment.

The effect of temperature was not pronounced until after 2 months of storage but after 4 months at room temperature practically all seeds were dead. The high germination obtained after 8 months of cold storage falls off rapidly during the following four months.

The fluctuation in the germination percentages, such as the "rise" in germination between 1 and 2 months and 6 and 8 months of cold storage, is apparently due to variation in the weather conditions in the nursery beds during the different seasons when sowings were made. This factor places a limitation on the interpretation of these data, but the sharp drop in germination after 1 month of room temperature and 8 months of cold storage can be considered a reliable indication of what to expect.

Sealing the seed had no statistically significant effect upon loss of viability, though sealed seeds tended to show a higher germination during some periods. Sealing is therefore unnecessary unless it is used to protect the seed from weevils or rodents.

Honduras Mahogany

Mahogany seed was found to be similar to cedar in its response to the various storage treatments, as shown in Table 2. The fluctuations in germination percentages after the various periods is less pronounced, indicating that the germination of this species is less affected by weather. The seed used had been stored in a sack at room temperature for 6 weeks prior to the study. While this circumstance probably had little effect upon the treatments, this period of time should be added to the storage periods to get actual age of the seed.

Table 2.—Germination by blocks and storage treatments - Honduras mahogany.

Storage Period	Room Temperature: Blocks of 25 seeds 1	2	3	4	Average Percent	Refrigerated: Blocks of 25 seeds 1	2	3	4	Average Percent	Total Average
	No.	No.	No.	No.	%	No.	No.	No.	No.	%	%
Open Storage											
0 days[1]	10	15	16	13	54	17	13	12	13	55	54.5
2 weeks	14	11	15	15	55	12	13	13	18	56	55.5
1 month	15	13	11	16	55	14	15	16	17	62	58.5
2 months	5	4	12	9	30	9	13	11	8	41	35.5
4 months	0	0	1	1	2	15	17	12	12	56	29.0
6 months	0	0	0	0	0	9	8	11	9	37	18.5
8 months	0	0	0	1	1	12	18	16	11	57	29.0
1 year	0	1	0	1	2	5	7	8	7	27	14.5
2 years	0	0	0	0	0	0	0	0	0	0	0.0
Total	44	44	55	56		93	104	99	95		

Storage Period	Room Temperature: Blocks of 25 seeds 1	2	3	4	Average Percent	Refrigerated: Blocks of 25 seeds 1	2	3	4	Average Percent	Total Average
	No.	No.	No.	No.	%	No.	No.	No.	No.	%	%
					Sealed Storage						
0 days[1]	12	19	14	16	61	14	14	16	12	56	58.5
2 weeks	14	17	15	13	59	16	16	16	18	66	62.5
1 month	15	7	15	13	50	16	14	14	13	57	53.5
2 months	13	13	9	15	50	13	14	19	16	66	58.0
4 months	0	1	4	3	8	12	15	16	15	58	33.0
6 months	0	0	0	0	0	13	13	8	17	51	25.5
8 months	0	0	1	0	1	16	8	16	9	49	25.0
1 year	0	0	0	0	0	10	12	12	8	42	21.0
2 years	0	0	0	0	0	1	3	1	0	5	2.5
Total	54	57	58	60		111	109	118	108		

1/ This period, corresponding to a check, involves no treatment.

As with cedar seed temperature was an important influence upon loss of viability. After 1 month unsealed and 2 months of sealed storage, the viability of seeds kept at room temperature fell off rapidly. In cold storage the loss in viability commenced at about the same time but was much more gradual, particularly that of the seeds which were in sealed containers.

The use of sealed containers preserved the viability of seeds stored at room temperature better than unsealed containers after 2 months storage. With cold storage the effect is shown to be similar in slowing the loss of viability after 8 months. Therefore with mahogany the sealed container can be considered the better practice.

Algarrobo

In contrast to the seeds of cedar and mahogany, which lost their viability after 1 or 2 months of storage at room temperature and 8 months or a year in cold storage, algarrobo seeds retained viability well during the first year regardless of storage conditions. (See table 3.)

It will be noted that viability increased in all treatments until 4 months had passed. Apparently this is partly due to after-ripening. The possibility of the need for after-ripening of this seed is indicated by the long period during which the seeds remain in the pods on the tree before falling.

Table 3.—Germination by blocks and storage treatments - Algarrobo.

Storage Period	Room Temperature: Blocks of 25 seeds 1	2	3	4	Room Temperature: Average Percent	Refrigerated: Blocks of 25 seeds 1	2	3	4	Refrigerated: Average Percent	Total Average
	No.	No.	No.	No.	%	No.	No.	No.	No.	%	%
Open Storage											
0 days1/	15	10	13	14	52	16	13	13	10	52	52.0
2 weeks	11	14	10	13	48	14	15	11	5	45	46.5
1 month	14	15	15	15	59	15	13	15	9	52	55.5
2 months	15	12	11	11	49	12	21	13	14	60	54.5
4 months	22	19	17	13	71	18	23	17	14	72	71.5
6 months	10	14	19	11	54	11	15	10	9	45	49.5
8 months	18	14	18	13	63	9	10	13	9	41	52.0
1 year	19	21	15	14	69	19	16	13	14	62	65.5
2 years	7	8	3	9	27	11	16	16	16	59	43.0
Total	131	127	121	113		125	142	121	100		
Sealed Storage											
0 days1/	18	16	13	11	58	23	11	12	12	58	58.0
2 weeks	17	19	18	16	70	19	16	20	13	68	69.0
1 month	16	18	20	21	75	22	19	15	21	77	76.0
2 months	22	17	17	15	71	23	16	21	20	80	75.5
4 months	21	21	20	19	81	19	16	21	17	73	77.0
6 months	12	17	15	21	65	13	17	18	16	64	64.5
8 months	17	18	13	13	61	19	16	21	16	72	66.5
1 year	10	10	11	13	44	24	19	22	17	82	63.0
2 years	0	0	0	2	2	16	3	19	17	55	28.5
Total	133	136	127	131		178	133	169	149		

1/ This period, corresponding to a check, involves no treatment.

Though the seeds store well regardless of temperature or container generally there was a significant difference between the sealed and unsealed storage, in favor of the former. However, at room temperature this relationship is reversed after 1 year. This may be a result of the high humidity maintained in the sealed container which could lead to more rapid exhaustion of the seeds.

The effect of temperature is not marked until after 1 year of storage when cold stored seeds were clearly better than those kept at room temperature. This difference is most pronounced in the seeds kept sealed.

Conclusions

Under the conditions of the study the following conclusions are justified:

1. Refrigeration is necessary for the safe storage of Spanish cedar seeds beyond two months. In this way seeds can be stored safely up to eight months although some germination was obtained up to 2 years.

2. Cedar seeds will keep equally well in either sealed or unsealed containers.

3. Honduras mahogany seed must also be refrigerated for satisfactory storage beyond 3 months. Seeds store fairly well up to 1 year in cold storage.

4. Honduras mahogany seeds retain their viability longer when stored in sealed containers.

5. The viability of algarrobo seeds can be satisfactorily preserved for 1 year at room temperature, but for longer storage, refrigeration is required.

6. For algarrobo seeds unsealed storage is to be recommended if storage is to be for periods in excess of 12 months.

Summary

In order to arrange nursery sowing schedules to provide a continual production of stock throughout the planting season it is frequently necessary to store seed for varying periods following its collection.

In Puerto Rico where seed has often been imported from other islands at considerable expense the development of improved storage practices has been an important phase of nursery research. Seed storage of many species has been tried, among them Cedrela mexicana, Swietenia macrophylla, and Hymenaea courbaril.

In a study covering 2 years and testing the relative effects of storage at room and refrigerated temperatures and sealed and unsealed temperatures it was found that:

1. The viability of seeds of Cedrela mexicana can best be preserved (satisfactory after 8 months) when kept at about 35° F., but need not be sealed.

2. Seeds of Swietenia macrophylla retain their viability longest (satisfactory after 1 year) also when refrigerated and preferably kept sealed.

3. The storage of the seeds of Hymenaea courbaril presents no problem during the first year but if storage for longer periods is contemplated, refrigeration is to be recommended.

Resumen

Para poder organizar un programa de siembra en el vivero que provea una producción continua de arbolitos durante toda la época de trasplante es necesario frecuentemente almacenar la semilla por períodos diversos después de la recolección.

En Puerto Rico, donde las semillas se han importado a menudo de otras islas incurriéndose así en grandes gastos, el desarrollo y mejoramiento de las prácticas de almacenaje ha constituído una fase importante en las investigaciones relacionadas con los viveros.

En un estudio que se prolongó dos años se probó el efecto relativo de almacenar semilla bajo temperatura ordinaria y fría y en envases sellados y sin sellar. Se encontró lo que sigue:

1. Para un almacenaje efectivo de Cedrela mexicana la refrigeración es necesaria para períodos en exceso de 2 meses. A temperaturas bajas las semillas se pueden almacenar convenientemente hasta los 8 meses aunque se obtuvo alguna germinación hasta los 2 años.

2. En el almacenaje de Cedrela no existe diferencia marcada con respecto a envases.

3. Para que la semilla de Swietenia macrophylla se conserve satisfactoriamente por más de 3 meses debe almacenarse a temperatura baja. En estas condiciones puede conservarse bien hasta un año.

4. Las semillas de Swietenia retienen mejor su viabilidad si se almacenan en envases sellados.

5. La viabilidad de las semillas de Hymenaea courbaril se conserva satisfactoriamente por un año bajo temperaturas ordinarias pero por un período más largo se requiere refrigeración.

6. Si se desea almacenar semillas de Hymenaea por períodos de más de 12 meses se recomienda el uso de envases sin sellar.

THE MANUFACTURE OF SHINGLES FROM LOCAL WOODS IN TRINIDAD AND TOBAGO

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Introduction

The manufacture and use of shingles from local woods was once common in Tobago where the two species Cedrela mexicana (cedar) and Ocotea leucoxylon (duckwood) were used for this purpose, both being naturally durable and sufficiently fissile to be riven into shingles by hand. The standard size was 18 inches by 4 inches with a thickness of 1/2 inch at the stouter end, while in 1933 their cost was around 60 cents per 100 or $3.60 per "square". Lengths of service for shingles used on roofs and walls of 20 and 30 years respectively are reported. From about 1935 their manufacture has been discontinued, probably on account of the ease and cheapness with which galvanized iron roofing became obtainable. It is not known to what extent locally made shingles were used in Trinidad itself, but in the Mayaro district a number of shingle roofs are still in existence and are in perfect condition after a known life of from 30 to 40 years. In these cases the shingles were made from Copaifera officinalis (balsam).

Research Work Carried out by the Forest Department - 1940 1/

Mainly with a view to finding an outlet for the less valuable and, at present, worthless species felled in large numbers yearly, both in the formation of teak plantations and by petroleum companies in the course of oil exploitation, the Forest Department conducted a small scale experiment in 1940 with the object of finding out whether any of these species were suitable for shingle manufacture.

To produce the test shingles the method described in the Malayan Forester (Volume 6. 1937) was employed as it involves only a small circular saw rip-bench and a simply constructed wooden craddle. A standard size of 18 inches by 6 inches tapering from 3/8 inch to 1/16 inch was adopted.

The timbers selected were mostly light, soft and not naturally durable, the shingles were therefore treated with a 50-50 creosote-diesel oil mixture using the open-tank hot and cold process. Except for one species absorption was heavy and penetration complete.

1/ The experimental work referred to in this section was carried out by J. C. Cater, Assistant Conservator of Forests, Trinidad.

The species used and results obtained are summarized in the following table:

Timber		Wt. of timber air-dry lbs/c.ft.	Absorption of preservative (approx.) lbs/c.ft.	Remarks on working qualities, etc.
Botanical Name	Local Name			
Hura crepitans	Sandbox	25	20	Cuts fairly easily without much pick-up when not absolutely green. Seasons well and retains its shape if properly stacked.
Erythrina poeppigiana	Anauca immortelle	25 (about)	40	Cuts fairly easily but with some pick-up. Seasons and retains shape well, but is very brittle.
Hernandia sonora	Toporite	20	36	Cuts well with little or no pick-up, except samples containing the false black heart. Seasons and retains shape very satisfactorily.
Spondias mombin	Hogplum	34	-	The sample was from a small tree and was very difficult to cut. The shingles were woolly, and warped and collapsed badly on seasoning. None suitable for use was obtained.
Bravaisia interrigima	Jiggerwood	35	14	Cuts with a fine smooth finish and seasons very well. Somewhat hard.
Cordia collococca	Laylay	30	24	Cuts moderately well but inclined to pick-up. Liable to warp and split during seasoning.
Sapium aucuparium	Milkwood	35	28	Cuts well with smooth finish and little pick-up. Seasons well.
Virola surinamensis	Cajuca	30	-	The sample was almost impossible to cut owing to woolliness. Only one shingle of poor quality was obtained and this split badly during seasoning.

The foregoing list by no means exhausts the possible species, but represents those of little commercial value at the time, although it is of interest to note that sandbox has since acquired considerable popularity as boarding for house construction with a corresponding increase in value. Additional local species which might repay investigation are Alchornea glandulosa (honeywood), Ficus tobagensis (figuier), Didymopanax morototoni (jereton) and Simaruba amara (maruba).

These experiments showed that at least three local species are capable of yielding a satisfactory roofing shingle as far as machining and seasoning properties are concerned: namely, sandbox, toporite and milkwood. Unfortunately cost of production using the cradle method was high and while the nature of the investigation prevented accurate costing it was estimated that a shingle should be produced for around 4 cents, corresponding to about $16.00 per square. This could not then compete with the price of imported Western red cedar shingles, or alternatives such as corrugated iron or roofing felt. Nor did the potential market seem sufficiently attractive to induce local sawmills to undertake production with specialized machinery capable of high output, though it is yet to be discovered whether a machine designed and constructed for use with a wood such as Western red cedar will prove suitable when used on structurally different tropical woods. Thus for a time the matter fell into abeyance.

Subsequent Investigation by a Petroleum Company - 1940

With the rapid rise in price and threatened lack of galvanized iron at the beginning of the present war considerable interest in the manufacture of shingles - or rather the possibilities thereof - from local woods was evinced by the various petroleum companies in Trinidad; and one of these, Messrs. Apex Trinidad Oilfields Ltd. began an investigation early in 1940 especially with a view to obtaining comparative costs of shingles and galvanized iron roofing.

Using the cradle method already referred to sufficient shingles were cut to cover a small lean to roof in order that they might be tested under working conditions. Two species only were used, toporite and sandbox. Of these, part of the toporite and all the sandbox were treated with a 50-50 creosote-diesel oil mixture by the open-tank hot and cold process. The remainder of the toporite shingles were laid untreated.

As far as costs were concerned this investigation lost much of its value when force of circumstance compelled the adoption of the slow cradle method of cutting, but the resulting shingles — however expensively produced— have given a good indication of their durability, for after almost three years the treated ones are perfectly sound and in excellent condition. The untreated toporite shingles lasted well for two and a half years but have subsequently rotted; they still form a watertight roof but cannot be expected to stand up much longer.

Full Scale Production by a Petroleum Company - 1942[2]

In January 1942 Messrs. Trinidad Leaseholds Limited commenced the production of shingles from timber felled in the course of clearing forest for well sites, etc. In the beginning a wide variety of timber was supplied to the shingle plant but many proved to be unsuitable owing to seasoning difficulties—warping, splitting and cellular collapse—while others were obviously too hard and heavy. Now toporite is being used to the exclusion of all others and its supply, therefore, has to be supplemented by selective fellings outside the normal oil clearings.

Logs are first cut at the sawmill into blocks measuring 18 inches by 6 inches by random widths of about 1 foot; these are then cut at the shingle plant on a machine, designed and made by the Company, which comprises a 24-inch diameter circular saw powered by a 3 H.P. electric motor, together with a metal cradle running on tracks and designed to give the correct degree of taper (5/16 inch to 1/16 inch) to the shingles as they are cut. The cradle is hand fed and by an ingenious rack device the block is advanced to the saw in such a way that alternate shingles are cut with their thick and thin ends together; this ensures that the grain of the wood runs parallel to the shingle's face.

After cutting, the shingles are soaked for 24 hours in a copper naphthenate solution. They are then removed to drain and are finally bundled in 50's. The plant is operated by two men, one cutting, the other dipping and bundling, and two shifts are worked daily - each shift producing 1000 shingles. By the end of 1942 well over 400 "squares" had been manufactured and put to use on buildings of all kinds throughout the Company's fields.

Wastage is rather excessive and with the present set-up embodying a saw of 1/4 inch kerf amounts to 55 per cent by volume of the wood blocks supplied to the shingle plant - exclusive of those rejected on account of splits, shakes, false heart and other defects. In spite of this the Company states that it is now producing shingles at a cost of $16.00 per "square", which may be itemized as follows:

Royalty value of wood	$0.36
Transport to mill, conversion into blocks and transport to shingle plant	9.88
Cutting into shingles and preservative treatment (labor)	1.36
Preservative treatment (material)	4.40
	$16.00

The present cost of galvanized iron is $13.00 per 100 square feet of roof covered, but it must be remembered that this material is now often

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2/ Grateful acknowledgement is made to the General Manager, Trinidad Leaseholds Ltd. for assistance in the preparation of this section.

obtainable or only so in comparatively small quantities. This venture of Messrs. Trinidad Leaseholds in the manufacture of shingles is, therefore, not only an extremely interesting one from the point of view of local wood utilization but would appear to be an economically sound one for themselves, at least under wartime circumstances.

Summary

Shingles were once made by hand from local species in Trinidad and Tobago and durability as high as 40 years is reported. In about 1935 their manufacture was discontinued - probably on account of the ease and cheapness with which alternative materials were obtainable.

In 1940 both the Forest Department and a local petroleum company conducted experiments in the manufacture of shingles by machine methods; the former mainly with a view to finding a use for certain less valuable species, the latter in order to compare the cost of shingles with that of galvanized iron roofing. Details of the species tested are given.

In 1941 another petroleum company started the production of shingles to meet their own needs, in part. The method of manufacture is described and the cost of timber, labor and preservative material given.

Resumen

En Trinidad y Tobago el tejamaní se fabricaba a mano, de especies locales y según información al efecto su índice de durabilidad ascendía a tanto como 40 años. Por el 1935 su fabricación se suspendió debido probablemente a que podían obtenerse materiales substitutos con más facilidad y a menos costo.

En el 1940 el Departamento Forestal así como una compañía petrolera local llevaron a cabo experimentos para fabricar tejamaní usando maquinaria adecuada; el primero con el propósito de encontrarle provecho a ciertas maderas de menos valor; la segunda, para poder comparar el costo del tejamaní con el del cinc de techar.

Los experimentos consistían en hervir las muestras previamente en una mezcla 50-50 de creosota y aceite diesel. Tres de las especies que se podían aserrar y curar bien y que retenían su forma si se apilaban debidamente fueron Hura crepitans, Hernandia sonora y Sapium aucuparium. Otras especies que podían usarse pero con resultados menos satisfactorios son Erythrina poeppigiana, Pentaclethra interrigima y Cordia collcocca. Dos especies que no dieron resultado fueron Spondias mombin y Virola surinamensis.

Una prueba posterior hecha por otra compañía petrolera mostró la posibilidad económica de fabricar tejamaní de Hernandia sonora por lo menos mientras dure la guerra ya que el cinc que se usa para techar es virtualmente imposible de conseguir.

CLASSIFICATION DES ARBRES A LATEX ET A SECRETIONS DE GOMMES, RESINES ET MATIERES COLORANTES AUX ANTILLES FRANCAISES

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Parmi les arbres, spontanés ou cultivés, aux Antilles françaises, une catégorie est nettement reconnaissable par le sylviculteur non spécialisé en botanique ou même par le profane grace aux secrétions laticifères, aromatiques: gommeuses ou résinifères, oléifères ou colorantes, émises par certaines de leurs parties ou par tous leurs organes. On peut en compter 70 environ dans ces îles et les classer rationnellement d'après la nature physico-chimique de la matière secrétée ou d'après des caractères morphologiques simples et extérieurs. Dans cette étude, une classification générale de ces végétaux a été élaborée, tenant compte à la fois de l'aspect extérieur du produit secrété, de la constitution botanique des feuilles et des fruits ainsi que de la couleur du bois qui revêt une certaine importance en Economie Forestière. Les distinctions taxonomiques faisant appel à l'organisation florale ont été laissées de côté pour simplifier l'emploi de la clef forgée dans un but d'utilisation pratique et en permettre aisément la généralisation.

Les sucs aromatiques de certaines espèces, comme celles du genre Zanthoxylum, brulent avec une grande clarté et sont utilisées pour la confection de torches ou flambeaux-caraibes alors que les résines des gommiers: Dacryodes excelsa Vahl, Protium attenuatum (Rose) Urban, Elaphrium simaruba (L.) Rose et Tetragastris balsamifera (Sw.) Kuntze, dégagent une odeur d'encens. La présence de ces résines balsamiques dans ces bois explique leur faculté d'être imputrescibles dans l'eau de mer, qualité mise à profit dans la confection des bateaux de pêche légers appelés "gommiers".

Les feuilles du Marila racemosa Sw., possèdent des canaux oléifères et celles de Pilocarpus racemosus Vahl, une huile essentielle d'où l'on extrait la pilocarpine; dans le Pterocarpus officinalis Jacq. et le Maclura tinctoria (L.) Gaud. des matières colorantes rouges sont secrétées par le bois ainsi que dans diverses espèces d'Acacia et dans l'Haematoxylon campechianum L.; le Myristica fragans Houtt. contient un suc visqueux pâle dans l'écorce du tronc. Des gommes-résines, âcres ou colorées, sont exudées par le Moronobea cocinea Aubl., le Tovomita plumieri Griseb., le Mammea americana L., le Sapium caribaeum Urb., etc.

Il y aurait lieu encore d'ajouter les végétaux à tannins qui ne sont pas traités dans la présente étude. Les exemples sont donc nombreux et la connaissance chimique de la constitution intime du produit secrété permettrait certainement de prévoir de nouvelles utilisations, de connaitre l'influence de ces matières sur la texture et la valeur du bois et de déduire les relations qui existent d'une part entre les diverses catégories d'excrétion et d'autre part la place occupée par les arbres qui les produisent, dans la classification générale des végétaux. Des affinités et des corrélations existent certainement. Pour les Antilles françaises, les arbres producteurs de résines aromatiques à odeur d'encens et d'élemis sont surtout de la famille des Burséracées (ou Térébenthacées), les substances amères dans les espèces des Méliacées, les sucs aromatiques entretenant la combustion et l'éclairement dans les Rutacées, les gommes aux Mimosacées, les tannins et phlobaphènes aux Combrétacées et Rhizophoracées, etc.

Le synopsis présenté ci-après a pour objet de faciliter la détermination et la distinction de ces arbres et dans l'appendice il est indiqué la référence du lieu où la diagnose a été publiée et les noms créoles des espèces à la Guadeloupe et à la Martinique.

I. Arbres à Latex

1. Feuilles par 3 ou 4:
  2. Feuilles oblongues ou elliptiques, acuminées... Rauwolfia lamarkii A.DC.
  2. Feuilles lancéolées-oblongues, obtuses... Rauwolfia biauriculata J. Müll.
1. Feuilles par 2, opposées:
  2. Feuilles oblongues-lancéolées, à pointe obtuse.. Tabernaemontana citrifolia L.
  2. Feuilles ovées-oblongues à orbiculaires, à pointe aigüe.. Calotropis procera Ait.
1. Feuilles alternes:
  2. Feuilles lobées:
    3. Limbe à 8-11 lobes pennés........................ Artocarpus communis Forst.
      4. Côte, nervures et pétioles glabres.............. var. non seminifera
      4. Côte, nervures et pétiole pubescents................. var. seminifera
    3. Limbe des jeunes feuilles à 3-5 lobes, feuilles adultes entières.............................. Artocarpus integrifolia L.
  2. Feuilles entières:
    3. Feuilles tipulées. Bois blanc tendres et mous:
      4. Feuilles très grandes, de 15 à 25 cm. de long:
        5. Feuilles ovées, stipules glabres.............. Ficus urbaniana Warb.
        5. Feuilles oblongues, stipules à poils dores.. Ficus crassinervia Desf.
      4. Feuilles moyennes, de 8 à 15 cm. de long:
        5. Feuilles elliptiques ou oblongues, arrondies ou obtuses à la base, à 13 nervures.................................... Ficus krugiana Warb.
        5. Feuilles ovées cordées à la base, à 3-5 nervures.. Ficus laevigata Vahl
      4. Feuilles petites, de 3 à 10 cm. de long....... Ficus omphalophora Warb.
    3. Feuilles non stipulées, bois résistants et colorés:
      4. Bois mi-dur, jaune foncé, de densité moyenne........ Hura crepitans L.
      4. Bois dur, gris, de grande densité:
        5. Feuille elliptique, coriace; bois gris, veiné de brun, nuancé de jaune Hippomane mancinella L.
      4. Bois durs, lourds, rouges ou brun-rouges:

5. Feuilles assez étroites, lancéolées, elliptiques ou oblongues:

6. Feuilles lancéolées-oblongues........ Achras sapota L. var. typica

Feuilles à plus long pétiole................ var. candollei Pierre

6. Feuilles nettement lancéolées.. Pouteria martinicensis (Pierre) comb. nov.

6. Feuilles elliptiques-oblongues.. Pouteria fabrilis (Pierre) comb. nov.

6. Feuilles nettement elliptiques:

7. Feuilles glabres ou presque:

8. Feuilles grandes, de 13-18x6-8, 5 cm. limbe de 10 à 16 côtes............... Pouteria semecarpifolia Pierre

8. Feuilles moyennes, de 5-12x4-6 cm., limbe de 42 côtes................ Manilkara riedleana (Pierre) Dubard

8. Feuilles petites, de 4-6x2-4 cm.. Pouteria chrysophylloides (Pierre) comb. nov.

7. Feuilles pubescentes à la face inférieure:

8. Poils soyeux argentés........... Chrysophyllum argenteum Jacq.

8'. Poils soyeux dorés:

9. Pétiole de 12-15 mm. Feuille cuspidée au sommet et acutée à la base.............. Chrysophyllum caeruleum Jacq.

9. Pétiole de 15-28 mm. Feuille moyennement acuminée:

10. Base obtuse ou acutée.. Chrysophyllum cainito L. var. typicum

10. Base arrondie ou atténuée.. var. pomiferum (Tussac) Pierre

10. Base brusquement acuminée..... var. martinicense Pierre

5. Feuilles assez larges, obovées:

6. Feuilles obovées-allongées ou spathulées.. Calocarpum mammosum (A.DC.) Pierre

6. Feuilles obovées-elliptiques:

7. Limbe de 16-21 cm., à pointe arrondie................. Pouteria dussiana (Pierre) comb. nov.

7. Limbe de 15-16 cm., à pointe obtuse.............................. Pouteria multiflora (DC.) Eyma

6. Feuilles nettement obovées.. Pouteria discolor (Walp. et Duchass.) comb. nov.

6. Feuilles obovées-arrondies. Pouteria hahniana (Pierre) comb.nov.

II. Arbres à Excrétions Aromatiques ou Colorées

(gommes, résines, etc.)

1. Feuilles simples, opposées ou verticillées, rarement alternes:

2. Feuilles longues et peu larges:

3. Feuilles elliptiques-lancéolées.................. Sapium caribaeum Urb.

3. Feuilles elliptiques-oblongues..................... Styrax glabrum Sw.

3. Feuilles ovales-lancéolées.......... Chlorophora tinctoria (L.) Gaud.

3. Feuilles oblongues-lancéolées:

4. Feuilles alternes, grandes et longues, sans canaux oléifères.................................. Mangifera indica L.

4. Feuilles distiques, moyennes, possédant des canaux oléifères.. Marila racemosa Sw.

3. Feuilles nettement lancéolées et acuminées:

4. Arbre cultivé, sans racines aériennes, écorce à suc visqueux rouge pâle...................... Myristica fragans Houtt.

4. Arbre spontané, à racines adventives aériennes, bois à gomme-résine jaune...................... Moronobea coccinea Aubl.

2. Feuilles amples et larges.

3. Feuilles suborbiculaires, cordées, entières ou lobées.................................. Ochroma pyramidale (Cav.) Urb.

3. Feuilles elliptiques-obovées......................... Mammea americana L.

3. Feuilles largement elliptiques:

4. Feuilles secrétant une gomme-résine, mucronées à l'extrémité.................... Tovomita plumieri Griseb.

4. Feuilles secrétant une huile essentielle par des cryptes, arrondies ou échancrées à l'extrémité.............................. Pilocarpus racemosus Vahl

3. Feuilles ovées ou ovales:

4. Feuilles membraneuses, dépourvues de canaux secréteurs, racines à matière colorante violette............ Nectandra membranacea (Sw.) Griseb.

4. Feuilles rigides et coriaces, à gomme résine jaune et odorante................. Rheedia lateriflora L.

3. Feuilles obovées ou obovales:

4. Feuilles verticillées à l'extrémité des ramaux, coriacées.......................... Anacardium occidentale L.

4. Feuilles opposées, épaisses et charnues:

5. Feuilles veinées, semi-amplexicaules........... Clusia venosa Jacq.

5. Feuilles à nervation peu apparente, attenuées à la base:

6. Fruit ové ou elliptique.......................... Clusia rosea Jacq.

6. Fruit globuleux ou sphérique.............. Clusia plukenetii Urb.

1. Feuilles composées, pennées, alternes:

2. Feuilles à pennes subdivisées en folioles:

3. Arbrisseaux à épines stipulaires de plus de 4 cm. de long; fruit plat:

4. Feuilles à 3-8 paires de pennes et 10-30 paires de folioles.......................... Acacia nilotica (L.) Del.

3. Arbrisseaux à épines stipulaires de 0.5 cm. à 4 cm. de long; fruit de 8 à 10 mm. d'épaisseur:

4. Feuilles à 2-6 paires de pennes et 10-25 paires de folioles linéaires, de 3-4, 5 mm. de long.................................. Acacia farnesiana (L.) Willd.

4. Feuilles à 2-8 paires de pennes et 10-20 paires de folioles linéaires-oblongues, de 4.5-7 mm. de long.......................... Acacia tortuosa (L.) Willd.

2. Feuilles à folioles simples:

3. Folioles crénulées sur les bords; arbrisseaux le plus souvent épineux:

4. Folioles peu nombreuses, 2-7:

5. Petit arbuste, folioles 2-7, généralement 3, ovées ou elliptiques-lancéolées, sessiles... Zanthoxylum punctatum Vahl
5. Arbre élevé, folioles 3-5 généralement 5, lancéolées ou losangiques, pétiolées................ Amyris elemifera L.
4. Folioles nombreuses, 5-15:
5. Fruit en folicules connés en leur milieu:
6. Folioles oblongues ou elliptiques, non ovées.......................... Zanthoxylum martinicense (Lam.) DC.
5. Fruit à folicules libres:
6. Foliole elliptique oblongue ou ovée; folicule reniforme obliquement orbiculaire................................ Zanthoxylum caribaeum Lam.
6. Foliole ové, lancéolé ou elliptique; folicule obovoïde.............................. Zanthoxylum flavum Vahl
3. Folioles entières, arbres le plus souvent inermes:
4. Feuilles paucifoliolées, 1-2 folioles:
5. Foliole unique, ovale ou elliptique-ovée; fruit: petit folicule globuleux ou globuleux-ovoide.............. Zanthoxylum monophyllum (Lam.) P. Wilson
5. Folioles 2 inégaux, oblongues ou oblongues lancéolées; fruit gousse oblongue, comprimée...... Hymenaea courbaril L.
4. Feuilles plurifoliolées, 2-10 folioles:
5. Fruit gousse oblongue:
6. Folioles 2-4 paires cunéiformes-ovées.... Haematoxylon campechianum L.
5. Fruit petit folicule globuleux ou ovoide:
6. Folioles 3-9, linéaires ou elliptiques.................................. Zanthoxylum spinifex (Jacq.) DC.
5. Fruit capsule piriforme, déhiscence loculicide, par 4 valves:
6. Folioles 1-3 paires membraneuses et elliptiques.. Guarea glabra Vahl
6. Folioles 1-5 paires coriaces et oblongues................................ Guarea perrottetiana A. Juss.
5. Fruit drupe de 2-4 loges ou à 3 valves:
6. Folioles 3-7, ovées ou obovées:
7. Drupe oblongue, triangulée et trivalvée................................ Elaphrium simaruba (L.) Rose
6. Folioles 5-9, oblongues ou elliptiques:
7. Drupe sphérique n'atteignant pas 2 cm. et comportant 2-4 loges.................................. Tetragastris balsamifera (Sw.) Kuntze
7. Drupe de 2-3 cm.:
8. Fruit oblong-elliptique, indéhiscent...... Dacryodes excelsa Vahl
8. Fruit ovoide à déhiscence valvaire et à 3 loges...................... Protium attenuatum (Rose) Urban
4. Feuilles multifoliées: 10-25 folioles:
5. Fruit: capsule à 5 valves, déhiscence septifrage:
6. Folioles 10-16, ovales-elliptiques................ Cedrela odorata L.
5. Fruit: drupe ovoïde ou globuleuse:
6. Fruit globuleux, de 1 cm. à 1 cm. 1/2 de diamètre:

7. Folioles 7-13, oblongues ou ovées-oblongues, drupe ovoide..... Picraena antillana (Eggers) comb. nov.
7. Folioles 5-9 paires, lancéolées-oblongues; drupe bianguleuse.................. Simaruba amara Aubl.
6. Fruit: ovoide de 2.5 à 10 cm. de long.
7. Folioles 9-25; drupe pourpre, de 2.5-3 cm. de long.............................. Spondias purpurea L.
7. Folioles 5-7 paires; drupe jaune, de 10 cm. de long........................ Spondias dulcis Forst. f.

Références et Désignations Vernaculaires des Arbres Cités

APOCYNACEAE

Rauwolfia lamarkii A.DC. Prodr. 8:337. 1844. Bois lait (G. et M.)1/
Rauwolfia biauriculata J. Müll. Linnaea 30.1860. Arbre à lait (G.)
Tabernaemontana citrifolia L. Sp.Pl. 210:8. 1753. Bois lait (G. et M.)

ASCLEPIADACEAE

Calotropis procera (Ait.) R. Br. in Ait.f. Hort. Kew.ed.2; 2:78. 1811. Arbre à soie, coton-France, bois-lait (G.); Coton-Siam, bois-canon, bois-pétard (M.).

MORACEAE

Artocarpus communis Forst. Char. Gen. 102. 1776. La var. non seminifera est l'arbre à pain (G. et M.) et la var. seminifera est le chataigner du pays (G. et M.).
Artocarpus integrifolia L.f. Suppl. 411. 1781. Jacquier (G. et M.).
Ficus urbaniana Warb. in Urb. Symb. Ant. 3:459. 1903. Figuier grandes feuilles (G. et M.).
Ficus crassinervia Desf. in Willd. Sp.Pl. 4:1138. 1806. Figuier banian (G.); figuier maudit (M.).
Ficus krugiana Warb. in Urb. Symb. Ant. 3:487. 1903. Figuier maudit (G. et M.); figuier marron, figuier à agoutis (G.) et cocoyer rivière (M.).
Ficus laevigata Vahl Enum. 2:183. 1805. Figuier maudit (G. et M.); figuier banian, figuier blanc (G.).
Ficus amphalophora Warb. in Urb. Symb. Ant. 3:466. 1903. Figuier ti-feuilles (G. et M.), multipliant (G.).
Chlorophora tinctoria (L.) Gaud. Bot. Freyc. Voy. 508. 1826; murier du pays (G. et M.).

EUPHORBIACEAE

Hura crepitans L. Sp. Pl. 1008. 1753. Sablier (G. et M.).
Hippomane mancinella L. Sp. Pl. 1191. 1753. Mancenillier, maximilier (G. et M.).

1/ G - Guadeloupe et M - Martinique. Lieux où le nom vernaculaire cité est employé.

Sapium caribaeum Urb. Symb. Ant. 3:308. 1902. Bois de soie (G.); bois la glue et aralie (M.).

SAPOTACEAE

Achras sapota L. Syst. 10, ed. 2:988. 1759. On distingue aux Antilles françaises la forme type: var. typica nov., sapotillier ordinaire (G. et M.) et la var. candollei Pierre, à fruit presque ovoide.

Pouteria martinicensis (Pierre) comb. nov Syn.: Lucuma martinicensis Pierre in Urb. Symb. Ant. 5, fasc. I, 105. 1904. Pomme pain, pain d'épice (M.).

Pouteria dussiana (Pierre) comb. nov. Syn.: Lucuma dussiana Pierre in Urb. Symb. Ant. 5, fasc. I, 105. 1904. Pomme pain, pain d'épice (M.).

Pouteria multiflora (DC.) Eyma, Not Guy. Sapot. in Rec. Trav. Bot. Neerl. XXXIII, p. 164 (1936) et in Meded. Bot. Mus. Herb. Utr. n. 27, p. 164 (1936). Syn : Lucuma multiflora DC. Prodr. 8: 168. 1844. Pomme pain, pain d'épice (G. et M.).

Pouteria fabrilis (Pierre) comb. nov. Syn.: Oxythece fabrilis Pierre in Urb. Symb. Ant. 5, fasc. I, 161. 1904. Balate blanc (G.).

Pouteria hahniana (Pierre) comb. nov. Syn.: Oxythece hahniana Pierre in Urb. Symb. Ant. 5, fasc. I, 161. 1904. Balata rouge (G.); balate, balata, palata, barac (M.).

Pouteria semecarpifolia Pierre in Symb. Ant. 5, fasc. I, 108. 1904. Bois caraïbe, bois contrevent, bois créole (M.).

Manilkara riedleana (Pierre) Dubard, Ann. Mus. Col. Marseille, III, 3:14. 1915. Sapotillier marron, sapotillier noir, bois noir (G.), balata, balate (M.).

Pouteria chrysophylloides (Pierre) comb. nov Syn.: Micropholis chrysophylloides Pierre in Urb. Symb. Ant. 5, fasc. I, 122. 1904. Caïmitier-grand bois, Caïmitier-bois (M.).

Pouteria discolor (Walp. et Duchass) comb. nov. Syn.: Chrysophyllum discolor Walp. et Duchass., ms.script. in herb. Berolin; Micropholis discolor (Walp. et Duchass.) Pierre in Urb. Symb. Ant. 5, fasc. I, 121. 1904. Caïmitier ti-feuilles, caïmitier grand bois (G.).

Chrysophyllum argenteum Jacq. Enum. 15. 1760. Bois la glue, Caïmitier bois, bois rabi, bois de bouis, petit bouis, acomat (G.), bois bouis, petit bouis (M.).

Chrysophyllum caeruleum Jacq. Sel. amer. pict. 30. 1780. Gros bouis, caïmitier noir (M.).

Chrysophyllum cainito L. Sp. Pl. I ed. I, 192. 1753. A l'état indigène et cultivé, existent trois variétés: var. typicum nov. à baies subsphériques violacées, caïmitier (M.), var. pomiferum (Tussac) Pierre, loc. cit., à baies sphériques a demi vert-rouges et à demi violacées et la var. martinicense Pierre, à fruits subglobuleux blancs: la grosse blanche (M.).

Calocarpum mammosum (L.) Pierre in Urb. Symb. Ant. 5, fasc. I, 98. 1904. C'est la forme type qui se trouve aux Antilles françaises: Sapote, grosse sapote (M.) et zapote ou sapote à crème (G.).

OLEACEAE

Styrax glabrum Sw. Prodr. 13. 1788 Oranger-bois, cypt-orangé, cypre orange (G.); laurier-caraïbe, bois chypre, bois madame (M.).

ANACARDIACEAE (Terebenthaceae)

Mangifera indica L. Sp. Pl. 200. 1753. Manguier (G. et M.).
Anacardium occidentale L. Sp. Pl. 383. 1753. Pommier d'acajou (G. et M.).
Spondias purpurea L. Sp. Pl. ed. 2, 613. 1763. Prunier d'Espagne, prunier du Chili (G. et M.).
Spondias dulcis Forst. f. Prodr. 34. 1786. Pomme-cythère et prune cythère (G. et M.).

HYPERICACEAE

Marila racemosa Sw. Fl. Ind. Occ. 19. 1797. Bois casse rosse, résolu-martinique (G.), bois cachiman, cachiman-grand bois (M.).

MYRISTICACEAE

Myristica fragans Houtt. Handleid. 3:333. Muscadier (G. et M.).

GUTTIFERAE

Moronobea coccinea Aubl. Pl. Guyane 2, 789:313. 1775. Palétuvier-jaune (G.).
Tovomita plumieri Griseb. Fl. Brit. W. I. I. 106. 1864. Mangle-bois, palétuvier grand bois (M.).
Mammea americana L. Sp. Pl. I, ed. I, 512. 1753. Abricotier, abricot des Antilles, abricot de Saint-Domingue, mamey, abricot-pays (G. et M.).
Rheedia lateriflora L. Sp. ed. 2, 1193. 1753. Bois l'onguent, abricotier bâtard (G.), ciroyer, abricotier-bâtard, abricotier-bois, abricotier montagne, abricotier bord de mer (M.).
Clusia venosa Jacq. Enum. 34. 1760. Mangle, mangle montagne, mangle rouge, figuier maudit des hauts, palétuvier montagne (G.).
Clusia rosea Jacq. Enum. 34. 1760. Figuier maudit, figuier marron, abricot bâtard, abricotier maudit (G.); aralie z'abricot, aralie grande feuille, aralie (M.).
Clusia pluckenetii Urb. Symb. Ant. 5, 432. 1908. Aralie rose, aralie grande feuille, grande aralie grise, aralie z'abricot (G.).

BOMBACEAE

Ochroma pyramidale (Cav.) Urb. in Fedde Repert. Beihefte 5, 123. 1920. Pripri, fromager-mapou, patte de lièvre, patte de lapin (G.) et bois flot (G. et M.).

RUTACEAE

Pilocarpus racemosus Vahl Eclog. I, 29:10. 1796. Flambeau caraïbe (G.); bois flambeau, flambeau noir (M.).
Zanthoxylum punctatum Vahl; West Bidr.Sante Croix 310. 1793. Lépineux rouge, bois flambeau, bois d'Inde marron, lépuni (G.); bois flambeau noir lépineux (M.).

Zanthoxylum spinifex (Jacq.) DC. Prodr. I, 728. 1824. Bois chandelle, bois lépineux blanc, bois à piano, bois blanc à flambeau (G.); bois flambeaux (M.).

Zanthoxylum martinicense (Lam.) DC. Prodr. I, 726. 1824. Lépiné jaune, lépuni jaune, lépineux jaune (G. et M.).

Zanthoxylum caribaeum Lam. Encycl. 2, 39. 1786. Lépineux blanc, bois chandelle blanc (G. et M.).

Zanthoxylum flavum Vahl, Eclog. 3. 48. 1807. Noyer, bois noyer (G.).

Zanthoxylum monophyllum (Lam.) P. Wilson, Bull. Torrey Bot. Club 37. 86. 1910. Lépuni jaune, bois noyer (G. et M.).

Amyris elemifera L. Syst. 10, ed. 2. 1000. 1759. Bois chandelle (G. et M.), bois pini, bois flambeau, bois chandelle blanc (G.).

LAURACEAE

Nectandra membranacea (Sw.) Griseb. Fl. Br. W.I. 282. 1860. Bois doux, laurier (G.); laurier-chypre (M.).

MELIACEAE

Guarea glabra Vahl Eclog. amer. 3:8. 1794; bois pistolet (G. et M.), néflier des bois (G.).

Guarea perrottetiana A. Juss. in Mém. Mus. Paris, 19, 241:285. 1830. Bois pistolet, bois rouge à balles (G.), bois cacao (M.).

Cedrela odorata L. Syst. 10. ed. 2, 940. 1759; Acajou (G. et M.); acajou amer, acajou senti, acajou à meubles, acajou pays, acajou rouge (G.).

BURSERACEAE

Elaphrium simaruba (L.) Rose North Amer. Flor. 25, 246. 1911. Gommier rouge (G. et M.), gommier, gommier-barrière (G.).

Tetragastris balsamifera (Sw.) Kuntze Rev. Gen.Pl. 107. 1891. Gommier encens (G.).

Dacryodes excelsa Vahl Skr. Nat. Selsk. 6. 117. 1810. Gommier blanc, bois cochon (G. et M.).

Protium attenuatum (Rose) Urban, Symb. Ant. VII, p. 240 (1912); Icica heptaphylla Duss, Fl. Ph. Ant. fr. p. 182, non Aubl. Bois d'encens, gommier blanc, bois gommier (G. et M.).

SIMARUBACEAE

Picraena antillana (Eggers) comb. nov. Syn.: Picrasma antillana Urb. Symb. Ant. 5, 378. 1908; Rhus antillana Eggers Fl. Sante Croix and Virg. Isl. 41. 1879; Aeschrion antillana Small, North Amer. Fl. 25. 333. 1911. Peste à poux, bois noyer, graines vertes (G.), bois amer (M.).

Simaruba amara Aubl. Pl. Guyane 2. 859. 332. 1775. Bois blanc (G. et M.); acajou blanc (G.).

Acacia nilotica (L.) Delile Fl. Aegypt. 79. 1812. Acacia de Cayenne (G.); acacia savane (M.).
Acacia farnesiana (L.) Willd. Sp. Pl. 4. 1083. 1803. Acacia jaune, acacia senti, pompons jaunes (G. et M.).
Acacia tortuosa (L.) Willd. Sp. Pl. 4. 1083. 1806. Acacia piquant, acacia savane (G. et M.).
Hymenaea courbaril L. Sp. Pl. 1192. 1753. Courbaril (G. et M.).
Haematoxylon campechianum L. Sp. Pl. 384. 1753. Campêchier (G. et M.).

Summary

Among the spontaneous and cultivated trees of the French Antilles a category is clearly recognizable by the forester not specialized in botany and even by the layman: trees which secrete gummy or resinous, oil or dye-producing substances by certain or all of their organs. There are approximately 70 of them in these islands and they can be reasonably classified according to the physico-chemical nature of the secretion or by certain exterior simple morphological characters. A general classification of these trees is presented, bearing in mind the exterior appearance of the secretion, the constitution of leaves and flowers and the color of the wood which has certain importance in forest economy. The taxonomic distinctions in relation to floristic organizations have been left out in order to simplify the use of this key to facilitate practical utilization.

The aromatic latex of certain species, for instance those of the genus Zanthoxylum, burns with great brightness, and is used to make torches and candles; while the resins of gum-trees such as Dacryodes excelsa Vahl, Protium attenuatum (Rose) Urban, Elaphrium simaruba (L.) Rose, and Tetragastris balsamifera (Sw.) Kuntze, give an incense-like odor. The presence of these balsamic essences in the wood is responsible for their durability when submerged in sea-water, a property required in light fishing boats or "gommiers".

The leaves of Marila racemosa Sw. possess oil ducts, and those of Pilocarpus racemosus Vahl, an essential oil from which pilocarpine is extracted. From the wood of Pterocarpus officinalis Jacq. and Maclura tinctoria (L.) Gaud. as well as from various species of Acacia and Haematoxylon campechianum L., a red coloring matter is secreted. Myristica fragans Houtt. contains a pale, viscous juice in its bark. Bitter or colored gum-resins are exuded by Moronobea coccinea Aubl., Tovomita plumieri Griseb., Mammea americana L., and Sapium caribaeum Urb.

The key presented does not include trees yielding tannin. There are many of these. Chemical analysis of these secretions will certainly produce new uses, will provide information on the influence of these substances on the texture and value of the wood, and the relations existing between the different secretions and the place occupied by the trees which secrete them

in the general classification of plants. Affinities and correlations certainly exist. In the French Antilles the trees which produce aromatic resins, with incense or gum elemis scent are mostly from the family Burseraceae (or Terebenthaceae); those producing bitter substances belong to species of the Meliaceae; those yielding aromatic juices which support combustion and burn with brightness belong to the Rutaceae; the gum-producing, to the Mimosaceae; the tannin and phlobaphene-yielding, to the Combretaceae and Rhizophoraceae.

The key serves to facilitate the determination and distinction of these trees. It is followed by a list of the references from which the diagnoses were obtained and also the creole names of the species in Guadeloupe and Martinique.

Resumen

Entre los árboles espontáneos y cultivados de las Antillas francesas el silvicultor no especializado en botánica y aun el lego, puede reconocer claramente una categoría específica gracias a las secreciones laticíferas aromáticas: gomosas o resinosas, colorantes o aceitosas, segregadas por algunos o por todos sus órganos. En esas islas pueden hallarse alrededor de 70, los cuales pueden clasificarse razonablemente según la naturaleza físico-química de la materia segregada y según ciertos caracteres morfológicos simples y externos. El texto comprende una clasificación general de dichos árboles tomando en cuenta a la vez el aspecto exterior de la secreción, la constitución botánica de las hojas y frutas así como el color de la madera que reviste cierta importancia en la economía forestal. Las distinciones taxonómicas relacionadas con la organización florística no han sido incluídas para poder así simplificar el uso de esta clave forjada con un propósito de utilización práctica.

El látex aromático de ciertas especies, como por ejemplo, las del género Zanthoxylum, arden con mucho brillo y se usan para hacer antorchas y velas mientras que las resinas de Dacryodes excelsa Vahl, Protium attenuatum (Rose) Urban, Elaphrium simaruba (L.) Rose, y Tetragastris balsamifera (Sw.) Kuntze, emanan un olor de incienso. A la presencia de estas esencias balsámicas en la madera se debe su incorruptibilidad al estar sumergidas en el agua de mar, por lo cual se usan en la confección de los botes de pesca livianos llamados "gommiers".

Las hojas de Marila racemosa Sw. poseen canales aceitosos y las de Pilocarpus racemosus Vahl segregan un aceite del cual se extrae la pilocarpina. De la madera de Pterocarpus officinalis Jacq., Maclura tinctoria (L.) Gaud., Haematoxylon campechianum L., así como varias especies de Acacia, segregan un tinte rojo. La corteza de Myristica fragans Houtt. contiene un jugo pálido viscoso. Moronobea coccinea Aubl., Tovomita plumieri Griseb., Mammea americana L. y Sapium caribaeum Urb., exudan gomorresinas amargas o coloreadas.

En la clave no están incluídos los árboles que contienen tanino los cuales son numerosos. El análisis químico de sus secreciones podrá delinear nuevos usos, dará un índice informativo de la influencia de estas substancias sobre la textura y el valor de la madera y además las relaciones que existen entre las diferentes secreciones y el sitio que ocupan los árboles que las segregan en la clasificación general de las plantas. Sin lugar a duda existen afinidades y correlaciones. En las Antillas francesas los árboles que producen resinas aromáticas con olor de incienso o elemí pertenecen en su mayoría a la familia de las burseráceas (o terebentáceas); los que producen substancias amargas, a ciertas especies de las meliáceas; los que segregan jugos aromáticos que ayudan en la combustión y arden con brillo, pertenecen a las rutáceas; los que producen goma, a las mimosáceas; los que producen tanino y flobafeno, a las combretáceas y rizoforáceas.

La clave sirve, por lo tanto, para facilitar la determinación y la distinción de estos árboles. Le sigue una lista de las referencias que se usaron en su elaboración junto con los nombres criollos de las especies en Guadalupe y Martinica.

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UN ARBORETO DE ARBOLES NATIVOS

El Instituto Politécnico de San Germán, Puerto Rico, ha reservado un rodal de 10 cuerdas en un lindero de sus terrenos con el firme propósito de crear allí un arboreto de árboles nativos exclusivamente.

El rodal está admirablemente adaptado para tal fin. El Dr. I. Vélez, profesor de biología y el Sr. L. E. Gregory, uno de los colaboradores de la Estación Experimental de Silvicultura Tropical encontraron allí setenta y cinco especies de árboles nativos. Entre los más numerosos se encuentran Hymenaea courbaril L., Ocotea leucoxylon (Sw.) Mez, y Eugenia sp.

Entre las dos especies exóticas mejor representadas en el rodal se encuentran el mango, Mangifera indica L. y la pomarrosa, Jambosa Jambos (L.) Millsp. Estos deberán descuajarse gradualmente y el área que ocupan será dedicada al cultivo de especies nativas.

El arboreto continuará siendo un lugar de recreo y esparcimiento como lo fué en el pasado y además servirá en el futuro de bosque de experimentación para las clases de biología y otras ciencias afines. Para aumentar su utilidad a este respecto el bosque se proveerá de los caminos necesarios para hacer accesibles todas sus partes y se le pondrá un rótulo metálico permanente por lo menos a un ejemplar de cada una de las especies que estén representadas en el arboreto.

La Estación Experimental de Silvicultura Tropical coopera ofreciendo su ayuda en la fase técnica del trabajo y enviando semillas y brinzales de las especies que faltan.

FUTURE MAY SEE MAHOGANY FORESTS IN FLORIDA[1]

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What kind of world shall we live in after this war is over? How drastic will be the economic changes that will determine the course of life and world commerce in those days? In an attempt to answer such questions one point is outstanding. The Americas, and the United States in particular, are determined to be more self sufficient, more completely contained. Hundreds of experiments are today under way that will, if successful, make Florida a new source of raw materials that formerly came from across the seven seas.

Production of Rhodesian mahogany, Khaya nyasica Stapf., on thousands of acres of little-used South Florida land is among the more commercially significant of these prospects. Observations in a forestry block containing 20 Khaya trees, at the Sub-Tropical Experiment Station, Homestead, and presented in table 1 indicate a marked superiority in growth of the Khaya over slash pine, Pinus caribaea Morelet, in the same plot and at the three ages measured.

Table 1.--Comparative growth data, Khaya ivorensis and Pinus caribaea.[2]

Age Years	Species	No. Trees	Average Diameter of Log: Top	Average Diameter of Log: Bottom	Average Height: Log	Average Height: Tree	Average Log Volume
			Inches	Inches	Feet	Feet	Cu. In.
9	Khaya	5	2.8	6.0	25.2	37.2	4167
9	Pine	10	2.0	3.3	11.2	21.6	739
10	Khaya	5	3.9	6.9	21.1	39.3	5538
10	Pine	7	2.3	3.4	12.7	23.8	1066
11	Khaya	10	3.4	7.3	22.1	39.9	5734
11	Pine	12	2.3	3.5	13.3	23.8	1091

Khaya nyasica--The bark of 10 year old tree was 0.25 in. thick at top of log and 0.38 in. thick at bottom.
Pinus caribaea--The bark of 10 year old tree was 0.33 in. thick at top of log and 0.67 in. thick at bottom.

1/ Reprinted from Florida Grower, August 1942.
2/ This table has been summarized from the original article.

The mahogany trees were almost twice as tall in over-all tree height and produced about twice as long a clear log length as pines of the same age. The story, from its beginning, is a fascinating and significant one.

The name mahogany has been applied, properly and improperly, to many kinds of woods during the last century. Originally mahogany was obtained solely from the West Indies and Central America from trees of the genus Swietenia in the family Meliaceae. This wood gained a unique reputation for its color, hardness, remarkably slight shrinkage, and its power of repelling the attacks of boring insects.

At present the woods on the timber markets of the world deserving the name "mahogany" come from Central America, the West Indies, and Tropical West Africa. The American woods are considered products of the genus Swietenia as mentioned before; and the West African wood is obtained in the main from two genera, Khaya and Entandrophragma, closely related in the same family to the American genus. Trees in these genera are so closely similar in foliage, flowers and seed, as well as in wood, that an experienced botanist is required to separate some of them. Lumbermen following the technical data of the Mahogany Association, Inc., consider the three species listed below as true mahogany.

West Indian Mahogany - Swietenia mahagoni Jacq., which grows in the West Indies and the southern tip of Florida.

Tropical American Mahogany - Swietenia macrophylla King., which grows from southern Mexico to northern South America.

African Mahogany - Khaya ivorensis A. Chev., is the principal species exported from Western Africa, but several other species are included under this type of mahogany.

African mahogany is often sold under the name of its port of shipment or region of derivation, such as Gambia mahogany or Cape Lopez mahogany, and is thus often confused in the markets. The color of the wood ranges from light pink through bright red to red-brown. The wood is hard, works well and produces veneer of unusual lengths and widths. As African mahogany is highly figured, most mahogany veneers are of African origin. It is also used in boat building, furniture making, and many types of finish work.

One of the several species considered as an African mahogany, Khaya nyasica, is native to the evergreen forest on the banks of streams in Nyasaland and the eastern part of Northern Rhodesia. R. J. Miller, Forest Office, Ndola, Northern Rhodesia, states it grows into a large, fine, erect tree attaining a height of over 100 feet and a girth of more than 15 feet. Trees have been reported of 200 feet in height and almost 50 feet in girth at breast height. "The wood is a rich brown color, is not attacked by borers and termites[3], weighs approximately 40 pounds per cubic foot, and works well except for a tendency to interlocking grain, which, however, results in an attractive 'striped' figure." The timber of this particular species, although of good quality, is practically unknown on our markets. In its native land the wood is often used for general building purposes but is usually employed for furniture and decorative work.

Seeds of Khaya nyasica were first secured forty years ago by the Plant Introduction Service, Bureau of Plant Industry, United States Department of Agriculture. The earliest introduction was received on January 31, 1902, from Dr. W. L. Thompson of Mt. Silinda, Southern Rhodesia, and was given the plant introduction number 8311. Dr. Thompson also sent to the Plant Introduction Service no fewer than six other lots of seed of this species from Mt. Silinda between the years 1921 and 1930. The Sub-Tropical Experiment Station received 10 plants of P. I. 85748 received at Washington on February 15, 1930, and 10 plants of P. I. 90449, received on December 5, 1930.

The February 15 introductions were planted in the Sub-Tropical Experiment Station forestry block in August 1932, as were also five of the plants of the December 5 introduction. The other five trees of the last introduction were transferred into the forestry block in May 1934, from a windbreak row. These last five were planted in dynamited holes, using one-half stick per hole. The other fifteen were planted in raw soil in any available pockets or crevices, in rows approximately 20 feet by 20 feet. The soil is Rockdale series with only a moderate amount of topsoil available. The forestry block was in second growth Pinus caribaea saplings 10 to 20 feet tall at the time the Khayas were planted among them.

Further introductions of seed were made by the Sub-Tropical Experiment Station from the Conservator of Forests, Ndola, Northern Rhodesia, in January 1936, March 1940, and May 1940. One hundred seventy plants of the 1936 introductions were planted in the forestry block under different degrees of shade and at various spacings. The remainder of this introduction and the plants from the two introductions made in 1940 were distributed to interested cooperators throughout South Florida. In three locations trial forests of fifty trees each were planted in 1941.

All of the Khaya trees growing in the forestry block are making very good growth. The oldest trees are as tall as, and in some cases taller than, the surrounding pine trees. The trees have survived low temperatures with the loss of only a few leaves. In March 1941 temperatures of 25 degrees F. were recorded in an open area within one-fourth mile of the forestry block. They do not show any injury from insects or diseases. In Northern Rhodesia this Khaya, when planted under open plantation conditions on dry land, has grown rapidly but has invariably been attacked within a few years by a shoot-

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3/ Ed. Note.—Samples of Khaya ivorensis were recently tested for termite resistance by Dr. G. N. Wolcott of the Puerto Rico Agricultural Experiment Station at Rio Piedras. This related species, while possibly differing in this respect from K. nyasica was found to have low resistance to attack by Cryptotermes brevis Walker, the common dry-wood termite of the West Indies.

borer (probably Hypsipyla sp.). This attack so kills back the stems that, in spite of frequently throwing out new shoots, growth is so completely arrested that the trees are often killed.

In the summer of 1941 measurements were taken of the 20 Khaya trees first planted in the forestry block. The ten oldest trees were considered as 11 years from seed, the five from the next introduction as 10 years old and five from the last Bureau of Plant Industry introduction which were transplanted were considered 9 years from seed. The volume of clear saw log was the object of the measurement. A good number of the Caribbean pines among which the Khaya were planted were measured also and their age determined by the use of an increment borer at 4 feet height with adjustments for seedling growth. Enough pines were measured so that there were data for as many pines of the same ages as there were Khayas. The length of the log was measured from a normal stump-cut to where the heavy branches were forming on the trees. Girth measurements were made with a steel tape at the top and at the bottom of the log. If the log was more than 20 feet the girth was taken at 20 feet. The average of these two was considered the log circumference, from which the average diameter was calculated. Total tree height was measured by triangulation to the tops of the tree foliage.

The maximum and minimum values for each measurement varied widely in each group for both species. As the number of trees measured in each sample was necessarily small, this variation must be borne in mind in the evaluation of the data.

The diameter at the bottom of the log of the Khaya trees was almost twice as great at 9 years and more than twice as great at 10 and 11 years of age as that of pines of a similar age. The greatest difference, however, is in the comparison of log volumes. At all three ages the Khaya produced a little more than five times the volume of potential log of the pines. The bark was calculated into this volume. It can be noted also from table 1 that the bark on the Khaya was not as thick as on the pine. This would tend to accentuate the difference in actual wood volume. The general increase in tree size and log volume as the trees increase in age is shown for both Khaya and pines.

The growth made by these young African mahogany trees has been most spectacular, especially when compared to the native Caribbean pines. How they will continue to grow and what diseases and insect pests they may eventually fall heir to remain to be seen in the future. The older trees have not bloomed to date. In the summer of 1940 one 3-1/2 year old tree put out a large panicle of bloom but failed to set seed. In a conversation with Dr. W. L. Thompson in 1940, he stated that the trees attained a large size and were about 20 years of age before they bloomed in Northern Rhodesia.

From their performance to date the Khayas appear to be the most promising hardwoods for reforestation in South Florida that have been tested by the Sub-Tropical Experiment Station. As there are many other species of African mahogany belonging to the genus _Khaya_, to say nothing of the species of the related genus _Entandrophragma_, this species can well be named "Rhodesian mahogany".

Summary

A recent introduction of Rhodesian mahogany, *Khaya nyasica*, into southern Florida by the Sub-Tropical Experiment Station, Homestead, has shown this species well adapted to the region.

Seeds of *Khaya nyasica* were brought from northern Rhodesia and were planted on the Experiment Station property in 1930. Three separate plantings were made which are now considered 9, 10, and 11 years old.

Measurements in these three plantations and in adjacent plantings of *Pinus caribaea* indicate that the growth of Khaya is definitely superior to that of the pine. Diameter growth was about twice as great and average merchantable and total heights were nearly twice as great for the Khaya.

As this species produces a wood with most of the desirable characteristics of Central American mahogany, *Swietenia* sp., it would seem desirable to plant it on little-used lands in southern Florida.

Resumen

La reciente introducción de la caoba de Rhodesia, *Khaya nyasica*, en el sur del estado de Florida por la Estación Experimental Subtropical de Homestead, ha demostrado que la especie se adapta bien a esa región.

En el 1930 se trajeron semillas de *Khaya nyasica* de la Rhodesia septentrional las cuales se sembraron en los terrenos de la Estación Experimental formando tres plantíos distintos que hoy tienen 9, 10 y 11 años.

Al medir los árboles en estos tres plantíos y hacer una comparación con plantíos de pino adyacentes, se encontró que el crecimiento de la *Khaya* es definitivamente mayor que el del pino. El crecimiento en diámetro fué el doble y la altura total así como la altura maderable fueron casi el doble.

Por lo tanto, debido al hecho que esta especie produce una madera con casi todas las características deseables de la caoba centroamericana, *Swietenia* sp., sería conveniente sembrarla en aquellos terrenos de poca utilización en el sur de Florida.

<u>RETENTION OF CREOSOTE OIL IN THE WOOD</u>

OF <u>PINUS OCCIDENTALIS</u> SWARTZ[1]

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The Duke University School of Forestry in collaboration with the United States Tropical Forest Experiment Station in Puerto Rico has initiated a program of research dealing with the determination of pertinent physical-mechanical properties of important tropical American timbers. One phase of this program is concerned with the behavior of certain of these woods in the treating cylinder. This paper reports the results of a series of oil impregnation experiments using wood of <u>Pinus occidentalis</u> Swartz from Haiti.[2]

Selected trees were felled and bucked into four-foot lengths and then sawn into flitches in accordance with A.S.T.M.[3] recommendations. After coding, the flitches were wired into bolt form and end-coated with tar to minimize drying and checking during shipment. The flitches, upon their arrival, were sawn and dressed into pieces of standard dimensions used in ascertaining strength data. The surplus heartwood was cut into 3 in. by 3 in. by 24 in. columns, numbered, painted with a 2 per cent solution of mercuric chloride to prevent the activity of blue stain fungi, and then stacked in open cribs for two months to permit drying.

Using Tippett's random sample numbers, four sets of four pieces each were drawn from the air-dried stock for use in the pressure cylinder. The moisture content (12 to 16 per cent) of each piece was determined with a Tag-Hepenstal resistance meter. Four experimental runs, simulating industrial practices as nearly as possible, were made using No. 1 creosote oil with schedules as indicated in Table 1.

Tables 2 and 3 present the observe physical data for each specimen treated, together with calculated oil retention per cubic foot of material.

1/ Reprinted from Tropical Woods No. 71, September 1942.
2/ Acknowledgements are due Mr. L. R. Holdridge, Societe Haitiano-Americaine de Developpement Agricole, Port-au-Prince, Haiti for his kindness in supplying the timber used in this study.
3/ American Society for Testing Materials. Standard Methods of Testing Small Clear Specimens of Timber, D143, 1927.

Table 1.—Treating schedules for each run.

Process	Run	Preliminary vacuum		Preliminary air pressure		Oil pressure		Final vacuum	
		Time in hours	Inches of mercury	Time in hours	Pounds per square inch	Time in hours	Pounds per square inch	Time in minutes	Inches of mercury
Bethell	1	1	28	-	-	4	200	5	26
Rueping	2	-	-	1	150	4	200	30	27
Bethell	3	1	28	-	-	2	200	5	27
Rueping	4	-	-	1	150	2	200	30	27

Table 2.—Specimen data, Bethell process.[1]

Run No.	Specimen Number	% Moisture Content	Air-dry weight lbs.	Volume of specimen cu. ft.	Oil retention lbs.	Calculated oil retention lbs./cu. ft.
1	4	14	5.49	.125	3.77	30.16
	11	14	6.21	.125	3.55	28.40
	17	12	5.28	.125	3.78	30.32
	27	12	5.30	.125	4.13	33.04
3	25	14	5.51	.125	4.03	32.24
	12	14	6.08	.125	3.57	28.56
	18	12	5.67	.125	3.90	31.20
	5	14	6.01	.125	1.65	13.20

1/ Specimen 3 was encased between steel end-plates to minimize end penetration.

Table 3.—Specimen data, Rueping process.1/

Run No.	Specimen Number	% Moisture Content	Air-dry weight lbs.	Volume of specimen cu. ft.	Oil retention cu. ft.	Calculated oil retention lbs./cu. ft.
2	10	16	6.02	.125	.81	6.48
	20	14	5.61	.125	.89	7.12
	7	12	5.98	.125	.78	6.34
	14	12	4.83	.125	1.25	10.00
4	23	12	5.49	.125	.59	4.72
	6	13	5.93	.125	.66	5.28
	8	12	6.06	.125	.82	6.56
	13	12	4.95	.125	.78	6.24

1/ Specimen 4 was encased between steel end-plates to minimize end penetration.

Results of this study indicate that the wood of Haitian pine will accept adequate amounts of oil using standard industrial practices. Specimens treated by means of the Bethell process absorbed oil to the point of refusal suggesting that a shorter pressure period could have been used and that suitable penetration in materials of larger dimensions may be anticipated. The average oil retention for the four pieces of Run No. 1 was 30.48 lbs./cu. ft. and that for Run No. 3, 26.32 lbs./cu. ft.; retentions far above those specified as minimum by the American Wood Preserver's Association. The average retention, however, for the two runs in which the Rueping process was employed, was only 7.46 and 5.68 lbs./cu. ft. respectively. These are minimum and it is recommended that somewhat longer pressure periods should be used than those currently employed.

Resumen

La Universidad de Duke en cooperación con la Estación Experimental de Selvicultura Tropical efectuó un estudio sobre la impregnación del pino de Haiti, *Pinus occidentalis*, con aceite combustible creosotado usando los procedimientos Rueping y Bethell.

Los resultados de las diversas pruebas efectuadas que aparecen en las tablas del texto indican que la retención del aceite por el procedimiento Bethell fué 4 ó 5 veces mayor que la del procedimiento Rueping.

FORESTS AND FOREST ENTOMOLOGY

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(Presented at a joint meeting of the Zoology and Forestry Sections of the S.A.C.A., Puerto Rico Chapter, Rio Piedras, April 4, 1942.)

The science of forest entomology had its beginnings in Germany, the first country to develop forestry, during the first part of the nineteenth century, and has since made great progress in many countries paralleling the development of scientific forestry. In our small island very little has been done on this phase of forestry although the protection of forests from destruction is a basic requirement. Fire, fungi, and insects are generally the most destructive elements in forests. The first, fortunately is not important in Puerto Rico, but our climate substitutes another direct source of forest destruction: the hurricane. Hurricanes have extensively damaged our forests, yet no even approximate figures are available to show the extent of the damage and little is known concerning the less obvious losses due to fungi.

It is the purpose of this paper to indicate some of the kinds of injuries caused by insects to the forests of Puerto Rico. Injury due to insects starts even before the tree seeds are planted. Many seeds are attacked by granary pests during storage, and often by other insects while they are still on the tree. Injury continues at every stage of the development of the forest; when seeds are planted, as the seedlings grow, later on when transplanted, and finally after a period of years develop into large forest trees. Injury by insects does not cease when these are cut, the timber sawed, and then used by man. In all this cycle some insects are in constant relation with the trees, from the beginning to the end, from the small, tiny seeds attacked during storage to the finished product.

To illustrate the great damage caused by insects to forest and forest products, I give some examples:

In a survey made in California in 1931 the losses of merchantable timber due to bark beetles in that year totaled about 1,250,000,000 board feet, or nearly $3,000,000 in stumpage value.

The lodgepole pine forests of Idaho, Montana and Wyoming, particularly those near Yellowstone National Park, have suffered losses during the ten years ending in 1932 totaling 7,250,000,000 board feet; more than 36,000,000 trees having been killed in one National Forest alone.

The Planting Division of our Caribbean National Forest has given me the following information on losses sustained as a result of attack by a single insect. The cedar shoot borer, Hypsipyla grandella Zeller, has been responsible for the loss of 835,000 mahogany trees and nearly 1,000,000 cedars from our plantations since 1935. With a value of 7-1/2 cents per tree the total loss is in excess of $137,000. No control is known for the borer, which has precluded the planting of cedars in Puerto Rico.

Of the many urgent entomological problems of our Island, I present a few:

Practical control measures for insect pests attacking seeds are rarely practised. Methods of collection and storage of forest tree seed in order to prevent destruction by insect pests must be developed.

No satisfactory methods for the control of such nursery pests as mole-crickets, white grubs, curculionid larvae ("vaquitas"), ants, and cutworms exist.

One of our common scale insects, Asterolecanium pustulans Cockerell, commonly known as the pustule scale, has been responsible for the nearly complete eradication of the silver oak, Grevillea robusta Cunn., in Puerto Rico, and now is attacking the yellow cassia, Sciacassia siamea (Lam.) Britton, a species of value for firewood. One of our beautiful cabinet woods, "maga", Montezuma speciosissima Sessé & Moc., appears to be the next victim. Scale insects were also responsible for the nearly complete destruction of a stand of an introduced ash (Fraxinus sp.) at El Guineo Lake, in the Toro Negro Unit, and of Cinchona plantings near Maricao.

The aceitillo weevil, Apion martinezi Marshall, is important in that it prevents successful propagation of aceitillo, Zanthoxylum flavum Vahl, possibly our most valuable cabinet wood. Nearly all the seeds are destroyed by the larvae of the weevil.

The seeds of Neltuma juliflora (Sw.) Raf., our common mesquite are also subject to attack by three species of insects found in the pods, two of which were recently described as new to science.

The termite is always troublesome, not only in our forests and in roadside plantings, but primarily attacking forest products. With the increased importation of coniferous building woods as sitka spruce and southern pine, and temperate zone hardwoods, all of which are susceptible to attack by the "polilla" or dry wood termite, Cryptotermes brevis Walker, this insect has increased rapidly during recent years. "Comejenes" or moist wood termites are also at work, attacking the beautiful Puerto Rican roadside trees. A flamboyán tree, Delonix regia (Bojer) Raf., without a "comején" nest or tunnel is hardly typical. We have become used to seeing them everywhere.

These are but a few examples. There are many more entomological problems related to forestry, and more will continually present themselves as forestry and entomology progress in our American tropics. The warm regions of the world present a more complicated study than the cold, for here the insects thrive throughout the year, making control more difficult.

One of the first requisites for forest entomology is a sound basis of silvics and silviculture. Not until one knows trees is he in a position to apply his entomological knowledge to them. No study of a tree species is complete without a related study of the insects as well as diseases affecting it in all stages of its development.

Now that the practice of forestry is increasing in Puerto Rico and will in future years become very important in South America, the study of forest entomology should also be expanded. As in the very beginnings when the work of the forester and the forest entomologist started together, their relationship should be maintained by parallel development and cooperation.

I hope to see forest pathologists as well as entomologists working on our forest problems in the near future. Conditions are now abnormal, but peace will come and with it the thoughts of men will return to the preservation of natural resources.

Resumen

En Puerto Rico, los insectos del bosque y su importancia en la economía forestal se han estudiado poco. En el futuro debe prestársele más atención a esta fase de la dasonomía para prever los problemas relativos a los insectos antes de que surjan en toda su intensidad.

En los Estados Unidos el daño que causan los insectos al bosque asciende anualmente a millones de dólares. En Puerto Rico, el *Hypsipyla grandella* Zeller ha destruído cientos de miles de árboles de cedro y caoba. No se conoce ningún método de combate efectivo para esa plaga.

Es poco lo que se sabe acerca de los métodos prácticos para combatir los insectos que destruyen las semillas. *El Asterolecanium pustulans* Cockerell ha atacado severamente y casi destruído algunas de nuestras especies forestales más importantes. El *Apion martinezi* Marshall destruye casi todas las semillas del aceitillo, *Zanthoxylum flavum* Vahl, haciendo casi imposible la propagación de esta valiosa especie.

Los termes, particularmente el *Cryptotermes brevis* Walker, atacan tantas de las maderas locales que la mayoría no pueden utilizarse en la fabricación de muebles.

Debido al énfasis creciente que se le está dando hoy día a la práctica de la dasonomía tanto aquí como en todos los países de la América latina, deben hacerse los preparativos pertinentes para que las investigaciones entomológicas destinadas a resolver los problemas creados por los insectos sean efectuadas conjuntamente con las prácticas de selvicultura.

THE IMPORTANCE OF RACE IN TEAK, *TECTONA GRANDIS* L.

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Teak is one of the foremost timber trees of the East and is native to monsoon-type forests (i.e. where there is a seasonal alternance of wet and dry seasons) in India, Burma, Siam and Indo-China. Centuries ago it was introduced into Java where it became naturalized, and was widely planted, so that in 1930 Java possessed 720,829 hectares of pure teak forests (1,800,000 acres). In view of its peculiarly fine qualities, teak has been carried to all the corners of the tropics. It arrived in the West Indies during the nineteenth century and old trees may be seen in various botanical gardens. It does not seem to have been tried as an economic timber crop, however, until 1913, in which year Mr. C. S. Rogers, Forest Officer, Trinidad, imported a small parcel of teak seed from Tenasserim in Lower Burma. Two small plantations were established in Trinidad which at the time of writing are just 30 years old. These trees yielded seed, with which trials were extended. Such success resulted that the species was taken up as a major commercial proposition and is now being planted at the rate of some 400 acres annually. All the seed required for annual operations is obtained from trees which were raised from seed collected in the plantations of 1913; in other words, present plantings are in the second "creole" generation.

The teak thus being grown in Trinidad fall, according to sample plot measurements, in a quality class slightly above the average of Quality II of Nilambur, India, according to the Nilambur Yield Tables. They are subject to no pests or diseases and are of excellent bole form.

In 1935 the late Professor R. S. Troup suggested that an investigation should be made as to whether Trinidad's stock was satisfactory or could be improved by fresh importations of seed from selected strains. There was reason to believe that the seed brought from Tenasserim had been collected from low, branchy trees in the paddy fields, though there was no evidence that these trees were genetically distinct from true forest teak. A request was therefore sent to the Silviculturist at the Forest Research Institute, Dehra Dun, India, for selected samples of seed, and a reply was received as follows:

> "I have asked the Silviculturists of Burma and Madras each to send you 4 lbs. teak seed from their best moist teak localities. There are well defined vegetative differences between the teak from these two localities though inherent timber and bole form differences have not yet been systematically sought for or discovered."

In June 1936, 4 lbs. of teak seed were received in Trinidad from Shencottah Division, Travancore State (Southern India) and were sown. No seed arrived from Burma. Unfortunately most of the seed sent did not germinate and for the planting season of 1937 (June) only about 150 plants were available. A plot containing 0.137 acre was however formed in the 1937 teak coupe at the Southern Watershed Reserve by the standard local method of stump-planting at 6 x 6 feet. The plot is located at an altitude of 200 feet and receives an annual rainfall of 65 inches. During the dry season from January to April 1/2 to 3 inches of precipitation falls monthly. During the rest of the year it varies from 4 to 14 inches monthly. The soil is a silty clay derived from a sedimentary formation. The aspect is southeast; the slope is moderate; and drainage is good.

The plot is entirely surrounded by teak of the local stock, which will be referred to as "Burma teak" in distinction to the "Indian teak".

At six years old the plot of Indian teak was thinned and measurements were taken with the result shown in table 1.

Table 1.—A comparison of the growth of Indian and Burma teak.

Criteria	Indian Teak	Burma Teak[1]
Standing Crop after Thinning		
Number of trees per acre	493	615
Average tree		
Girth at 4 ft. 3 in. - inches	14.75	14
Total height - feet	32	42
Average height of dominants - feet	36	47
Form factor	.156	.204
Bark per cent	53	30
Basal area per acre - square feet	46.0	48.9
Volume per acre under bark - cubic feet	230.0	312.5
Intermediate Yield		
Number of trees per acre	456	362
Average tree		
Girth at 4 ft. 3 in. - inches	10.75	10.50
Total height - feet	31	38
Basal area per acre - square feet	23.1	15.4
Volume per acre under bark - cubic feet	98.6	72.6
Total Crop		
Basal area per acre - square feet	69.0	74.3
Volume per acre under bark - cubic feet	328.6	385.1
Mean Annual Increment		
Basal area per acre - square feet	11.5	12.4
Volume per acre under bark - cubic feet	54.8	64.2

1/ Average at Southern Watershed Reserve.

The comparative figures shown were obtained by averaging the figures of three sample plots in Burma teak on similar soil and situation within a radius of half a mile from the plot of Indian teak. These three sample plots agree fairly closely in quality with each other and also, according to the measurement of a few selected trees felled, with the teak immediately surrounding the Indian plot. It is unfortunate that the latter is so very small: more accurate measurements could have been taken if it were of larger area.

A heavier thinning is shown as having been made in the Indian plot. This is merely in accordance with recent practice in Trinidad, the comparative figures dating from 1935-37. It does not affect the results under consideration. The Indian trees are markedly inferior in height growth, a whole quality class lower. In point of over-bark girth they are superior but this is offset by the much greater thickness of the bark, bark per cent being 53 as against 30 in the Burma teak. Total volumes and mean annual increment are inferior in the Indian trees. Form of the Indian trees is very definitely poor and must be inherent, for the immediately adjoining Burma teak are of excellent form. Almost all stems are wavy, very few being absolutely straight, and a fair proportion (12 per cent) had bent over towards the southeast, i.e. down the slope, and towards the prevailing wind. Burma teak grown locally are of very straight growth. Table 2 summarizes vegetative differences between the two varieties.

Table 2.—Vegetative differences between Indian and Burma teak.

Character	Indian Teak	Burma Teak
1. Length of internodes:		
Young stem up to 7 ft.	4" - 6"	8" - 13"
Branches	2-1/2" - 3"	2-1/2" - 4-1/2"
2. Stem	Wavy	Straight
3. Small branchlets	Many	Few
4. Leaf surface	Shiny and smooth	Rough
5. Leaf size		
Sun leaves:		
Petiole	1-1/2"	1"
Lamina	9"-10-1/2" x 4-1/2"-6"	20"-24" x 15"-16"
Shade leaves;		
Petiole	3/4"	Nil
Lamina	9"-13" x 6"-8"	20"-24" x 12"-15"
6. Flush leaves	Green	Deep red-purple
7. Flowers and fruit	Not examined	Not examined

An apparent greater density of the Indian teak is to be inferred from a noticeably greater hardness. It is not yet possible to test relative durability as hardly any heartwood is as yet being formed.

The marked vegetative differences between the teak of India and Burma referred to in the Silviculturist's letter are thus established, and it is evident that the two belong to markedly different "races". These are not recognized botanically even as varieties, presumably because there is no variation in the flowers.

Race in trees has long been recognized in Europe, where trees such as larch and pine in different localities are known to be of different growth and form--hereditary differences which persist in a new environment. In Java where much work has been done on teak, several races of teak are recognized. Experimental plots have even been laid out to compare them.1/ Seven strains in all were compared: from Malabar, Godavari and the Javanese. Indian forms were all found to be of bad shape with heavy branching, and those from the north of India showed inferior height growth. Siam and Burma teak races were found to be the best both in form and height-growth. Each race could be easily distinguished by vegetative differences such as those noted in Trinidad.

The indications certainly are that Trinidad luckily obtained one of the best races of teak in the preliminary trials. Had the first importation of seed been made from Northern India, teak in Trinidad might well have been judged a failure. Others in tropical America who contemplate trials with teak should bear this in mind. Best results will be obtained from planting in Burma or Siam, and seed should be obtained only from a reliable source. There are a number of old teak trees in the Botanic Gardens in St. Vincent, which appear to belong to an Indian race. When experimenting with a view to starting afforestation two years ago, the Agricultural Department of St. Vincent imported planting stock (of Burmese race) from Trinidad instead of collecting seed from these trees. The young trees show considerable promise and are probably superior to those which would have been raised from the trees already growing in St. Vincent.

Summary

Teak has been raised in Trinidad from seed imported both from India and Burma. There are marked differences between the quality of the two strains, and vegetative differences which divide them into separate "races". In Java several distinct races of teak are recognized and trials have shown those from Burma and Siam to be the best. Those who wish to introduce teak in tropical America should be careful as to the source of their seed.

1/ See reports in "Tectona", organ of the Forest Service in Netherlands' India.

Resumen

El establecimiento de plantaciones de "teca" en Trinidad se inició en el 1913 con la importación de semilla del sur de Burma. Los árboles crecieron bien y por lo tanto anualmente se siembran 400 acres de arbolitos obtenidos de la semilla de los plantíos más maduros.

Para determinar si la semilla que se estaba usando era la mejor que se podía obtener se importó un segundo lote del sur de la India. Un estudio de los plantíos que se lograron con esta semilla demostró que es inferior a la de Burma ya que el rendimiento es menor y la forma del árbol es deficiente.

Los resultados obtenidos muestran que cualquier Departamento Forestal interesado en la "teca" debe obtener su semilla preferiblemente de Burma y Siam.

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LA CREACION DEL NUEVO BOSQUE EXPERIMENTAL CAMBALACHE

La Estación Experimental de Silvicultura Tropical en representación del Servicio Forestal de los Estados Unidos, firmó recientemente un acuerdo con la Autoridad de Tierras de Puerto Rico para reservar un área de 660 cuerdas con el propósito de establecer un bosque experimental. Se escogió un trecho situado en la región caliza seca cerca de la costa norte entre Barceloneta y Arecibo.

El área consta de colinas calizas de 200 a 300 pies de altura separadas por pequeñas áreas llanas. La precipitación pluvial anual es de 50 pulgadas. El bosque que allí existe ha sido talado ya, pero contiene aún algunos de nuestros árboles de maderas más preciadas aunque en su mayoría son pequeños. Entre ellos encontramos a Montezuma speciosissima Sessé & Moc., Coccolobis grandifolia Jacq., Bucida buceras L., e Hymenaea courbaril L. Un reconocimiento preliminar indicó que el bosque comprende un gran número de especies, algunas de las cuales se conocen hoy día sólo de nombre.

Después que se hagan las provisiones necesarias para la protección adecuada y la ordenación en banda el área será dividida en tres compartimientos: (1) una superficie circular para estudiar el rendimiento, (2) una parte para estudios de siembra, crecimiento y silvicultura y por último (3) un área que no ha de tocarse y que será dedicada a un estudio ecológico.

Los objetivos de las investigaciones en este bosque serán: (1) determinar la utilidad y durabilidad de varias de las maderas que pueden obtenerse de allí y que son relativamente desconocidas, (2) determinar los métodos silvícolas que deben emplearse para encauzar las mejores especies, (3) determinar si tiene valor práctico el introducir en este bosque varias especies preciosas, y (4) determinar el crecimiento de los rodales y de las distintas especies para tener una base con la cual pueda estimarse el máximo rendimiento anual constante y poder preparar así un plan dasocrático detallado.

THE LAS COBANITAS CAMPECHE PLANTATION

Frank H. Wadsworth
Tropical Forest Experiment Station

The chief forest problems of Puerto Rico have resulted from the clearing of forest lands. Consequently efforts to reforest such lands have constituted a major phase of the work done in the government-owned National and Insular Forests.

One of the first plantings made in 1924, was with campeche, or logwood, Haematoxylon campechianum L. Though the early records of this plantation have been lost as a result of the 1928 hurricane, part of the information was found to be still available through the Forest Guard, Mr. Oscar Rivera, who was on hand at the time the planting was made.

The planting site was Las Cobanitas arroyo in the northern portion of the Guánica Insular Forest in the arid southwestern part of the island. The soil is a colluvial stony clay of volcanic origin. The slope averages 10 per cent, and drainage is good. The soil surface is loose and granular in texture.

The average annual precipitation at nearby Ensenada is 27 inches and the temperature averages approximately 80° F. The original forest was short, deciduous, and rather open as a result of the low rainfall and the protracted dry season each year. The dominant species in the climax was evidently úcar, Bucida buceras L.

The seed was imported from Mexico, presumably to start local production of dyewood. The stock was raised in the Rio Piedras forest nursery. When about 15 inches tall it was sent by train to the field. The trees arrived in November, at the beginning of the dry season. The site, which was covered with low herbaceous vegetation at that time, was prepared by plowing furrows for the trees. Approximately 30 acres were planted with 20,000 trees, spaced 8 x 8 feet. Early survival was good and no replanting or weeding was done.

The general appearance of the plantation at the present time, 18 years after planting, is shown in figure 1. No thinning has been done, so it is possible to determine the survival which is approximately 75 per cent, giving a stand of 510 trees per acre.

The characteristic spreading growth of this species, as shown in figure 2, makes measurement of growth difficult. Nearly one fourth of the trees were forked at the ground level, and at the breast height point (4.5 ft.) the average number of stems per tree was 2.8. Probably the measurement which has the greatest meaning is diameter above the butt swelling, as at this point (6 to 12 inches above the soil) most of the trees have but one stem. However, even at this point error results because most of the stems are fluted and therefore present an irregular cross-section. The average diameter of the trees at this point, as determined with a diameter tape in a 0.37 acre plot is 7.0 inches, and the basal area is 138.2 square feet per acre.

Fig. 1.—A general view of the 18 year old plantation showing the spreading habit of the trees.

The growth of this plantation is slower than that in Jamaica.1/ Part of the difference may result from the fact that this site is more arid than any on which this species is found in that country. However, another factor adversely affecting growth, and one which is obvious, is stagnation. The spreading habit of this species, so characteristic of many trees on dry sites, indicates its preference for wider spacing than that of this plantation. The branches are interlaced, little herbaceous cover is found beneath the trees, and the basal area is undoubtedly very high for this site. Trees as large as 15 inches in diameter are found in openings.

The density of the canopy has prevented the abundant natural reproduction from growing beyond the sapling stage except in scattered openings. These young saplings, found under many parts of the stand, do not appear destined to survive unless they are released.

1/ Comparative notes were furnished by C. Swabey, Conservator of Forests, Jamaica.

Fig. 2.—An 18 year old logwood or campeche tree, 8 inches d.b.h., showing the fluted bole.

At present the stand is of no commercial value for dyewood, and in view of the uncertain future demand for natural dyes, it is doubtful that the trees should be appraised for other than their fuel value. For this purpose the stand may be considered mature and should be cut either partially or completely, depending upon the objectives of management. The apparent stagnant condition points to the need of a partial cutting to improve growth of the smaller trees and the saplings. Such a cutting, removing half of the basal area will tend to perpetuate campeche which is almost the only species reproducing on the site.

If campeche is to be valued only for fuel either of two other species should be artificially introduced to increase the yield of the site. Bayahonda, Neltuma juliflora Sw., has invaded and is growing well on similar sites nearby. It is a rapid growing coppice and produces excellent fuel and durable posts. Dominican mahogany, Swietenia mahagoni Jacq., has already been underplanted in parts of the stand. This species grows well in the vicinity and should provide more yield than the campeche.

Measurements of current growth and studies of reproduction and conversion techniques are being planned as a part of the Station's research program for the near future.

Resumen

En el árido Bosque Insular de Guánica, en Puerto Rico, se estableció en 1924 una plantación de campeche, Haematoxylon campechianum L. Los árboles se plantaron en surcos y no se les ha desyerbado ni aclarado desde entonces. La supervivencia es de cerca de 75 por ciento y el promedio de crecimiento en diámetro en la base es de 7.0 pulgadas.

El rodal está ahora apiñado lo cual parece haber influído adversamente en el crecimiento. Los árboles no son lo suficientemente grandes para usarse en la fabricación de tintes y como la demanda de madera para extraer tintes está decayendo la plantación debe valorarse primordialmente de acuerdo con la leña que puede suministrar.

El campeche no parece dar un rendimiento en leña tan grande como la bayahonda, Neltuma juliflora Sw., debido a lo cual se tratará de suplantar el campeche por esta especie en una parte de la plantación. Como la caoba dominicana, Swietenia mahagoni Jacq., crece bien aquí, otra parte del área en cuestión será substituída experimentalmente por esta especie.

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¿QUE PUEDE LOGRAR LA REFORESTACION?

La reforestación va más allá del mero hecho de sembrar árboles o de levantar una cosecha forestal. Significa de por sí el mejoramiento de la tierra. Sirve (1) para mantener el suelo arenoso fijo, (2) para evitar las inundaciones, (3) para proveer con un refugio natural a la vida silvestre, (4) para proteger las tierras inhabitadas del viento y la nieve, y por último (5) para devolver la fertilidad al terreno baldío formando la capa humífera. Y a estos servicios tan útiles de los árboles se añaden las bellezas del bosque y las oportunidades que ofrece para la recreación saludable. (Tomado de una conferencia dictada en el N. Y. Botanical Garden por E. W. Littlefield, miembro del State Department of Conservation.)

FOREST LAND ASSESSMENT POLICY IN JAMAICA

In the Empire Forestry Journal, Vol. 21, No. 2 (1942) appears an article "The Development of Forest Policy in Jamaica" by C. Swabey, Conservator of Forests. Obviously the article was prepared only after considerable study of Jamaica's forest problem and deserves the attention of all foresters in Latin America.

As many of the countries of the Caribbean, and particularly the Antilles are now, or will be, faced with problems similar to those in Jamaica, a portion of Mr. Swabey's article dealing with forest land assessment considered of especial interest, is quoted because of its fundamental nature:

"It is not possible or desirable to lay down hard and fast rules as to what areas should or should not be in forest; it is, however, possible to indicate certain basic considerations which should govern every assessment:

1. In view of the high and increasing density of population it is essential that every acre in the island should be put to its highest use.

2. Land which is capable of permanent productive agriculture must be retained or developed as such, provided this can be carried out without affecting disproportionately water supplies, flood control, etc.

3. In normal times the proximity of the North American continent permits the importation into Jamaica of supplies of softwood at a reasonable rate; there is no reason to suppose that there is a likelihood of this source of supply becoming permanently unavailable. It is therefore, believed that there is no justification for maintaining forest solely for timber production on land intrinsically suitable for agriculture. In this the Division is guided by the realization that probably 25-30 per cent of the total land area of the island is unsuitable for agriculture, and it is on these areas that timber production should be concentrated.

4. It therefore follows that forest areas should be confined:

    (a) to areas unsuited to any form of permanent agricultural usage, or to areas yielding higher returns under forest management, than under agricultural management; and

    (b) areas possibly suitable for agriculture, but which must be maintained under forest for protective purposes (water supplies, flood control, etc.).

5. Finally, it cannot be too strongly stressed that the selection of forest areas for protective purposes must be influenced by the agricultural practices followed on adjoining lands. Protective forests can only be of value if adequate soil and water conserving methods are practised on the agricultural lands in the watershed."

REORGANIZATION OF FOREST SERVICE ACTIVITIES

IN TROPICAL AMERICA

All activities of the Forest Service of the United States Department of Agriculture, which deal with research, administration and cooperation in tropical forestry, have been reorganized and placed under a Director of Tropical Forestry with headquarters at Rio Piedras, Puerto Rico. This action brings together under one head the direction of the Tropical Forest Experiment Station, the protection and management of the Caribbean National Forest, the services rendered to the Insular Government in the administration and management of the Insular forests, and the forest resources projects being handled cooperatively with certain Latin-American countries. Arthur T. Upson has been appointed by the Secretary of Agriculture to this newly created federal position of Director of Tropical Forestry, and by the Commissioner of Agriculture and Commerce of Puerto Rico to the position of General Superintendent of Insular Forests.

The consolidation of the heretofore separately supervised forestry activities, besides continuing the present programs of forest research and administration, will aid the progress of tropical forestry in a number of ways. The forest research program itself can be more closely correlated with the needs of the protection and management of forest lands and the utilization of forest products throughout Puerto Rico, whether those lands be in private, Insular, or Federal ownership. The Caribbean National Forest, besides being administered for the social and economic benefit of the Island's people, can be used as a testing ground for the practical application of results of forest research. Similarly the results of such research will be employed on the Insular forests. The protection, management and development of the two units making up the Caribbean Forest and the many units making up the Insular forests, can be coordinated to the extent that the difference in laws applicable to each will permit. The inclusion of the general direction of the cooperative forestry projects conducted for Latin-American countries is a still further step in the correlation and integration of all elements of tropical forestry. Thus the Tropical Forestry Unit should become the center for the interchange of knowledge in the entire forestry field between the United States and its American neighbors.

A graduate in forestry from the University of Nebraska, Mr. Upson has had 33 years of experience in research and administrative and industrial forestry. It comprised 21 years in the U. S. Forest Service, 11 years with the National Lumber Manufacturers Association, and one year as Chief of the Lumber and Lumber Products Division of the War Production Board. From the latter position he took up his duties as Director of Tropical Forestry in May 1943.

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HOW TO MAKE WOOD UNPALATABLE TO THE WEST INDIAN DRY-WOOD TERMITE, CRYPTOTERMES BREVIS WALKER. I. WITH INORGANIC COMPOUNDS

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The scarcity of old wooden houses in Puerto Rico is largely due to their destruction by hurricanes and termites. Hurricanes are unpredictable and may not occur for long periods of years, but the termites are present all the time, and the damage they cause is steady and cumulative. Indeed, one may say that they are even more certain than death and taxes. Of the numerous species of termites occurring in Puerto Rico, the wet-wood termite, or "comején", which constructs nigger-head nests and large carton tunnels from its next to points of attack on wood, is comparatively little to be feared, for it can readily be controlled by putting dry Paris green in its main tunnels or on top of the nest. The various species of subterranean termites, have, until recently, been scarce or of localized distribution, and methods of control have not been needed. The West Indian dry-wood termite, Kalotermes (Cryptotermes) brevis Walker, locally known in Puerto Rico as "polilla", and generally present throughout the neotropical region, is by far the most destructive and most to be feared because of the insidious nature of its attack. It constructs no external nest, and no external tunnels, but lives and feeds entirely within infested wood, giving no outward indication of the injury it is causing. All the moisture it needs for any stage of existence can be extracted from dry wood, thus it can live within the timbers of houses kept dry by a roof, and in furniture, in books and stored papers, and even in picture frames on the wall. As a commensal with man, it is no country cousin, but essentially a city or town dweller, and as truly symbiotic with man as cats and dogs, cockroaches, bedbugs and silverfish, and, if anything, even more difficult to get rid of.

The Spanish have no word differentiating butterflies from moths, but the minute clothes-moth (and the injury which its larva causes to woolen clothes) is called "polilla". In the tropics, the little insect that causes a somewhat similar injury to wood came to be called "polilla de madera", and eventually simply "polilla". Even this does not begin to show all the changes that may occur in a language in a new environment and confronted with new conditions to be described, for as the clothes-moth is recognized (if at all) largely by the damage caused by its larva, which is a minute caterpillar, so the dry-wood termite is recognized largely by the grains of its hard, lozenge-shaped excrement, which is seen in little conical piles on top of infested wood, or loosely scattered over the floor when dropped from an infested ceiling, and it also is called "polilla". Only well-informed people know the winged adults of the polilla, which swarm about lights on humid nights in the late spring, breaking off each others wings and seeming to be playing "follow the leader", with the leader invariably trying to be last. By next morning, one recognizes a flight of polilla of the night before by the piles of gauzy, irridescent wings, their former owners having been eaten piecemeal by ants during the night, or swallowed whole by pet house lizards, with a possibly fortunate few avoiding such an untimely fate by escape under the cover of a book, or into cracks in furniture or woodwork. Figures 1 and 2 show a de-alate adult and a soldier.

Radios seem especially designed for becoming most easily infested by dry-wood termites, for, when in operation, their lights attract the adults, and they have any number of points of entrance for such small insects, in addition to the often open and unfinished rear. The thin plywood covering of panels of expensive cabinet woods merely deludes the purchaser, for the termites eat the cheaper foundation wood inside, and finally make repeated holes through the plywood covering to void their excrement, or in search of new worlds of wood to devour. Pianos are larger and necessarily have even more places where termites can gain access to their interior. Pictures on the wall, especially those over a table-lamp, are similarly very susceptible to attack, for the de-alate adults collect where the picture back is in contact with the wall, and, if undisturbed, burrow into the back and frame of the picture, eventually often eating the picture itself. Many a framed doctorate "sheepskin" is shown to be nothing but parchment of vegetable origin when polilla start eating it.

Dust covers on books lift the cover just enough so that de-alate adults find a secure refuge and prompt protection if the house-holder leaves them lying about on tables. Daily inspection is the price of safety for books left exposed during the flight periods of the adults in April, May, and June. Newspapers get carried away or destroyed, and are of temporary value in any case, but stacks of undisturbed magazines and correspondence on the living room table will be found to harbor dozens of termites. The more expensive magazines, printed on heavily coated paper, are considerably less subject to attack than the "pulps", which present an almost undiluted food supply of cellulose for termites to eat.

The problem of furniture is more complex, and some articles escape attack, even if made of susceptible woods. Not even constant use and being moved about prevents others from becoming infested, if some ready avenue of infection is present. The angle of a rocker on the floor presents a perfect opportunity for termites to burrow inside, and often the rocker becomes infested when the remainder of the chair is still sound. Bureau and desk drawers fit with just enough clearance to permit termites to enter, and the sides, backs and bottoms of drawers are almost invariably made of woods susceptible to termite attack. Solid wicker, caning or rattaning gives perfect security against disturbance when termites are starting their tunnels, and also serves to hide a termite-susceptible piece of wood in an article of furniture in all exposed parts made of a tropical cabinet hardwood resistant or immune to termite attack. (See Fig. 3.)

All the common building woods are susceptible to termite attack, and even if the walls of a house are of concrete and its floors of tile, any or all of its wooden members may become infested with termites. Even if the semi-circular openings where corrugated zinc sheets used for roofing rest on the plate are carefully closed to prevent the entrance of bats, mice and rats to the attic, and the ventilators under the eaves screened, this still leaves an abundance of entrances large enough for winged termite adults to get into the attic, and, entirely undisturbed, begin their tunnels into roof beams and ceilings of the rooms below. Hurricanes pull such weakly-attached zinc sheets off termite-infested roof beams with ease, and to the ordinary dangers for anyone

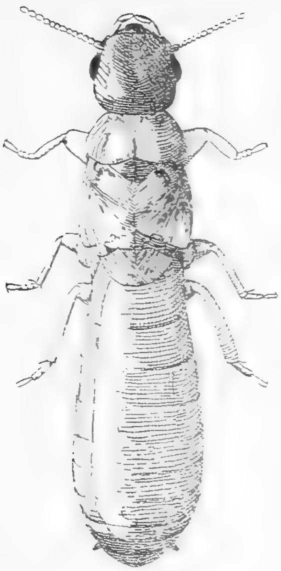

Fig. 1.—De-alate adult of Cryptotermes brevis Walker, eight times natural size.

Fig. 2.—Soldier of Cryptotermes brevis Walker, six times natural size.

Fig. 3.—Destruction by termites of a susceptible rung, which, covered with caning, forms part of the seat of a chair whose other members are made of mahogany.

out in such storms adds that of being cut by the flying sheets of metal. Hurricanes also feel out all the weak places in shutters and doors where termites have been at work, and under the unusual pressure they give way and permit the entrance of the full fury of the storm. Of course the termites suffer as much from the hurricane as do the human inhabitants of houses, for they are specifically dry-wood termites, and many die as much from exposure to rain as from having their tunnels broken open when the wood gives way. Enough of them survive, however, so that there is no danger of extermination, and reconstruction after the hurricane furnishes them with fresh supplies of uninfested wood to attack. Is it surprising that the cost of living in the tropics in anything better than a thatched shack of palm fronds proves to be absurdly high?

Hundreds of years of experience have shown, however, that some native tropical hardwoods are disliked, or unpalatable to dry-wood termites to such an extent that articles made of these woods will survive from one generation to the next as family heirlooms, while those of inferior woods disappear in a few years. The well-earned reputation of West Indian mahogany is primarily because of its durability in the tropics. A mahogany four-poster bedstead, with canopy, is not only immune to termite attack, but its canopy protects against termite excrement falling from the ceiling. These hard little pellets are like so many grains of sand on a smooth sheet, and if one gets in your eye, proves to be exceptionally irritating and hard to dislodge. Dry-wood termites can and do eat mahogany (usually the sapwood, it will prove to be upon investigation), but in practice its heartwood is so nearly immune to attack as to constitute a standard by which one may judge of the value of other woods. These statements apply only to West Indian mahogany, Swietenia mahagoni; not to Philippine mahogany, Shorea negrosensis, nor to African mahogany, Khaya ivorensis, the latter being very susceptible to polilla attack, and the former not much better. Not one of the temperate zone hardwoods can be compared with real mahogany in resistance to termite attack, although the hardness of the wood has nothing to do with the ease with which it is eaten by termites. In this respect, hard maple is no better than willow. The soft coniferous woods commonly used for building are also varyingly susceptible to attack, the exceptionally gummy heartwood of cypress or southern pine being resistant only because of their impregnation by gums. Dipping a sample of a susceptible wood in oil of cedar will prevent its being eaten by termites, even though the amount of cedar oil naturally present in red cedar heartwood will not prevent termites eating it, and the white sapwood, so admired for contrast in cedar chests, is very susceptible to attack. Many other substances besides the gums and oils naturally found in woods serve to protect them against termite attack, and the number of commercial remedies available for this purpose on the market is legion. Most of them are "shotgun" remedies, intended to protect against rot and decay as well as against termites, and not only against dry-wood termites, but also against wet-wood and subterranean termites. Most unfortunately, substances and combinations able effectively to do all this incidentally possess properties that are undesirable, such as objectionable odor, stains that color the wood, or they leave a surface that cannot be painted.

Such general purpose wood-preserving substances have their place and value, but against Cryptotermes brevis, the dry-wood termite of the West Indies, some of these supposedly essential characteristics are valueless. In all shotgun remedies, one requirement is that of deep penetration of the toxic or repellent substance in solution, followed by its precipitation in insoluble form inside the wood, so that it will not subsequently be leached out when exposed to moisture. Obviously, this is a needless requirement for any substance to be used only to repel the attack of dry-wood termites, for the woods normally subject to attack by them will never be exposed to the weather. Roof-beams, ceilings, sash, doors, shutters, furniture, pictures, radios, pianos, books, and magazines: all these normally exist under a roof, and we hope and expect to keep them dry. With this requirement eliminated, the problem of protection solely against dry-wood termites is greatly simplified. Methods of testing out the varying natural resistance or susceptibility of many woods to the attack of this termite have already been worked out[1,2] and it is a simple matter to test common inorganic substances on the basis of the toxic or repellent element.

Termites that naturally live in a picture frame can quite as easily live in a petri dish, if this is kept in the dark most of the time, and only exposed to light for a few minutes when observations are being made. The termites obviously do not enjoy exposure to light, but this constitutes a minute fraction of their existence while being used in the experiments, and in practice has little effect on their choice of woods, or survival, while it admits of ready inspection at all times. To correlate with previous tests, samples of wood a quarter of an inch thick, an inch wide and an inch and a quarter long were used, the wood selected being almácigo, or West Indian birch, Bursera simaruba (L.) Sarg. a common tropical soft wood of little commercial value and very susceptible to termite attack. For the preparation of a large number of these samples, the writer is indebted to the Tropical Forest Experiment Station at Rio Piedras.

West Indian mahogany, Swietenia mahagoni, was used as the basis of comparison, and the tests conducted to determine whether almácigo when treated proved to be eaten in preference to mahogany, or the untreated mahogany eaten in preference to the treated almácigo. Other woods, such as gummy southern cypress heartwood, Taxodium distichum; lignum-vitae, Guaiacum officinale; maga, Montezuma speciosissima; aceitillo, Zanthoxylum flavum; cobana negra, Stahlia monosperma; acacia, Albizzia procera; and swamp-seasoned mangrove, all substantially or more than equal to mahogany in resistance to termite attack, filled out the space in the petri dish, so that all pieces fitted together tightly and did not shift about to injure the termites. It is obvious that the termites were presented with a real opportunity to make a choice of what they would eat: a normally unpalatable wood or a treated very susceptible wood; very decidedly not the kind of choice presented to the American public as to the color of their model T Ford. Cryptotermes is not much of a builder, but it promptly accepts the conditions as it finds them in the petri dish, and uses most of its excrement to cement some of the samples to each other, or to the dish. Admittedly conditions are abnormal, but even with only mahogany or less palatable woods and treated almácigo to eat, some of these treated samples most of the time would prove to be more palatable and then the termites would have a real meal, especially once they had eaten inside the treated crust.

1/ Wolcott, G. N. The comparative resistance of woods to the attack of termite, Cryptotermes brevis Walker. Bull. #33, Insular Experiment Station. Aug. 1924.
2/ Wolcott, G. N. A list of woods arranged according to their resistance to the attack of the "polilla", the dry-wood termite of the West Indies, Cryptotermes brevis Walker. Caribbean Forester 1 (4): 1-10. July 1940.

It should be emphasized that the purpose of these tests was not to discover the substances toxic to the termites, but merely those which were sufficiently repellent so that the termites would not eat the wood treated with them. It happens that the elements toxic to termites (thallium and arsenic) are not repellent to them in small amounts, and before the reaction on the termites treated with such substances became known, and the samples could be removed, hundreds of the termites died, and the experiments in unpalatability were thoroughly disorganized. A few of these poisoned termites continued to live for weeks afterwards (after being removed from the regular tests), too sick to eat a little more and die promptly as other members of the colony had done, but showing no tendency to throw off the effect of the poison and become normally active.

The tests were started with a saturated solution of copper sulfate, in which samples were dipped six seconds, one minute, ten minutes, one hour and forty minutes, and finally sixteen hours and forty minutes. All of these samples proved to be so repellent that the termites would not even approach them. After discussion with the plant physiologist, Dr. E. F. Hopkins, a standardized procedure was adopted. For testing the value of each element, the chloride was used by preference because of usual availability and solubility in water, but in many cases, and also as check, the acetate, nitrate and sulfate might also be used. For elements of which these compounds are not possible, the salt of sodium or potassium was used, the potassium or sodium affecting palatability so little that 5 per cent of these alkaline earths as chlorides were apparently unnoticed by the termites.

For preparing the test samples, a solution was prepared which contained a 2 per cent solution of the element to be tested, samples dipped, the solution diluted to 1 per cent of the element and samples dipped, and a final series of samples dipped in a 0.5 per cent solution of the element. Treatment by dipping was restricted to three periods: the six seconds dipped samples were kept in constant motion to dislodge air bubbles and favor even penetration of the solution, and the ends of the one minute and ten minutes dipped samples were reversed in the middle of the period. All samples were dried in the sunshine on a window ledge, and not tested until the following day, by which time they were thoroughly air-dry. Before treatment, each sample was marked with india ink as to the kind of wood, length of treatment, per cent of element and kind of compound, such an extensive legend being very useful later in determining just where and how much the termites had eaten, if the attack was slight, for they completely disregard the legend of india ink, and eat it or leave it entirely on the basis of the wood and treatment underneath. Of course this method of procedure does not give a definite concentration of the chemical in the wood, its strength varying from the outside where it is most concentrated and quickly tapering off to nothing in the interior of the sample. In practice, however, it appears to work well, with complete consistency as indicated by the reactions of the termites.

The sample dipped six seconds was placed in a petri dish with other woods somewhat less attractive to <u>Cryptotermes</u> than untreated almácigo; that dipped one minute was placed with woods considerably less attractive; while only the ten minutes dipped sample was tested against mahogany and similarly resistant woods. Practically, the ten minutes dipped samples vs. mahogany constituted the real test, but the others were useful checks when the treatment had little or no value and all treated samples were promptly attacked, as well as when they were effective and all the treated samples were untouched by the termites. No set time was required by the tests. If the termites had begun to eat the treated samples by the first day, and the attack was unquestionable by the second day, that was ample time for a positive test. On the contrary, the treated samples that proved to be almost the exact equivalent of mahogany in attractiveness required a longer time; while somewhat less palatable samples might remain in a test for a week or longer, and be put back again at a later date, to make sure of the termites' attitude towards them. After all eaten samples had been eliminated, all those remaining were finally tested against each other, alternating with mahogany and other less palatable woods, using fresh termites that had been just taken from the original colony and had previously eaten only sycamore, Platanus occidentalis. All of the termites in all the tests came from this same colony that had developed in a box that originally contained two five-gallon oil cans.

If the termites ate the 2 per cent concentration, the other samples were valueless, and further tests with that element could be abandoned as requiring too large an amount of the chemical to be practical for commercial use. On the contrary, if the 0.5 per cent solution treated sample was uneaten by the termites, the solution could be further diluted to 0.2 per cent, 0.1 per cent, and 0.05 per cent, and samples dipped at each concentration for additional tests. By continuing the tests, it was possible to determine the minimum concentration at which the treated almácigo samples were less palatable than mahogany, and the next dilution at which the almácigo was preferred to the mahogany. The final results appear as a table on the following page--the two concentrations on opposite sides of the mahogany dividing line.

In the table as given, there appears to be no consistency by our standards as of what elements the termites are conscious. Of course they are presented with a problem with which they or none of their ancestors have had any experience, for it would never occur in nature, yet it seems inexplicable that ferric iron should be repellent, and many times as much of the chemically similar cobalt, nickel and manganese (and chromium at less than 2 per cent strength) be apparently imperceptible to their senses. Why should silver and tin be imperceptible, and copper and zinc repellent? When placed in the periodic table, four repellent elements: zinc, cadmium, barium, and mercury are in the same group II, but this makes even more inexplicable why the intermediate strontium is imperceptible. Indeed, aside from this, the reactions of the termites appear to be largely or entirely determined by the specificity of the organism.

In the selection of elements to be tested, those which are so rare as to be unavailable in the chemical laboratories of the Experiment Station (Mr. F. J. Ramírez Silva of the Plant Phisiology Department), the University (Prof. Osvaldo Ramírez Torres), and the Institute of Tropical Agriculture (Dr. J. A. Bonnet) were not considered in the preliminary stages of the investigation, and it is quite possible that the results of tests with these rare elements, locally unavailable, might considerably change the picture. From the practical standpoint, however, a sufficiently large number of elements, cheap and abundant, are sufficiently repellent to the attack of the dry-wood termite as

The relative value of various elements as repellents to the attack of the West Indian dry-wood termite, *Cryptotermes brevis* Walker

West Indian mahogany eaten in preference to almácigo treated ten minutes with:	Mahogany LINE	Almácigo treated ten minutes, as below, eaten in preference to West Indian mahogany.
0.15% Copper (as sulfate)	↑	0.1% Copper (as sulfate)
0.2% Copper (as chloride)		0.1% Copper (as chloride)
0.2% Zinc (as sulfate, chloride and nitrate)		0.1% Zinc (as sulfate, chloride, and nitrate)
0.2% Mercury (as chloride)		0.1% Mercury (as chloride)
0.3% Barium (as chloride)		0.2% Barium (as chloride)
0.3% Cadmium (as nitrate)		0.2% Cadmium (as nitrate)
0.2% Ferric Iron (as chloride)		0.1% Ferric Iron (as chloride)
0.4% Ferric Iron (as sulfate and nitrate)		0.2% Ferric Iron (as sulfate and nitrate)
		0.3% ARSENIC (as sodium arsenate) <u>toxic, not repellent</u>
0.5% Aluminum (as sulfate)		0.2% Aluminum (as sulfate)
1% Antimony (as chloride)		0.5% Antimony (as chloride)
1% Lead (as nitrate)		0.5% Lead (as nitrate)
2% Boron (as sodium perborate)		1% Boron (as sodium perborate)
	2% Chromium (as chloride)	1% Chromium (as chloride)
		2% Chromium (as sulfate and as potassium dichromate)
	2% Fluorine (as potassium fluoride)	1% Fluorine (as potassium fluoride)
		2% THALLIUM (as acetate) <u>toxic, not repellent</u>
		2% Ferrous Iron (as sulfate)
		2% Silicon (as sodium metasilicate)
		2% Tin (as chloride)
		2% Iodine (as potassium iodide)
		2% Bromine (as potassium bromide)
		2% Manganese (as sulfate)
		2% Cobalt (as chloride)
		2% Nickel (as chloride)
		2% Silver (as nitrate)
		2% Strontium (as chloride)
		2% Uranium (as acetate)
		2% Thorium (as nitrate)
		2% Cerium (as sulfate)
		2% Calcium (as chloride)
		2% Magnesium (as chloride)
		5% Sodium (as chloride)
		5% Potassium (as chloride)

to furnish a considerable choice as to what will be selected in practice for treating wood or wood products to be made immune to termite attack. It now becomes apparent why heavily coated paper, in the manufacture of which various compounds of aluminum are used, should be more resistant to termite attack, and the possibility of making paper entirely immune seems to be quite possible if the amount of this element (or others) is increased somewhat.

Translating the amounts of elements of positive value as shown in the table, into pounds of compound per gallon of water, gives as the minimum protective concentration approximately 3/4 ounce of copper sulfate, zinc chloride, barium chloride, and cadmium nitrate per gallon of water. This is such a small amount of copper sulfate in solution that its presence is almost imperceptible because of its color, while the other solutions are colorless. One-third of an ounce of mercuric chloride per gallon of water is completely protective, but over an ounce is needed of ferric chloride. From the practical standpoint, mercuric chloride, despite its greater efficiency, is at once ruled out because the price per pound wholesale is in dollars, while that of the other substances averages around 5 cents, with barium chloride the cheapest of this group. Aluminum sulfate is even cheaper, but aluminum being a very light element requires twelve to fifteen times as much of its compound to equal in effectiveness the heavy metals, and its use in repelling termites would be indicated as preferable only on account of its other desirable properties. The other substances are either commercially unavailable, or too expensive for use unless for some other special value. Certainly the cost of the materials for making wood or wood products repellent to termite attack is negligible by comparison with the benefits obtained.

The possible combinations of repellent substances is infinite, but no obvious advantage is anticipated, at least so far as the termites are concerned. Only a few combinations were tried: copper with chromium, zinc with chromium, and zinc with copper, and in no case did the combination prove more repellent than a single chemical, at comparable strength. Because of unavailability, such chemicals as the dichromates, borates, and fluorides of copper, zinc, and barium, which contain two repellent elements and should theoretically therefore be doubly repellent, were not tested.

The time and strength of application as given made the wood sample unpalatable to the termites, but not repellent to the extent that they would not rest upon it or walk over it. By somewhat or considerably increasing the concentration of the chemical, the wood is made actually repellent to the termites, but this seems an unnecessary precaution, except possibly in special cases. It should be emphasized, however, that the reactions of the termites applying to a minimum amount of an element applied under optimum test conditions might well be considerably modified to give a somewhat greater safety factor of time or concentration, or both, for commercial application. Presumably depth of penetration in each kind of wood is proportionate to length of time of application, and should be long enough so that the wood is thoroughly wetted. This may not be essential, however, if the cracks and crevices where the termites are most likely to seek entrance are given special attention. Indeed, flat underside surfaces may be merely brushed over with a more concentrated solution, which in the case of copper sulfate on wood not readily penetrated forms a thin crystalline film, like frost on a windowpane, that is actually repellent to any termite happening to alight upon it. Of course, in the manufacture of paper, wallboard, and lignin plastic, all the wood fibers are finely divided, and possibly in such cases the minimum amount of chemical can be used with reasonable safety. In soaking logs for making them ready for cutting into sheets or panels of plywood, the liquid used for this cooking might well contain a minimum amount of appropriate chemical, or the flitches dipped or sprayed with a stronger solution before being placed in the press. In the construction of furniture, the manufacturer should use a considerable margin of safety, either in the strength of the solution or the length of time for which susceptible parts are to be soaked (and dried) before assembly in the completed furniture.

Anyone in Puerto Rico, or in the Caribbean area, purchasing furniture known to be made of a susceptible wood, in whole or in part, can protect it against termite attack by a suitable treatment. It is rarely possible to dip the entire article of furniture in a liquid, and the results might be disastrous for some kinds of plywood. It is quite possible, however, to paint or spray the underside and hidden parts of new furniture with a strong solution of a repellent chemical, making an especial effort to get into the cracks and crevices where termites are most likely to seek shelter. This should not affect the varnish or other finish applied by the manufacturer, for it is not through such parts that termite attack is at all likely. This is not because the paint, varnish or other finish applied by the manufacturer is repellent to the termites, for it is not, but these painted or varnished surfaces will not be attacked by the termites from the front, where you can see them, but from the hidden back and inside, and it is these parts which must be treated if the infestation by termites is to be prevented.

Two methods of procedure are possible in preventing termite infestation of attics in new houses. When the house is being built, all lumber used in permanent construction should be painted with a solution of the chemical after it has been cut to fit, and preferably the ends soaked in a solution of the chemical for some hours, or overnight, before being nailed into place. All holes left by pulling out nails must be filled with putty, or better, the nails driven farther in so that they will not be removed. Each and every nailhole is an invitation to termites to enter, all the more enticing if all the remainder of the exposed wooden surface is repellent. The other method consists in spraying the interior after completion, being especially generous with the liquid in corners and at the eaves, and in all crevices and nailholes where the termites are likely to seek shelter. It is effective only as the person doing the spraying thoroughly understands the habits of termites and takes suitable precautions to outwit them.

When entire structures, such as houses and army barracks, are constructed of wood, complete protection with water-soluble chemicals cannot be anticipated for parts exposed to weather. Furthermore, the wear and tear of constant use will wear away the thin external layer of repellent wood, and the mopping of floors gradually dissolve away the repellent chemical. Actually, the surfaces most subject to wear and tear are those where termites would have least chance of entering, and in practice, thorough treatment of all members cut to fit in the process of construction, or spraying the interior of the completed structure will at least very considerably reduce the danger of infestation. A discussion of more effective methods and chemicals to be used in such cases is outside the purpose of this paper, as is also the treatment of houses or barracks already infested. For practical purposes, they seem a hopeless proposition. Replacing the worst infested members with new wood only temporarily postpones eventual total depreciation. Treatment of the new wood is of course desirable, but almost invariably some small colonies of termites will remain in the apparently uninfested wood of the original structure, and after the repairs have been made, will continue to eat and spread destruction.

The case for infested furniture is somewhat different. For those vindicative persons (this includes the writer) who are satisfied with nothing less than the destruction of the termites in infested furniture they already have had for some time, one can suggest with caution the 0.3 per cent arsenic solution, of which somewhat more than a gram of sodium arsenate will make 100 cc of solution in water. (Thallium is also effective, but the quantity required is several times as great, making it much more expensive, and it is by no means so readily available as is arsenic.) First, with a sailmaker's or upholsterer's needle, one should open up the carefully plugged holes through which the termites have voided their excrement, and to each such hole apply one drop of the solution with the medicine dropper. The major lesions in the wood where the external crust left by the termites has broken through may also be used for applying the solution, but most of it should go into the smaller holes, some of which will accept considerable amounts, if it is administered gradually. This renders the wood permanently toxic, not alone to the termites present in it, but to any others that may attempt to re-colonize the deserted burrows, and incidentally it is also toxic to domestic animals other than termites that may chew the poisoned wood.

Summary

The West Indian dry-wood termite, Kalotermes (Cryptotermes) brevis Walker, is possibly the most important species in Puerto Rico because of its ability to live in dry wood within houses, and because it does not construct an exposed nest or tunnels, therefore being very difficult to control.

The adults are frequently seen flying about lights at night during the late spring. During this period those which are not killed by their many enemies crawl beneath or behind some article of furniture or pile of papers or books and start tunneling into the material. Radios and picture frames are frequently attacked, as are large pieces of furniture such as bureaus, desks, and pianos, and also parts of houses constructed of susceptible woods. Gradually the tunneling consumes the insides of the various wooden articles until they are mere shells without strength.

Experience has shown that some woods are disliked or are unpalatable to dry-wood termites. A notable example is West Indian mahogany, Swietenia mahagoni. Other more susceptible woods are sometimes treated with various solutions to reduce their susceptibility to both termite attack and decay, but some of these "remedies" are not entirely satisfactory, as the appearance, or some other character of the wood is adversely affected. As dry-wood termites attack wood which is not generally exposed to the rain, a satisfactory

chemical repellent need not be insoluble in water and the treatment may be shallow in its penetration.

Tests were made with about 40 of the more common inorganic chemical compounds to determine which elements would most effectively repel termites when deposited on the wood in aqueous solution by dipping treatment. Small samples of the very susceptible wood of Bursera simaruba were dipped in solutions of various strengths for various periods of time and were then made available to the termites, along with untreated mahogany and other woods of known susceptibility for comparison. It was found that samples dipped for 10 minutes in a solution of approximately one-half ounce of either copper sulfate, zinc chloride, barium chloride, or cadmium nitrate per gallon of water became more resistant to termite attack than mahogany.

The practical importance of this finding is obvious. Treatment of new furniture and other wooden articles by dipping or by applying the chemicals with a brush previous to painting or varnishing will provide cheap protection. The added finding that arsenic is toxic but not repellent leads to the suggestion that the introduction of a 0.3 per cent arsenic solution into the tunnels of infested wood might not only kill the present colony but prevent reinfestation.

Resumen

Puede decirse que el termes de las Indias Occidentales, Kalotermes (Cryptotermes) brevis Walker, insecto que corroe la madera, es el más dañino de Puerto Rico ya que vive en el interior de las casas y las galerías o túneles que construye no se ven superficialmente lo cual hace sumamente difícil su exterminación.

Ya avanzada la primavera los termes adultos se ven con frecuencia volando alrededor de las luces durante la noche. En este período los que no son matados por sus muchos enemigos se deslizan debajo de cualquier mueble, en los libros y papeles y empiezan a construir sus túneles. Atacan tanto los marcos de los cuadros y los aparatos de radio así como los muebles más grandes, como escritorios y pianos y aún aquellas partes de la casa que están hechas de maderas susceptibles. Gradualmente esos túneles van corroyendo el interior de los objetos hasta que se desgranan.

Por experiencia sabemos que hay ciertas maderas que no son del agrado de estos termes. El ejemplo típico es la caoba de las Indias Occidentales, Swietenia mahagoni. Puede reducirse la susceptibilidad de otras maderas tanto al ataque de los termes como a la podredumbre si se tratan con ciertas disoluciones pero algunos de estos "remedios" no son del todo satisfactorios porque alteran adversamente el aspecto y otros caracteres de las maderas. Debido al hecho de que los termes atacan la madera cuando está seca, lejos de la intemperio, no es preciso que el reactivo químico que se use sea insoluble en agua y el tratamiento por lo tanto puede ser superficial.

Se hicieron varias pruebas con cerca de 40 de los compuestos inorgánicos más comunes para determinar qué elementos al ser aplicados en las maderas en disolución acuosa por el procedimiento de sumersión eran capaces de repeler más efectivamente a los termes. Pequeñas muestras de la madera Bursera simaruba, una de las más susceptibles al ataque de los termes, fueron sumergidas en disoluciones de distintas concentraciones por diversos períodos de tiempo y se sometieron luego al ataque del insecto junto con otras muestras de caoba y de maderas de susceptibilidad conocida, que no habían sido tratadas previamente y que habrían de servir como índice de comparación. Se encontró que las muestras que habían sido sumergidas por 10 minutos en una disolución de aproximadamente 1 onza de sulfato de cobre, cloruro de cinc, cloruro de bario o nitrato de bario por cada galón de agua eran más resistentes al ataque de los termes que la caoba.

La importancia práctica de este hallazgo es obvia. Al fabricar objetos de madera, pueden sumergirse o puede aplicárseles cualquiera de estos reactivos con una brocha, antes de pintarlos o barnizarlos, logrando así un método de protección barato. Como también se encontró que el arsénico aunque no lo ahuyenta es sumamente tóxico al insecto, llegamos a la conclusión que si se añade una disolución de arsénico al 0.3% y se trata la madera infestada no sólo se exterminará la colonia que allí exista, sino que se verá libre de futuros ataques.

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PLANTAS QUE SUMINISTRAN TANINO EN EL AFRICA ORIENTAL

En un artículo publicado en el Vol. 39 (3) del Boletín del Imperial Institute, el Sr. P. J. Greenway, botánico sistemático del East African Agricultural Research Station, Amani (Tanganyika) expone un compendio de la información existente sobre las plantas que se usan para la extracción de tintes y tanino.

Este científico indica que el tanino se usa poco en el Africa oriental pero que existen allí dos fuentes comerciales de dicho producto: la corteza de Acacia decurrens Willd. var. mollis Lindl y la corteza de los mangles Bruginera ceriops y Rhizophora. La lista de plantas que él somete incluye notas que especifican la cantidad y la clase de tanino que se puede obtener de las distintas plantas, la distribución geográfica y los diversos usos de dichas plantas. Muchas de éstas se encuentran comúnmente en el Hemisferio Occidental, entre ellas las que siguen:

Especie	Por ciento de tanino y localización en la planta
Avicennia nitida Jacq.	Corteza, 12%
Cassia fistula L.	Corteza, 18%
Casuarina equisetifolia	Corteza, 15-18%
Haematoxylon campechianum L.	Madera, 6%
Hymenaea courbaril L.	Corteza, 19.2%
Mangifera indica	Corteza, 16%
Pithecolobium dulce Benth	Corteza, 25%
Prosopis juliflora DC.	Corteza; raíces, 6-7%
Psidium guajava L.	Corteza, 30%; hojas, 9-10%
Terminalia catappa L.	Corteza, 11-23%; frutas, 6%

ENCINA, QUERCUS VIRGINIANA MILL.[1/]

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Notas Generales

La encina es un árbol corpulento pero de poca altura. Su tronco es corto y grueso. Su copa es amplia o irregular y está formada por gruesas y tortuosas ramas. Corteza gris, profundamente agrietada. Hojas pequeñas, duras, de color verde claro, opaco. Sistema radicular amplio y profundo. En suelos estériles crece lentamente y adquiere poca altura. En suelos fértiles crece rápidamente, pudiendo llegar a la categoría de árbol grande. Sembrada en las mejores condiciones, alcanza la altura de 1 metro al año; 1.50 metros a los 2 años; 4 metros a los 5 años; 15 metros y 6 pulgadas de diámetro a los 10 años.

La encina es nativa. Existe naturalmente también en Virginia, Florida y sur de Texas. En Cuba se le encuentra en la mitad occidental de la provincia de Pinar del Río y norte de Isla de Pinos, en cuyas localidades, ocupa los suelos silíceos y sílico-arcillosos de reacción ácida, secos o bien saneados y de fertilidad escasa. Especie intolerante y ávida de sol, se encuentra generalmente formando montes homogéneos, o mezclada en proporciones variables con pinos, *Pinus caribaea* y *P. tropicalis*; granadillos, *Brya ebenus*; y alguna otra especie de follaje claro. No vive en el monte denso de los suelos calcáreos fértiles donde predominan las especies de copa amplia y tupida. Los mejores ejemplares de encina de cualquier edad son los que se encuentran en las faldas de las lomas, o en terreno llano de fertilidad apreciable, en mezcla con el macurije, *Matayba* sp.; el pino macho, *Pinus caribaea*; el encinillo, *Pithecolobium obovale*; y alguna especie de menos importancia, indicando que se beneficia con esta asociación. En las cuchillas estériles, donde la roca madre ha sido expuesta en muchos lugares por erosión, el encinar es homogéneo y de poca altura.

La encina es monoica. Comienza a florecer desde marzo. Las flores masculinas en amentos que presenta en pequeños racimos. Las femeninas solitarias.

1/ No empleamos la palabra "roble" como sería lo correcto, ya que en Cuba este nombre se aplica a diferentes especies maderables que no pertenecen a las fagáceas ni tienen semejanza alguna con nuestra encina. Tales son:

Roble amarillo, roble dulce	*Citharexylum fruticosum* L.
Roble australiano	*Grevillea robusta* Cunn.
Roble blanco, roble de yugo	*Tabebuia pentaphylla* Hemsl.
Roble caiman	*Ekmanianthes actinophylla* Urb.
Roble de olor	*Macrocatalpa punctata* Brit.
Roble de guayo	*Petitia domingensis* Jacq.
Roble prieto	*Ehretia tinifolia* Lin.

El fruto es una bellota sostenida en una cúpula característica. Madura de octubre a diciembre. La recolección se hace en el suelo. Las bellotas son de forma subcilíndrica y tamaño muy variable: 2 a 4 cm. de largo por 1 a 2 de diámetro. De 250 a 300 bellotas pesan 1 kilo y una medida cúbica de 1 litro puede contener 200. La semilla fresca, recién colectada, comienza a germinar a los 10 días y puede alcanzar una germinación de 85 por ciento en 20 días.

La germinación es hipogea y comienza con un pivote carnoso y profundo de cuya parte superior brota una plántula de aspecto delicado y hojas alternas iguales a las del árbol adulto. Se trasplanta sin riesgo entre marzo y abril.

La encina se reproduce espontáneamente con notable abundancia. Los árboles, plenos de sol, fructifican copiosamente desde edad temprana y la especie se establece y persiste a pesar de tales factores adversos como la Agricultura, los fuegos de las sabanas y los animales domésticos.

Selvicultura

El encinar puede ser regenerado por métodos naturales. Bajo las condiciones cubanas, se sigue el método de selección pura, extrayendo del monte solamente los árboles que han alcanzado cortabilidad legal (12 pulgadas de diámetro a la altura del pecho de un hombre normal) y sirven para horcones de viviendas rurales o traviesas de ferrocarril de primera clase.

Como el encinar es un monte claro, aun en las mejores condiciones, la regeneración tiene lugar todos los años, no siendo necesarias las cortas uniformes que se emplean en otros tipos de monte. Las cortas totales, aun en pequeñas áreas, no son recomendables en el caso de la encina. En suelos pobres donde el monte tiene poco vuelo o es simplemente un matorral, lo mejor es dejar el encinar intacto. En la mayoría de los encinares cubanos, la regeneración tiene que comenzar con cuidadosas cortas de mejora.

Esto será efectivo en los mejores suelos. En estas operaciones se tratará de fomentar la asociación de la encina con especies subordinadas, como el macurije, por ejemplo. Con las cortas de mejora se extraen los árboles viejos dañados, los copeyes y los bejucos y cualquiera otro árbol que tienda a suprimir a la encina. Conjuntamente se pueden plantar en lugares convenientes, tocones fuertes de encina y pimpollos de pino macho si se quiere proteger o introducir esta especie.

Desde luego, la regeneración de los encinares requiere medidas eficientes de protección contra los fuegos, frecuentes en estas localidades durante el período seco.

Artificialmente la encina se puede establecer por siembra directa o por plantación, empleando en este caso, tocones de plantas de viveros de 15 a 18 meses o mejor aun, de 2 años y medio.

En la siembra directa conviene obtener una germinación mínima de 5 plántulas por metro cuadrado, o sean 50,000 por hectárea. Esto es necesario, porque la encina no tiene una tendencia al crecimiento en altura, el que es necesario estimular por medio de la densidad. Asumiendo para la semilla de encina un valor real de 50 por ciento, se necesitarán 364 kilos de bellotas para sembrar una hectárea (275 bellotas pesan un kilo).

La siembra directa puede ser a voleo, en terreno parcialmente preparado, bastando alterar la capa superficial del suelo con una o dos labores de roturación. Si el área elegida contiene una cubierta vegetal densa, se procede a chapear y quemar antes de la preparación del suelo. Esta siembra debe hacerse con las primeras semillas de la estación en octubre si es posible, para aprovechar la humedad del suelo y las probables lluvias de este mes.

La reforestación a base de encinas puede hacerse por plantación, empleando tocones procedentes de viveros. Con la debida anticipación se establecen los semilleros. Las bellotas se recogen maduras en octubre y es necesario transportarlas rápidamente al lugar de la siembra, evitando envases voluminosos que provocan calor y fermentación. El semillero se establece con preferencia junto a la plantación para evitar el transporte de los plantones. Se prefiere suelo muy suelto y muy profundo. Los suelos pesados son indeseables, pues dificultan las operaciones de trasplantar.

Se preparan canteros o terraplenes a pleno sol donde se siembran las bellotas a 5 x 10 cms.; un total de 200 por metro cuadrado de semillero. Con un valor real de 50 por ciento, germinarán a razón de 100 por metro cuadrado de cantero. Las bellotas se colocan en pequeños surcos y se entierran o cubren con una pulgada de suelo arenoso. Se mantienen moderadamente húmedas hasta el comienzo de la germinación que tendrá lugar hacia los 10 días. No es necesario hacer ningún trasplante provisional en el vivero. Las plántulas pueden medir 25 cms. de altura a los 5 meses y de 80 cm. a 1.20, a los 15 meses, con un diámetro máximo de 1.5 cm. en la base, que ya es buen tamaño para plantar. En los semilleros de 27 a 30 meses las mejores plantas miden 2 metros de altura con un diámetro de 3 cm. Los tocones de esta edad plantados en marzo, parten con extraordinaria rapidez. La plantación se realiza entre marzo y abril, con preferencia en marzo, antes de que las encinas se encuentren en plena actividad vegetativa.

Se trasplanta a raíz limpia empleando una coa grande para extraer las plantas del semillero. Éstas se llevan a un lugar sombreado donde se escogen, desechando las que han quedado demasiado pequeñas y se recortan, dejándolas reducidas a pequeños tocones de 1-1/2 a 2 pulgadas. En estas condiciones se cuentan y atan en pequeños manojos, se sumergen por sus raíces en una suspensión de tierra arcillosa, se envuelven en paja, se forran de yagua y se remiten a la plantación.

La plantación se realiza en suelo que puede haber sido preparado de antemano o no. Cuando la cubierta vegetativa del área a repoblar es espesa, se puede chapear y quemar. No es necesario romper el terreno. Entendemos que no es conveniente hacerlo en el momento de plantar. La plantación se ejecutará a jan, empleando una barreta de hierro, coa fuerte o jan de madera dura. Se practica un hoyo estrecho y profundo, donde la simple raíz de la encina pueda ser insertada cómodamente hasta el cuello de la raíz y apretada con un segundo golpe de barreta dado hacia un lado. Plantada en estas condiciones, la encina se pone desde luego en contacto con la humedad del suelo profundo que es mantenida por capilaridad, pudiendo hacerse la plantación aun en tiempo seco.

Se aconseja plantar 10,000 tocones por hectárea como espaciamiento provisional, entendiendo que no resulta una plantación demasiado densa y que en suelo arenoso bastante fértil, no necesitará aclareos antes de los 5 años.

Los Encinares del Pinar del Río

Las encinas de la provincia de Pinar del Río se pueden contar billones, pero el volumen de madera de primera clase disponible, es muy pequeño. Un examen superficial de nuestros encinares da a conocer con bastante aproximación la cantidad y calidad de la madera que contienen.

Con motivo de las limitaciones impuestas por la guerra se ha pensado en establecer en Cuba la fabricación de toneles, prefiriendo la madera de encina, pero esta no existe en las cantidades y de la calidad que se requiere en esta industria especializada. Los industriales de este género establecidos en Cuba no deben demorar en ensayar maderas como el roble blanco, el roble guayo, el mangle prieto y otros, en la fabricación de toneles.

Los mejores toneles de fabricación americana, destinados al trasiego y envase de vinos y aguardiente, se fabrican exclusivamente de la encina blanca, Quercus alba y de los montes en que se encuentra esta especie, solamente los mejores árboles son apeados. La madera destinada a la fabricación de toneles no puede tener defectos de ninguna clase. Considerando nuestros encinares desde este punto de vista, encontramos que no contienen el volumen de madera que se necesita para la industria tonelera. La poca madera de nuestros encinares, es una madera dañada y defectuosa y se emplea casi exclusivamente en construcciones rurales de la localidad y para traviesas.

El uso de la madera de encina se encuentra limitado también por otro factor: el valor alimenticio de la bellota, empleada en la ceba de cerdos. Muchos de los terrenos ocupados por la encina son de propiedad privada y los propietarios encuentran más utilidad en la recolección de la fruta que en la venta de la madera y por consiguiente no se interesan en extraer los árboles de cortabilidad legal o de efectuar aclareos.

Los encinares de Pinar del Río son en su mayor parte homogéneos y ocupan áreas de extensión considerable interrumpidas frecuentemente por sabanas donde la yerba es escasa. En algunas localidades han sido reducidos a pequeños bosquetes diseminados.

En todos nuestros encinares, son evidentes aun los efectos de los ciclones que visitaron la provincia de Pinar del Río el año 1910 y algunos años después. Los árboles de 20 pulgadas o más son muy escasos y están sumamente dañados. Las clases de edad inferiores se encuentran en mejores condiciones y prometen formar un monte de alto valor maderable si continúan bajo la protección de la ley y libres de ciclones por algunas décadas.

A pesar de que la encina es eminentemente gregal, se nota a primera vista la calidad superior de las que crecen en terrenos de alguna fertilidad, en sociedad con especies subordinadas que proporcionan protección al suelo. Este es el tipo de monte que podría ser mejorado por medio de cuidadosos aclareos seguidos de regeneración artificial.

Bajo las condiciones económicas que han prevalecido en Cuba los encinares nunca han recibido tratamiento alguno. El producto de las cortas intermedias no paga su ejecución. Leña, traviesas y postes podrían obtenerse de las cortas de mejora, pero en la actualidad no es económico iniciar estas operaciones, ni conviene confiarlas a los dueños del monte poco interesados en su (lejano) futuro valor maderable.

La encina en Pinar del Río persiste tenazmente, sobre todo en los suelos arenosos, que con frecuencia son dedicados al cultivo del tabaco.

La encina y también el pino macho debían ser bases principales de la riqueza de Pinar del Río. Grandes extensiones de suelos arenosos propios para el sostenimiento de este tipo de monte se encuentran actualmente desocupados, improductivos, pudiendo estar plantados de pinos y encinas. Dada la facilidad con que estas especies se pueden criar y trasplantar y el valor relativamente bajo de sus semillas, que se pueden recoger en cantidades considerables bajo los árboles, es lamentable que todavía no hayamos intentado el establecimiento de extensos pinares y encinares artificialmente.

Summary

Encina, a short tree with a thick trunk, is native to the western half of the province of Pinar del Río and the northern part of the Isle of Pines. It is confined chiefly to sandy and sandy clay soils and prefers the base of slopes and fertile plains, though it persists on poor soils despite fire and grazing. It forms extensive pure stands and also occurs in mixture with _Pinus caribaea_, _P. tropicalis_, _Brya ebenus_, and others.

Though there are extensive encina forests in Pinar del Río the quantity of high grade sawtimber is very limited. The production of encina barrels, a recent proposal for the alleviation of limitations imposed by the war, is impracticable for this reason. However, much of Cuba's defective encina is widely used for rural construction and railroad ties. Many owners of encina forests consider the fruits of more value than the wood, for they are valued for fattening swine.

Encina may be regenerated naturally by partial cutting. To favor encina in mixed forests the overstory should be gradually removed, first removing the declining trees and others of low value. Artificial regeneration is successful either by direct seeding or planting. The fruits mature between October and December. There are 125 per pound, and germination is 85 per cent complete after 20 days. Seeds should be sown soon after collection, but if storage is necessary they should be kept exposed to the air, as they tend to heat. Direct seeding is most successful at the time when the seeds first ripen in October, as it is then possible to take advantage of the probable rains during that month. Provision should be made for at least 5 seedlings per square meter, as close spacing is required to produce straight trees.

In the nursery the seeds are sown in unshaded beds at a spacing of 5 x 10 cms. They are covered with an inch of sandy soil. After 15 months without transplanting they average 80 cms. in height and are ready to transplant. Transplanting is most successful during March and April. About 4,000 trees are planted per acre. The trees are moved with bare roots and are cut back to 1 to 2 inches in height. The holes are made narrow and deep, just enough to permit the insertion of the taproot to the same depth as in the nursery.

To the present economic conditions have prevented improvement of encina forests, and as a result they are now valuable chiefly for firewood, ties, and posts. It is regrettable that it has not been possible to build up these forests on the extensive idle sandy lands in Pinar del Río, where the species, together with Pinus caribaea should provide a principal source of income.

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APUNTES SOBRE LA MYRICA CERIFERA L. DE HONDURAS

Recientemente tuve la oportunidad de estudiar la planta de la cera vegetal, Myrica cerifera L., que crece sobre las faldas del Picacho, inmediatas a las Crucitas (lugares próximos a la capital). Esta planta, llamada comúnmente "encinillo" pertenece a la familia de las Miricáceas. Se trata de un arbusto que sobrepasa la estatura humana, bastante ramificado, consistente, de hojas alternas, simples, menudas, incompletas, coriáceas y tiene aspecto de encina tierna a lo cual se debe su nombre vulgar. Prefiere los sitios elevados y frescos y por eso se manifiesta en los claros sobre la parte ascendente del camino a San Juancito. También se encuentra en occidente en los pueblos de Ojojona y Maraita.

El período fructificativo se inicia desde noviembre y los frutos en estado de madurez son apiñados, esféricos, pequeños, cenicientos y casi sentados. Deben los frutos el color blanquecino a la capa grasienta que los envuelve, la que no tiene un espesor uniforme sino estructura de tejido, semejando pavimento, que por la fricción entre los dedos se desintegra en grasa y carcoma, dejando en libertad la semilla y una emanación aromática.

La presencia de esta grasa en los frutos es una adaptación natural que favorece la propagación de la especie. Dado el hecho de que la planta crece en parajes elevados y de que fructifica en tiempo frío, es lógico suponer que esa capa grasienta aisladora protege la semilla contra la humedad y las heladas. Pasado el período de la fructificación viene el cambio favorable del tiempo que con el calor de la estación seca, derrite la protección grasienta de los frutos caídos para que con las lluvias venideras germinen las semillas y evolucionen las plantas.

La cera hoy día sólo se utiliza en pequeña escala para la fabricación de jabones y velas pero ya una fábrica de la capital trató de industrializar el producto. En mis experiencias yo pude obtener un rendimiento de dos libras de la recolecta de tres arbustos. La cera se extrae mediante la ebullición lo cual hace flotar la grasa que luego se desnata y recalienta hasta eliminar todo el agua.—PROF. LUIS LANDA ESCOBER, Tegucigalpa, Honduras.

LA VEGETATION MUSCINALE DES ANTILLES FRANCAISES

ET SON INTERET DANS LA VALORISATION SYLVICOLE

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Les mousses, d'une manière générale, n'ont guère été l'objet d'études écologiques ou phytosociologiques dans les régions tropicales et cette observation s'applique aussi bien aux Antilles françaises qu'aux autres Iles Caraîbes et aux Grandes Antilles.

Cependant, l'étude systématique ou descriptive de ces végétaux cryptogamiques a donné lieu dans la plupart de ces Iles a de nombreuses publications intéressantes. Les bryologues ont eu en effet la possibilité de procéder aux déterminations spécifiques et aux études taxonomiques ou anatomiques les plus diverses dans les laboratoires botaniques, alors qu'il est plus délicat d'observer avec précision les groupements muscinaux <u>in situ</u>, leur biologie et leur évolution, d'interpréter leur présence et l'aspect particulier qu'ils impriment au paysage floristique et de montrer enfin l'intérêt qu'ils offrent dans la valorisation sylvicole d'une région déterminée.

L'étude suivante, appliquée au cadre des Antilles françaises, n'a pas la prétention de résoudre complètement les problèmes posés, mais elle a pour but de faire ressortir la richesse et l'aspect de la végétation muscinale de nos Iles, la composition générale des groupements bryologiques et hépaticologiques qu'elle héberge et de déduire les indications qu'ils peuvent fournir pour caractériser les associations végétales et leur évolution, les stades de colonisation sur sols nus ou sur laves récentes et pour orienter le forestier vers des localisations ou des modes de valorisation plus judicieux.

Une légère adaptation permettrait certainement son application dans les Iles Caraibes voisines où des relevés analogues pourraient mettre en lumière les nombreux points communs qui nous paraissent y exister et les différences qui se manifestent dans leur constitution intime.

La connaissance approfondie de la végétation muscinale des Antilles françaises est rendue plus difficile encore pour les deux raisons suivantes: Ces Îles, comme tout le groupe de l'archipel antillais, sont situées en Amérique tropicale, région, qui, d'après l'<u>Index</u> du grand bryologue, le Général Paris, est la plus riche en mousses du monde entier. Le caractère insulaire, montagneux et humide de ces Petites Antilles renforce encore cette richesse dûe à leur situation générale. En effet, la Guadeloupe et la Martinique possèdent à elles seules un total d'environ 410 mousses se répartissant en 200 Hépatiques et 210 Muscinées.

Une comparaison analogue à celle que nous avons effectuée pour les Fougères et Alliées dans le "Catalogue des Cryptogames Vasculaires des

Antilles françaises", publié dans un numéro antérieur du Caribbean Forester, (Vol. 4, No. 1), permet de chiffrer proportionnellement cette richesse bryophytique. Sur les 2500 végétaux vasculaires qu'on y rencontre, nous avions décompté 313 Ptéridophytes, soit un rapport de 1 fougère pour 7, 8 plantes vasculaires. Si nous faisons le décompte des végétaux feuillus des Antilles françaises: Phanérogames, Fougères et Mousses, le total approximatif s'élève à 2910 espèces, sur lesquelles 410 sont des Muscinées, ce qui représente un rapport de 1 mousse pour 7 plantes feuillues (1:7,09). A cette proportion spécifique élevée, doit s'ajouter encore le foisonnement quantitatif de certaines espèces et leur large extension dans les milieux où l'humidité et la topographie les favorisent, expliquant la prépondérance du caractère imprimé par le paysage bryophytique dans l'aspect général de la végétation.

Les études systématiques relatives aux Muscinées de notre flore dignes de retenir l'attention sont celles de T. Husnot: Catalogue des Cryptogames recueillies aux Antilles françaises en 1868 et essai sur leur distribution géographique dans ces Iles, Caen 1870, puis dans la Revue bryologique 1875-76. Pour les Hépatiques, E. Bescherelle a donné en 1893 une "Enumération des Hépatiques connues jusqu'ici aux Antilles françaises", à laquelle le R.P. Duss a ajouté en 1903 une trentaine d'espèces (nommées par Stephani) dans son "Enumération des Muscinées des Antilles françaises: I. Hépatiques, Lons-le-Saumier". Ces espèces ont fait ensuite l'objet de révision et de compléments avec d'autres nouveautés par Stephani dans son "Spec. Hepaticarum", in Bull. Herb. Boissier et dans "Hepaticae novae Dussianae, in Urban, Symb. Ant. Vol. II, Oct. 1901, puis par A. W. Evans dans diverses publications principalement in Bull. Torrey Bot. Club, Trans. Conn. Acad. 28 en 1927, Ann. Bot., Bryologist et Annales Bryologici (1937). Pour la Guadeloupe, une étude récente: "The Hepaticae of Guadeloupe" a été publiée par F. M. Pagán.

Pour les Muscinées (str. sens.), la connaissance des mousses de nos Iles est basée principalement sur la "Florule bryologique des Antilles françaises" de E. Bescherelle, de 1876, in "Ann. Sci. Nat. Paris ser 6, III, à laquelle une trentaine d'espèces nouvelles, de même que pour les Hépatiques, ont été ajoutées également par le R. P. Duss, dans son "Enumération des Muscinées" de 1903: II. Mousses. Ces espèces ont été déterminées par Bescherelle lui-même, puis par Brotherus, le savant bryographe du "Natürlischen Pflanzenfamilien" d'Engler et Prantl dans la première édition (1901-09) et la deuxième édition (X.1924 et XI.1925) duquel sont décrites de nombreuses mousses antillaises. Quelques espèces nouvelles, guadeloupéennes et martiniquaises sont ajoutées en outre dans les "Symbolae Antillanae" d'Urban, Vol. IV, Mai 1903: "Musci novi Dussiani". Dans la North American Flora", Williams, XV, 2, 1913, en cite également.

Au fur et à mesure de nos récoltes botaniques, commencées en 1934 aux Antilles françaises, nous avons collecté les mousses et hépatiques, plus spécialement au cours de ces quatre dernières années. De 1939 à 1942 les doubles de nos récoltes ont été adressées à Dr. Winona Welch de Depauw University, qui a fait parvenir les hépatiques à Dr. Margaret Fulford de University of Cincinnati et les Muscinées (str. sens.) à M. Edwin B. Bartram de Philadelphie. Ces spécialistes ont procédé à l'étude de nos spécimens et nous leur exprimons ici l'expression de notre vive reconnaissance. De nombreuses espèces se sont révélées nouvelles pour nos Iles et deux Muscinées (str. sens.)

nommées par Bartram sont des nouveautés pour la Science: Pilotrichum Stehlei Bartr. et Meiothecium antillarum Bartr. inéd.

Les principaux collecteurs de Muscinées aux Antilles françaises, grace auxquels la flore bryologique a pû être établie sont: Bertero, Badier, Lessueur, Wickstroëm, Beaupertuis, Perrottet, Duchassaing, L'Herminier, Husnot, Bélanger, Hahn, Duss et pour ce dernier siècle le R.P. Quentin, d'abord seul, puis avec Madame H. Stehlé et nous-même, les botanistes de la Mission Cryptogamique du Prof. P. Allorge à la Guadeloupe (1936) et plus récemment M. A. d'Questel. Il ne nous semble pas que leurs récoltes aient fait l'objet de publications bryologiques autres que celles ci-dessus énumérées. Chacun de ces collecteurs a apporté sa contribution, mais la plus large est certainement celle dûe au R.P. Duss, chercheur infatigable, qui a accumulé de nombreuses récoltes d'hépatiques, de bryées et de sphaignes. Cependant, la publication relative à "l'énumération méthodique des Muscinées des Antilles françaises: I. Hépatiques et II. Mousses", réalisée par lui en 1903, sans description, synonymie, dessins, références d'auteur ni clef dichotomique, est le seul travail que le R. P. Duss ait publié sur les Cryptogames cellulaires feuillues. Depuis 40 ans qu'elle a vu le jour, de nombreux binômes ont changé dans la désignation rationnelle des espèces, des nouvelles mousses ont été décrites, aussi un nouveau catalogue à jour, ou mieux une Flore bryologique, descriptive et illustrée, des Antilles françaises serait elle indispensable dans l'état actuel de nos connaissances.

Les affinités géographiques des mousses et hépatiques des Antilles françaises sont surtout accentuées avec le domaine intertropical de l'Amérique du Sud et les Grandes Antilles. Pour les mettre en évidence, une étude critique des espèces collectées ou publiées s'imposait en se plaçant au double point de vue taxonomique et géographique. La comparaison des espèces de notre Catalogue préliminaire des Muscinées et Hépatiques des Antilles francaises, en cours de mise au point définitive, avec les plus récentes publications des Antilles voisines fait apparaitre une étroite liaison bryophytique. Ainsi, pour Porto Rico, la plus petite des Grandes Antilles et la plus proche de nos Iles, F. M. Pagán a publié en 1939 (in the Bryologist, Vol. XLII, Febr., Apr., Jun. 1939) une liste: "A preliminary list of the Hepaticae of Puerto Rico including Vieques and Mona Island", comportant 244 espèces d'Hépatiques. Sur ce total nous avons pu en reconnaitre 90 qui appartiennent à notre Flore, soit une proportion commune par rapport à l'ensemble de Porto Rico s'élevant à 37% et, par rapport aux 200 Hépatiques des Antilles françaises, une communauté de 45% avec notre flore. Pour les mousses proprement dites, la comparaison de notre flore avec l'Ile de Cuba, la plus grande Ile de l'archipel des Grandes Antilles, est rendue aisée par la publication du "Catalogue des Mousses de Cuba" par le Frère León, de la Havane (in Annales de Cryptogamie exotique, tome VI, fasc. 3-4, Sept. 1933) où 268 mousses sont citées et qui a été complétée en 1939 par I. Thériot (in "Memorias de la Sociedad Cubana de Historia Natural", Vol. XIII, n. 5, 20 Déc. 1939): Complément au Catalogue des Mousses de Cuba, élevant le nombre des mousses de cette Ile à un total approximatif de 300 espèces. Sur ce nombre, 75 appartiennent à notre flore muscinale, soit un taux de communauté de 25%. Sur les 50% que le frère León indique (loc. cit. p. 4) comme se trouvant aux Antilles, la moitié existe donc dans nos deux Iles. Ces valeurs comparatives sont d'autant plus appréciables que le taux d'endémicité des hépatiques et muscinées des Iles Antillaises est assez élevé: celui de Cuba pour les Mousses (str. sens.) est indiqué par le Frère León à 20% et le nombre des hépatiques spéciales à Porto Rico et n'étant pas connues ailleurs, s'élève, d'après notre calcul sur le travail cité de Pagán, à 9% (22 espèces sur 244).

Les relations géographiques examinées confirment donc pour les Hépatiques et les Mousses, les conclusions formulées pour les Phanérogames et les Pteridophytes relatives à la connexion antérieure des Grandes Antilles par les Iles Caraïbes avec l'Amérique du Sud dans le vaste domaine floristique de laquelle nos Iles doivent être inclues.

Du point de vue écologique et stationnel, les mousses présentent des exigences variées et bien définies. Elles reflètent l'action du milieu aussi nettement que les végétaux supérieurs, action qui se manifeste par des adaptations, des variations écologiques et des formes de croissance particulières.

Aux Antilles françaises, les milieux biologiques naturels sont extrêmement favorables au foisonnement muscinal: terrestre, épilithe, corticicole ou épiphylle, car les différents facteurs: lumière, température, état hygrométrique, ainsi que l'eau et le sol, exercent sur les mousses leur action simultanée dans des conditions souvent optimales. L'influence de chacun de ces facteurs devrait faire l'objet d'observations et de mesures pour définir exactement la part qui leur revient séparément dans le complexe observé.

Il n'y a qu'une cinquantaine d'années que, dans les régions tempérées, cette action du milieu sur les muscinées a été envisagée et a notre connaissance, le seul travail d'ensemble publié sur ce sujet est celui du Dr. Adrien Davy de Virville, de la Faculté des Sciences de Paris: "Action du milieu sur les Mousses", in Revue Générale de Botanique, 1927. Les résultats qu'il a obtenus par experimentation sur des espèces des régions tempérées d'Europe, exposés dans ce magnifique travail, concordent pleinement avec les constatations que nous avons pû faire sous les conditions naturelles de la forêt dense intertropicale des Antilles françaises. Cette forêt, du point de vue physique, est caractérisée par une atténuation très accentuée de la lumière dont les rayons ne passent que difficilement à travers les frondaisons épaisses, par une grande constance de la température, moyenne en général, par un état hygrométrique toujours élevé et parfois voisin de la saturation totale, par le calme de l'atmosphère, par le suintement de l'eau le long des branches et des feuilles et par l'imprégnation permanente de son sol humifère.

Cet ensemble de causes détermine des effets assez comparables à ceux du milieu cavernicole et dans les sylves les plus sombres de la Guadeloupe et de la Martinique, les muscinées sciaphiles sont en grande abondance formant de nombreuses colonisations. Mais, lorsqu'une clairière ou une trouée se produit en forêt ou que l'aspect de haute futaie disparait pour céder le pas au taillis régressif, l'augmentation de la luminosité et le passage de courants d'air éliminent rapidement ces espèces sensibles. Elles appartiennent à la catégorie des espèces que J. Amann, qui a étudié leur biologie a désignées sous le nom d'apanémophiles. Cette disparition est rapide si les causes qui la provoquent agissent brusquement et la dessication du tapis muscinal, qui suit celle encore plus immédiate des épiphytes diverses, se fait alors sans transition. Si, au contraire, le passage à une plus forte luminosité ou à une atmosphère plus ventilée, se fait de façon progressive, des modifications des mousses s'observent avant la mort du végétal: le tapis vert foncé devient plus clair puis vert-jaunâtre, les feuilles deviennent moins colorées, leur taille diminue et elles se recroquevillent, se resserrent les unes contre les autres et les dents s'accentuent. Presque toutes les mousses vertes peuvent présenter en forêt de telles adaptations en milieu défavorable alors que nous n'en avons observé aucune apperemment sur trois mousses blanchâtres ou d'un vert-jaune et pâle, assez fréquentes: Octoblepharum albidum (L.) Hedw., Leucobryum antillanum Schimp. et L. crispum C. M.

Ces mousses sont au contraire douées d'une grande stabilité dans la nature et des cas semblables ont été signalés expérimentalement par Davy de Virville au laboratoire en particulier sur Leucobryum glaucum Hpe et Anomodon viticulosus H. et T., d'Europe, "espèces rebelles à toute modification pour des raisons d'ailleurs inconnues". Ce comportement négatif nous parait devoir être en liaison avec la nature des membranes cellulaires des tissus et l'intensité de coloration plus faible des chloroplastes du limbe.

Dans l'ensemble, les mousses sylvicoles sont des appareils météorologiques enregistreurs, vivants, sensibles et complexes, qui réagissent sur un ensemble de conditions édaphiques et climatiques à un instant donné. Cette réaction est favorable à leur développement lorsque, ainsi qu'on peut l'observer: la lumière solaire ne les frappe pas directement et exerce son action de façon discontinue, l'humidité atmosphérique est très élevée, l'atmosphère ambiante non soumise à des agitations sensibles, le degré thermique moyen, l'eau abondante sans tomber violemment et le sol humide et acide. L'acidité du milieu influence non seulement le développement des mousses et des hépatiques, mais encore la germination de leurs spores et la presque totalité des bryophytes de la Martinique et de la Guadeloupe nous parait se développer en solutions acides.

Le milieu "forêt caraïbe" a donc suscité la création des conditions énumérées nécessaires au développement et à l'équilibre biologique des végetaux qu'elle abrite et parmi lesquels les muscinées sciaphiles sont les plus abondants et les plus sensibles. L'étude de leurs colonisations pourra être utilisée pour reconnaitre une ambiance forestière, pour orienter la reforestation vers une évolution progressive artificielle ou vers la culture et pour déduire des indications biologiques complétant, s'il y en a, les observations météorologiques et plus précieuses que celles-ci pour le forestier ou l'agriculteur car la présence et le comportement des groupements muscinaux sont le reflet de ces actions physiques sur le végétal.

A la différence des régions tempérées où les mousses sont généralement terrestres ou aquatiques, le paysage bryologique antillais comporte une variété abondante de mousses que l'on peut classer en cinq groupes écologiques: elles peuvent en effet être plaquées sur le sol, latéritique, ponceux, humifère ou calcaire; ce sont des terrestres comme en renferment les genres Bryum, Rhodobryum, Riccia et Isotachis. Certains vivent sur les rochers secs ou suintants comme les Hyophila, Fissidens, Dicranella et Marchantia alors que d'autres recherchent plus particulièrement le bois pourri ou les substances végetales en voie de décomposition; ce sont les saprophytes des genres Rhizogonium et Conomitrium. Les muscinées qui vivent sur la matière organique comprennent deux catégories: celles qui vivent sur les feuilles des arbres ou des plantes, les épiphylles représentées surtout par les genres Odontolejeunea, Diplasiolejeunea, Cyclolejeunea et Meteoriopsis; celles qui vivent sur les troncs des arbres et des écorces vivantes des branches, les épiphytes cortici-coles qui sont très abondantes et variées. Ces épiphytes peuvent appartenir à trois types distincts: type pendant: Phyllogonium, type appliqué: Radula, Meiothecium, type dressé: Porotrichum et Pilotrichum. Certaines cependant qui présentent le port dressé ou appliqué dans un stade juvénile passent au type pendant par la quite, comme c'est le cas de l'Omphalanthus debilis Lehm. et Lindenb.

La strate n'est pas à la fois une "strate herbacée et muscinale" comme on la désigne souvent dans les études écologiques dans les régions tempérées; elle est discontinue et surélevée. La strate muscinale, par l'épiphytisme arboricole, s'étend depuis le sol jusqu'au sommet des grands arbres mais de façon discontinue aussi bien en élévation que le long du tapis inférieur. C'est sur le sol qu'il y a le moins de mousses en forêt humide et un substratum organique ou minéral: tronc vivant ou pourri, branches, feuilles, talus ou rocher, est nécessaire à leur colonisation. Dans l'eau des rivières, il ne s'en trouve pas, sauf sur les rochers émergés ou sur les berges formant ceinture au niveau des hautes eaux, comme l'indique le Sematophyllum caespitosum (Sw.) Mitt.

Sur les coulées boueuses, les dépots meubles et les laves andésitiques récentes de la Montagne Pelée, les muscinées épilithes et terricoles constituent la première phase de la colonisation végétale depuis les abords même des cratères et des aiguilles volcaniques. Comme pionniers de colonisation dans les successions végetales qui apparaitront sur de tels sols jusqu'à leur mise en valeur, les mousses offrent par conséquent un intérêt pratique digne de considération.

L'étude phytosociologique aux Antilles françaises n'a été entreprise qu'au cours de ces dernières années et a porté naturellement d'abord sur les phanérophytes qui occupent la place prépondérante dans l'aspect et la constitution des grands groupements végétaux. Déjà, dans l'Introduction à sa "Flore Phanérogamique des Antilles françaises" le R. P. Duss, en 1896, donnait quelques indications de Géographie botanique sur les deux Iles et la distribution succinte des plantes en zones et en régions. Dans notre "Essai d'Ecologie et de Géographie botanique" publié en 1935, pour la Guadeloupe et dans l'"Esquisse des associations végétales de la Martinique" in Bulletin Agricole Mart. Vol. VI, No. 3-4, Déc. 1937, les climax forestiers, les associations et les successions végétales ont été caractérisées. Dans le cadre de chaque groupement, l'aspect du paysage bryophytique y a été indiqué chaque fois, mais aucune étude spéciale n'a encore été faite de manière détaillée.

L'évolution du tapis végétal aux Antilles fait apparaitre parfois un rôle important des Muscinées, surtout dans la région moyenne en forêt dense, dans la région supérieure, en forêt de transition et dans le sphagnetum guadelupense des plateaux et sommets volcaniques. Dans les associations de la végétation inférieure, au contraire, le caractère xero-héliophile des secteurs qui les abritent, convient peu au développement muscinal et les bryophytes y sont très rares. Parmi les stades évolutifs que présente la végétation de nos Iles, diverses associations muscinales apparaissent dans lesquelles les groupements précurseurs de la bonne forêt ou de la culture doivent être mis en évidence.

La présente étude a pour objet de tracer l'esquisse des colonisations muscinales et de leur écologie en les plaçant dans les groupements végétaux dont l'évolution des phanérophytes et des ptéridophytes a déjà été établie antérieurement dans les travaux énumérées. Comme les diverses strates d'une même association sont étroitement interdépendantes les unes des autres et que leurs réactions réciproques ou sur le milieu se manifestent dans l'entité générale qu'elles constituent, il nous a paru nécessaire et logique de décrire ces formations bryophytiques dans le cadre défini de la végetation étudiée.

Il sera donc envisàgé successivement:

Forêt xérophytique et taillis héliophiles de l'étage inférieur.
Forêt mésophytique et cultures.
Forêt hygrophytique de l'étage moyen avec son complexe muscinal.
Peuplements à fougères arborescentes et à bambous.
Forêt sciaphile de transition à Clusia.
Sylve montagnarde rabougrie de l'étage supérieur.
Marécages des plateaux et sommets volcaniques et cuvettes à sphaignes.
Colonisations végétales sur laves récentes aux abords des cratères et cônes volcaniques. Rôle des mousses.

Comme nous l'avons fait pour les végétaux vasculaires: Les associations végétales de la Guadeloupe et leur intérêt dans la valorisation rationnelle, in Rev. Bot. appl. XII, 186-87, 1937, nous ferons ressortir ici, pour chacun de ces groupements l'intéret pratique qui s'attache à la présence et l'évolution des strates muscinales, les indications qu'elles donnent et même les espoirs qu'elles autorisent dans la valorisation sylvicole ou agronomique.

Forêt Xérophytique et Taillis Héliophiles de l'Etage Inférieur

Les associations xéro-héliophytiques de l'étage inférieur ont été décrites au double point de vue Géographique et Botanique dans le détail, pour la Guadeloupe dans notre Essai d'Ecologie et pour la Martinique dans l' Esquisse des Associations Végétales, mais aucune muscinée ne figure dans les relevés indiqués. Leur localisation est cependant étendue dans les deux Iles où elles couvrent toute la Grande-Terre à la Guadeloupe et le Sud de la Martinique. Pour ces régions, d'assez vaste superficie comparative, ni Husnot, ni Bescherelle, ni le R.P.A. Duss, n'indiquent des mousses ou des localisations de bryophytes. Il y a en effet très peu de muscinées dont le type stationnel est la forêt xérophile, le taillis ou la pelouse qui endérivent. Néanmoins, une recherche minutieuse à travers les bois et sur les mornes permet de détecter quelques mousses dont la présence doit être sujette à interprétation.

En effet, la lumière directe et l'air sec qui caractérisent cet étage, sont des conditions de vie néfastes aux muscinées et les mousses héliophiles qui s'y adaptent n'y trouvent pas leur optimum biologique mais les supportent alors que les autres y périssent. Cette adaptation est plutôt une tolérance et nécessite des modifications que W. Watson: Xerophytic adaptations of Bryophytes in relation to habitat (in The new Phytologist t. 13, 1914), a décrites d'une manière générale: longueur et incurvation du pédicelle, développement des papilles, carnosité des tissus, absence de cellules chlorphylliennes. Les touffes de ces mousses sont plus serrées et disposées en coussinets compacts;

elles sont d'un vert-jaunâtre ou grisâtre et les denticulations des limbes sont plus accusées. Là où poussent ces végétaux, les conditions optimales pour leur croissance ne sont pas réalisées, mais il y existe un minimum d'humidité ou d'ombrage périodiques pendant certaines époques, de courte durée sans doute, mais toujours présentes, expliquant non seulement cette végetation bryophytique mais encore des possibilités culturales ou sylvicoles demeurées inaperçues.

Le faciès sableux de la forêt xérophile à Ceiba caribea-Tabebuia pallida ne comporte pas de mousses caractéristiques de l'association. Des débuts de colonisation sans fructification ont pû seuls, dans certains cas, être observés sur des troncs d'arbres dont les organes végétatifs se rapportaient les uns à des Hépatiques de la famille des Lejeuneacées et les autres à des Muscinées du genre Calymperes. Parfois, l'Octoblepharum albidum y installe ses touffes cespiteuses mais elles demeurent sporadiques et d'un développement limité.

Le faciès calcaire, abondant en Grande-Terre et réduit à quelques parcelles du Sud à la Martinique, possède une flore bryophytique d'une extrème pauvreté et les quelques espèces récoltées ne sont que des accidentelles d'autres secteurs dont le microclimat favorable: suintement de l'eau, maintenant un état permanent d'humidité sur ce sol perméable, abord de ravin ou pente topographiquement bien abritée du vent desséchant, explique la présence, d'ailleurs étroitement localisée.

Le faciès volcanique décrit pour la Martinique sous le nom d'association à Fagara (Bull. Agr. Mart. VI, n. 3-4, p. 211, 1937): Fagara microcarpa-Myrcia paniculata var. Imrayana et ses dérivés régressifs, possèdent au contraire de petites associations muscinales dépendantes.

Nous pouvons les classer en trois catégories en liaison avec le substratum: terrestre, saxicoles et murales.

1. Association muscinale terricole des taillis à Acacias ou Hypophiletum microcarpae.—Au dessous de la strate herbacée du taillis à acacias et à campêches de Sainte-Anne, une strate muscinale parfaitement développée et fructifiée, s'observe sur une grande étendue constituant un véritable peuplement bas et plaqué sur le sol. Elle est formée uniquement par l'Hyophila microcarpa (Schp.) Broth., (Dét. E.B. Bartram), espèce qui n'avait jamais pourtant, à notre connaissance, été signalée aux Antilles francaises. Elle se développe sur une large étendue, entre 10 et 100 mètres d'altitude, sur le sol de tuff volcanique d'origine sous-marine et sur les pierres andésitiques dont l'ensemble constitue le substratum du Morne Saline de Sainte-Anne, la hauteur boisée située la plus à l'Extrème Sud de la Martinique. Ses touffes cespiteuses et denses, son port dressé et ses feuilles d'un vert grisâtre, font reconnaitre à première vue son caractère xéro-héliophile. Dans ce secteur, l'élevage du cabri, à demi-sauvage d'ailleurs, est un élément destructeur de la végétation où les mimosées épineuses (Acacia et Haematoxylon) et même les cactacées (Opuntia et Cephalocereus) ont apparu.

La régénération naturelle de la forêt xérophytique à poiriers: Tabebuia pallida Miers, qui constitue le climax de cette région; pour réaliser ensuite sous son couvert des peuplements d'essences plus précieuses, de mahogany du pays, Swietenia mahagoni L. ou du Honduras, S. macrophylla King d'acajous rouges, Cedrela odorata ou de bois blanc, Simaruba amara Aubl., devra faire intervenir les localisations de cette mousse. Pendant les périodes de carême, des semis de ces espèces devront être réalisés dans les pentes, les creux et les ruissellements abrités des vents secs du Sud où le minimum d'humidité nécessaire pour la vie de la mousse subsiste, indiquant manifestement des possibilités d'habitat pour ces essences forestières. Quelques "seedlings" naturels de poiriers ont pû être observés en effet parmi les buissons de campêches qui leur offrent une protection et un ombrage dans le jeune âge. La détermination des stations les plus favorables par le groupement muscinal, le choix des essences rustiques et de haute progressivité et la meilleure saison pour les semis, après parcage des cabris, permettront d'allier toutes les conditions les meilleures pour la réussite de cette valorisation. Dans ce "Sud déshérité", sur le sort duquel on se lamente depuis des années et pour lequel tout agriculteur, forestier, géographe ou même économiste, a proposé en vain une solution différente en vue de son amélioration, le seul moyen de contrecarrer l'oeuvre néfaste de l'érosion et de la stérilité est, pour nous, l'étude de l'évolution du tapis végétal qui seule fait connaitre la vocation naturelle d'une terre.

Un tel aménagement, convenablement réalisé, constituerait le berceau d'où pourrait se développer en tache d'huile une plus large zone boisée rejoignant progressivement un centre voisin et réalisant ainsi un quadrillage de reboisement de plus en plus ténu grace à des points d'appuis judicieusement disposés. Cela permettrait de récupérer l'ambiance perdue de cette sylve méridionale dont on atteste la présence passée et à laquelle se sont substituées l'érosion, la sécheresse excessive et la stérilité du sol. Le Sud cependant était autrefois la région de l'Ile la plus fertile celle où les premiers défricheurs de P. Gournay en 1623 se sont installés pour la culture du tabac et celle où les usines à sucre et distilleries de cannes étaient les plus nombreuses. L'action de l'homme, par la destruction de la forêt, la culture intensive sans récupération pour le milieu exploité et les méthodes primitives d'élevage, a déclanché, puis accéléré, cette évolution régressive facilitée par les conditions naturelles.

Du point de vue agricole, les taillis et savanes hyperxérophiles sont difficiles à valoriser, ainsi que nous l'avons exposé dans l'Esquisse des Associations végétales de la Martinique, (III. Paratypes de substitution p. 232-242), tant la dégradation a été poussée loin. Néanmoins, dans l'installation des jardins créoles du Sud et dans l'organisation de parcelles mises en défens, pour la constitution de prés-bois, dans la réalisation d'un élevage plus rationnel, l'Hyophiletum microcarpae sera un indicateur précieux.

Un autre groupement muscinal terricole des taillis héliophiles est celui constitué par l'Hymenostomum Breutelii (C.M.) Broth. Cette mousse, qui ne figure pas dans l'Enumération Méthodique de Duss, caractérise nettement les talus xéro-héliophiles des Anses d'Arlet, au Sud de la Martinique. Elle colonise les taches humifères qui subsistent encore sur les talus dioritiques en cours de latéritisation et où les hydrarguilites sont parfois mises à nu; elle appartient au faciès à Fagara microcarpa - Myrcia paniculata Kr. et Urb. et M. leptoclada DC.

Elle indique l'existence d'un complexe argilo-humique élevé et des possibilités culturales sur ces taillis.

Le Bryum crügeri (Hampe) C.M., mousse terrestre, nouvelle pour les Antilles françaises, très polymorphe, variable tant dans ses caractères morphologiques que dans son habitat, a été récolté par nous le long du ruisseau s'écoulant du bassin de la prise d'eau des Trois Ilets (Propriété G. Hayot), sous un peuplement artificiel de mahoganys du Honduras, Swietenia macrophylla King d'une douzaine d'années et de très belle venue. Une pépinière forestière a été installée là.

2. Groupement muscinal practicole xérophytique à Riccia dussiana.—Dans une pelouse xérophytique et sous le taillis à Croton du Diamant, au Sud de la Martinique et dans une prairie graminoïde aux Saintes, dépendances proches de la Guadeloupe, dans l'Ile de Terre de Haut, à la base du Morne Chameau, nous avons récolté une hépatique le Riccia dussiana Steph. plaquée sur le sol de tuff. C'est dans la savane à Bouteloua-Sida (loc. cit. p. 239) ou les cactacées (Opuntia) étaient disséminées, que nous l'avons détectée, à quelques kilomètres du bourg du Diamant.

Leur localisation révèle les emplacements à adopter pour tenter la régénération forestière par série progressive ou pour procéder en bonne saison pluvieuse aux semis de bonnes fourragères (Tricholaena repens, Panicum, Digitaria) dont la dissémination anémophile permettrait l'extension naturelle.

3. Groupement muscinal saxicole: Barbuletum agrariae.—Sur les roches calcaires et les murs, quelques mousses héliophiles plaquées, tant à la Guadeloupe qu'à la Martinique, forment de petites colonisations à partir d'une très faible altitude.

Constituant plus spécialement une association murale, l'on rencontre entre 0 et 400 m. d'altitude Barbula agraria Hedw. et B. husnoti Schp. Deux autres constituant une petite association homogène, sont terrestres ou saxicoles et forment parfois de larges pelouses plaqués contre le sol humide, surtout dans les environs de Saint-Pierre. Ce sont le Barbula hymenostegioides Broth. et l'Anaectangium breutelianum Br. et Schimp.

Ce Barbuletum est l'indication de champs pierreux maix cultivables et présente un caractère nettement rudéral.

Les mousses électives de la forêt xérophytique sont donc des Muscinées proprement dites appartenant surtout à la famille des Pottiacées.

Forêt Mésophytique et Cultures

La forêt mésophytique, de par sa topographie, et ses conditions édapho-climatiques favorables à l'exploitation forestière et à la culture, n'est plus guère représentée aux Antilles françaises que par des lambeaux disséminés et corrodés entre 150 et 400 mètres d'altitude. Pour la Martinique, "l'Esquisse des Associations" en 1937 (loc. cit. p. 212-215 et p. 242-247) a fait connaitre ses conditions naturelles, ses caractères, l'organisation floristique de ses strates, ses paratypes de substitution et les successions régressives auxquelles a donné lieu cette forêt. A la Guadeloupe et dans les Dépendances, elle était localisée au "domaine intérieur" dont les différents secteurs ont été décrits dans l'"Essai d'Ecologie" en 1935 (p. 126-191). L'absence d'épiphytisme sur écorces et sur feuilles y était mise en lumière pour établir une différence marquée entre la physionomie de la forêt mésophytique et celle de la forêt dense et humide, située supérieurement à celle-ci dans l'étage moyen. Parmi les Cryptogames épiphytes, une seule mousse du genre Leucobryum était citée comme caractéristique.

Il y a en effet très peu de muscinées dans cette forêt mésophytique, mais les reliquats qui en subsistent encore, les peuplements artificiels établis sur les emplacements en certains points favorables pour constituer des forêts de protection ou d'exploitation, et les cultures qui s'y sont installées un peu partout aux Antilles Françaises, hébergent cependant quelques groupements corticicoles où, avec les lichens gris incrustants, des mousses prennent place. Pour les détecter, les forêts de reboisement du Sud et du Centre de la Martinique ainsi que les arbres des exploitations d'arboriculture fruitière et des jardins d'essais de nos Iles ont été fouillés avec soin.

1. Relicts de la forêt mésophytique naturelle.—On peut distinguer trois petits groupements muscinaux sur les arbres de la forêt mésophytique dont les relicts, comme ceux qui s'étendent au Nord de la Martinique, entre Céron et Grand-Rivière, sont suffisamment éloignés des grands bourgs, pour ne pas être encore détruits ou, comme ceux situés au Sud de cette Ile, appartiennent encore au patrimoine domanial de la Colonie et sont l'objet de protection par le Service forestier. Ce sont:

Octoblepharetum albidi de la forêt à Lonchocarpus.
Calymperetum richardii de la forêt à Inga.
Pilotrichetum crypheoidei de la forêt à Simaruba.

La forêt à Andira inermis-Lonchocarpus latifolius, décrite in Bull. Agr. (loc. cit. p. 214), héberge quelques épiphytes de phanérogames et fougères et sur l'écorce des arbres, des lichens gris et verts, plaqués ou incrustants, des algues de la série des Trenthepohliacées, aux couleurs rouge et brique et deux mousses vert-pâle ou blanchâtre, de la famille des Leucobryacées: Leucobryum antillarum Hampe et surtout: Octoblepharum albidum (L.) Hedw. Ces deux mousses cespiteuses, en rosettes, forment de petites colonisations parfois assez larges sur les bois-savonnettes lorsqu'une aspérité du tronc permet l'accumulation d'un peu d'humus.

Dans le Sud de la Martinique, les bois de Montravail, dans les hauteurs de Sainte-Luce, vers 230 mètres d'altitude, abritent des relicts végétaux mésophytiques où les bois blancs, Simaruba amara Aubl. dominent nettement. Sous cette forêt, présentant un bel aspect de haute futaie dans les endroits les mieux abrités une strate herbacée à orchidées et graminées s'y développe largement mais, exception faite des mousses banales des abords de cours d'eau, où elles sont localisées, aucune muscinée terricole ou saxicole ne se rencontre. Sur l'écorce des bois blancs et des autres arbres de cette forêt, l'Octoblepharum est assez abondant mais les colonisations corticicoles plaquées les plus nombreuses sont celles du Pilotrichum crypheoides Schp. Elles ne s'observent cependant que dans les secteurs les plus centraux et les plus humides du peuplement de Montravail.

A Rivière-Pilote, les bois de Préfontaine et la forêt de Beaudelle, situés à 300 m. d'altitude, sont hétérogènes mais avec, comme essences dominantes les poix-doux du genre Inga et surtout le pois-doux poilu, Inga ingoides Willd. ainsi que le bois blanc. Sur les troncs des plus gros arbres, des thalles de fougères et des jeunes organes végétatifs de mousses forment de nombreuses plaques vertes mais leur identification est difficile. Les deux plus abondants qui colonisent ces écorces sont le Calymperes richardii C.M. et un Macromitrium sp.

Ces lambeaux forestiers méridionaux sont séparés du massif central de la forêt humide, très riche en mousses, par de vastes champs de cannes à sucre qui sont totalement exempts de muscinées et constituent une barrière à la dissémination des mousses, surtout épiphytes. Les groupements muscinaux corticicoles qu'ils ont conservés sont l'indice d'une ambiance favorable à la vocation forestière. Autour de ces relicts, la dissémination des bonnes espèces forestières sera facilitée par des éclaircissages du sous-bois, de l'élagage artificiel et l'enlèvement du mort-bois; la fabrication du charbon en forêt sera évitée et un nettoyage des herbes coupantes (Scleria) faciliterait la germination par la chute naturelle des semences sur le sol.

Il est à noter que ces Muscinées électives de la forêt mésophytique, appartiennent à la famille des Calympéracées et des Leucobryacées, sont des mousses acrocarpées comme les Pottiacées de la forêt xérophile. La présence en outre d'une Pilotrichacée, mousse pleurocarpée, d'une famille dont tous les autres représentants caraïbes sont localisés en forêt dense, dans un des rares bois du Sud doit être interprétée comme l'indice d'une reforestation possible, non seulement par les bois-blancs mais encore, sous leur couvert, par des mahoganys du pays, Swietenia mahagoni Jacq. et du Honduras, S. macrophylla King, essences plus sciaphiles.

2. Reconstitution forestière par les peuplements de mahoganys.—Depuis une vingtaine d'années, mais de façon sporadique, des reboisements par le mahogany du pays et le mahogany du Honduras ont été effectués en diverses régions de l'Ile, aussi bien sèches qu'humides ou moyennes, sans distinction de l'évolution antérieure du tapis végétal. En forêt xérophile et en forêt hygrophile, ils n'ont pas donné d'intéressant résultats. Ceux situés aux abords des postes forestiers, faisant l'objet de surveillance du garde, et ceux topographiquement bien situés ont seuls subsisté. Les peuplements de la forêt de la prise d'eau du Marin (12 ha), de Saint-Joseph: Bois de la Savane Bouliqui, de Sante-Anne: Propriété Desportes à Caritan, sont situés sur des emplacements d'anciennes forêts mésophytiques dégradées ou détruites et ont pris un très beau développement.

Dans les reboisements de Swietenia macrophylla King, de Bouliqui, âgés de 22 ans, entre 350 et 400 mètres, une colonisation muscinale forme une strate discontinue, depuis le sol jusque sur les branches. Il y figure sur le sol humide, étroitement associées: Macromitrium scoparium Mitt., M. mucronifolium (H. et G.) Schwaeg. et Calymperes donnellii Aust; constituant le Macromitrietum scoparii des talus humifères de la forêt à Swietenia. Lorsque le ruissellement a entrainé les matières solubles de la couche superficielle, le pouvoir absorvant est réduit et l'humus entrainé, l'hydrargile ferrugineuse apparait et les éléments de l'association muscinale précitée disparaissent, sauf cependant le

Macromitrium mucronifolium qui subsiste sur les talus en cours de latéritisation si l'érosion des talus n'a pas été trop forte.

A la base des plus gros troncs de la même forêt du rôle colonisateur des empatements et des contreforts de mahoganys incombe à la var. galipense (C.M.) Smith du Sematophyllum caespitosum (Hedw.) Mitt., dont l'écologie sylvicole est toute différente de l'espèce type, rivulaire et terricole. Plaquées sur l'écorce du tronc et des branches il y a lieu de noter la coexistence de deux mousses épiphytes: Lepidopilum subenerve Brid. et Meiothecium scabriusculum Besch. Ces dernières espèces qui figurent également dans les relevés floristiques effectués en forêt dense là où son atmosphère est moins saturée, peuvent être adoptées comme indicatrices du reboisement en forêt humide dégradée par l'essence précieuse et de haute progressivité que constitue le mahogany du Honduras, en particulier pour le comblement des trouées ou des clairières. Ailleurs, en général, la saturation et l'ombrage de la forêt dense, manifestés par un épiphytisme muscinal abondant, ne permettent pas aisément, ainsi que le démontre la venue difficile des peuplements de l'Alma et des Deux Choux, le reboisement par ce mahogany, éssence méso-sciaphile, pour laquelle un éclairement suffisánt est cependant nécessaire.

3. Epiphytisme muscinal des cultures.—L'arboriculture fruitière fait l'objet aux Antilles francaises de culture hétérogène suivant la méthode créole où, le verger mixte, contigü aux plantations vivrières, comporte de nombreuses espèces en mélange. Des mousses et hépatiques colonisent souvent le tronc et les branches de ces végétaux cultivés ou introduits et il est curieux de constater qu'en outre de l'altitude qui agit par le microclimat, une adaptation spécifique parait exister entre la mousse et l'hote qui l'héberge.

D'une façon générale, partout où nous avons observé des groupements muscinaux corticicoles sur les arbres cultivés, les rhizoïdes de ces muscinées n'étaient pas fixés directement sur l'écorce de l'arbre mais sur le lacis formé par les racines et les tiges enchevetrées de fougères et surtout de Polypodium polypodioides L. et de P. astrolepsis Liebm. D'autres épiphytes, surtout des Orchidées: Jacquinella globosa (Jacq.) Schltr. et Epidendrum sp. pl. etc....., se fixent également sur le même support avec des lichens et les mousses.

D'après les nombreux relevés effectués, il ressort l'électivité suivante:

Sur manguiers: Macromitrium mucronifolium (Hook. et Grev.) Schwaegr.
(Jardin de Tivoli, alt. 300 m.)
Macromitrium apiculatum (Hook.) Brid.
(Fonds Saint Denis, alt. 480 m.)
Calymperes richardii C.M.
(Jardin de Tivoli, alt. 300 m.)

Sur arbre à pain: Macromitrium cirrhosum (Hedw.) Brid.
(Camp de Colson, alt. 500 m.)
Macromitrium apiculatum (Hook.) Brid.
(Morne Rouge, alt. 520 m.)

Sur orangers: *Syrrhopodon martinicensis* Broth.
Lepidopilum integrifolium Broth.
(Fonds-Saint-Denis, alt. 480 m.)
Macromitrium perichaetiale Hook. et Grev.
(Camp de Balata, alt. 450 m.)
Macromitrium cirrhosum (Hedw.) Brid.
(Camp de Colson, alt. 500 m.)
Frullania Kunzei L. et Lindenb.
(Camp de l'Alma, alt. 500 m.)

Sur pommiers-cythères: *Macromitrium mucronifolium* (Hook. et Grev.) Schwaegr.
(Poste forestier de l'Adonis-Balata, alt. 450 m.)

Sur cocotiers: *Macromitrium Husnoti* Schp.
Macromitrium mucronifolium (Hook. et Grev.) Schwaegr.
(Morne Rouge alt. 375 m. et Camp Colson, alt. 500 m.)

Sur palmiers: *Roystonia regia* Bailey: *Pterogonidium pulchellum* (Hook.) C.M.
(Poste forestier de l'Adonis-Balata, alt. 450 m.)
Chrysolidocarpus lutescens L.: Calymperes Richardii C.M.
(Jardin de Tivoli, alt. 320 m.)
Elaeis guineensis L.: *Octoblepharum albidum* (L.) Hedw.
(Jardin de Tivoli, alt. 310 m., également sur *Oreodoxa*).

Il y a lieu cependant de faire intervenir la proximité de la forêt ou des rivières qui hébergent des mousses. Ainsi, les abords de la Rivière Madame à Tivoli, étant des réserves à: *Taxithelium planum* (Brid.) Mitt., *Vesicularia amphibola* (Spr.) Broth. *Isopterygium tenerum* (Sw.) Mitt. et *Sematophyllum caespitosum* (Hedw.) Mitt. sur des talus humifères et ses racines de bambous, ces espèces se retrouvent à la base des manguiers ou orangers voisins et des divers arbres cultivés. A Saint-Joseph sur l'habitation Deslands, humide et peu éloignée de la forêt humide, ce sont l'*Hookeriopsis guadalupensis* (Brid.) Jaeg. et le *Calicostella Belangeriana* (Besch.) Jaeg., qui colonisent la base des manguiers.

Néanmoins, l'affinité du genre *Macromitrium* pour les arbres fruitiers de culture ressort nettement quels que soient les secteurs et l'altitude envisagés. Le *M. apiculatum* préfère les écorces de manguiers, le *M. cirrhosum* celles d'arbres à pain, le *M. perichaetiale* celles d'orangers, le *M. mucronifolium* celles de pommiers-cythères et le *M. Husnoti* celles de cocotiers. Il y a donc là un *Macromitrietum corticicole* des arbres fruitiers des Antilles françaises. Les lisières culturales arbustives ont également leurs muscinées électives. Les espèces du genre *Macromitrium* y sont plus rares, remplacées par des Hookériacées. Ainsi, au Morne Rouge et au Camp de Colson où les lisières culturales sont entre 400 et 600 m. d'altitude on trouve sur les gliricidias: *Gliricidia sepium* (Jacq.) Steud., sur des racines de *Polypodium polypodioides* L.

Lepidopilum radicale Mitt.
Crossomitrium subepiphyllum Besch.
Macromitrium mucronifolium (H. et G.) Schwaegr.

Ces espèces constituent une association corticicole sur les troncs vivants de Gliricidia sepium (Jacq.) Steud.

Sur les bois-carrés ou bois-côte: Cytharexylum quadrangulare Desf. on trouve en Guadeloupe, à 50 mètres d'altitude (Vieux Bourg), le Thuidium involvens (Hedw.) Mitt.

Les pois-doux du genre Inga surtout: I. laurina Willd. souvent utilisés pour brise-vents ou arbres d'ombrage, tant en Guadeloupe qu'en Martinique, portent des Macromitrium et le Frullania kunzei Lehm. et Lindenb.

Il est à noter que les arbres de lisière conservés de la forêt à la limite des cultures portent des mousses plus xérohéliophiles que celles de la forêt d'ou elles dérivent par régression ou qui sont les moins sciaphiles de cette forêt qui se sont adaptés à plus d'insolation et de chaleur.

Forêt Hygrophytique de l'Etage Moyen

La forêt hygrophytique, constituant l'étage moyen aux Antilles françaises entre 400 et 800 mètres d'altitude, qui reçoit une tranche d'eau moyenne de 5 à 6 m. par an, est dense, humide, polystrate et sempervirente, conditions favorables au foisonnement muscinal. Elle présente des aspects variés déjà décrits: des noyaux constituant au centre des relicts préliminaires, de la forêt native, très belle en certains points, à la Guadeloupe; autour de ce noyau, de la forêt dégradée où l'aspect de futaie se mêle aux taillis et où parmi les essences primaires s'intercalent abondamment des espèces régressives, des peuplements secondaires sur humus ou sur terrains dénudés, enfin des paratypes de substitution issus de la superposition de l'action de l'homme à celle des éléments naturels. Alors que la sylve primitive et la forêt primaire dégradée sont hétérogènes et pourvues de groupements muscinaux abondants sur les écorces les plus diverses et au niveau de toutes ses strates, les peuplements purs de bambous et fougères arborescentes, qui sont très homogènes, possèdent au contraire des colonisations bryophytiques homogènes et stables où l'on retrouve d'une façon constante les mêmes espèces avec la même biologie. Ils seront étudiés séparément.

A tous les stades de régression, cette forêt demeure polystrate et depuis la strate des "miscinae humifusae" (décrite in Bull. Agric. 1937. Esquisse des Assoc. Végét. p. 223) jusqu'à la strate supérieure épiphytique au sommet des branches des plus hauts arbres, les mousses sont représentées avec les coefficients de présence les plus élevés. Suivant le mode de vie et le substratum, les principales strates que l'on peut distinguer sont: les muscinées terrestres ou humicoles, les muscinées épilithes ou saxicoles, les corticicoles: celles dont le support est constitué par les arbres vivants ou épiphytes et celles recouvrant les troncs pourris et pourrissants, ou saprophytes; enfin les épiphylles formant des colonisations plus ou moins étendues sur les feuilles toujours vertes des arbres.

En forêt primaire, l'abondance des muscinées corticicoles et le peu de mousses terricoles est un fait saillant aux Antilles françaises (voir Ecologie, 1935, p. 208), ainsi que l'absence de muscinées aquatiques dans les cours d'eau (loc. cit. p. 225).

Lorsque la dégradation a permis la compétition de nombreux arbres plus petits et d'un sous bois feuillu très dense, abrité du vent, de la lumière et des pluies d'orage, l'épiphytisme sur feuilles prend une large place et parmi ces épiphylles, les mousses dominent avec les hépatiques, des lichens et des algues (Ecologie p. 215). Leur phytosociologie est particulière et elles sont l'indice d'une humidité hygrométrique élevée et du calme ambiant de l'atmosphère des bois. Les peuplements entièrement substitués possèdent surtout des mousses saprophytes à leur base sur les racines enchêvetrées ou fibreuses et à peine au dessus du niveau du sol, là où la matière organique s'accumule.

Pour déterminer avec précision les associations muscinales qui entrent dans le complexe muscinal de la forêt hygrophytique, des comptages minutieux, la détermination des complexes in situ, dans leur strate et des hôtes qui les hébergent, sont nécessaires. L'étude de la composition intime des strates doit d'abord être effectuée en faisant ressortir l'action du milieu inerte et vivant.

1. Strate des muscinées terrestres ou humicoles.—Cette strate est discontinue, sporadique et n'existe pas partout en forêt où les brindilles, les détritus végétaux et de toutes sortes, jonchent la surface du sol et ne permettent pas l'installation des bryophytes terricoles. Une surélévation du substratum est pour les mousses de la forêt humide une condition plus favorable.

Cependant, cette, réduction comparative des mousses et hépatiques n'est pas si poussée qu'elle ne puisse permettre de distinguer des colonisations terrestres sur les talus forestiers qu'ils soient volcaniques, latéritiques ou humifères.

(a) Colonisation des talus volcaniques: Ponceux, Andesitiques ou Dioritiques.—Sur les talus où la roche mère d'origine volcanique a été mise à nu, puis désagrégée, sur le sol ponceux, dioritique, basaltique ou labradoritique, sur les coulées boueuses et partout où l'humus forestier a été entrainé, sans que les terrains argiloides se soient constitués, on trouve des colonisations bryophytiques, formant parfois des tapis étendus, verts et foncés, qui tranchent sur ce support clair. Certains sont même de couleur noire comme le Dicranella caespitans Besch. Les électives des ponces et les colonisatrices des coulées boueuses et laves éruptives s'y trouvent mêlées, mais ces dernières, qui constituent les pionniers du premier stade de la végétation des abords des cratères, ne tardent pas à être éliminées pour demeurer confinées à l'étage supérieur sur les pentes et les sommets des cônes volcaniques et sur les cailloux et même sur les rochers ponceux d'éruption récente. Telles sont par exemple: Breutelia scoparia (Schwaegr.) Schimp., Dicranella perrottetii (Mont.) Mitt. et Philonotis uncinata (Schwaegr.) Brid. Ces espèces qui sont des saxicoles volcaniques, suivent les rochers qui les hébergent sur les sommets, dans leur fragmentation, leur décomposition et leur entrainement vers les parties inférieures.

Les électives des taillis ponceux sont des muscinées proprement dites, minces et étroites, cespiteuses et dressées en brosses courtes au dessus de la terre; on n'y rencontre pas d'Hépatiques qui, au contraire, caractérisent les talus argileux. Ce sont surtout des acrocarpes: Dicranellacées et Fissidentacées. Les principales figurent ci-après.

Dicranella subinclinata Lor. (Syn. D. martinicae Broth.)
Dicranella hilariana (Mont.) Mitt.
Dicranella longirostris (Schwaegr.) Mitt.
Dicranella caespitans Besch.
Fissidens martinicae Besch.
Fissidens polypodioides (Sw.) Hedw.
Microdus crispulus Besch.
Entosthodon husnoti Schwaegr.
Philonotis glaucescens (Hsch.) Par.
Raphidostegium dicranelloides Schimp.
Ectropothecium globitheca (C.M.) Mitt.

Les conditions bien définies de ce milieu humide mais d'une grande perméabilité où la pluviométrie est régulière et élevée, à une altitude de 500 à 700 mètres, nous permettent de désigner cette colonisation homogène sous le nom d'association à Dicranella hilariana-Fissidens martinicae des ponces de la forêt humide. Elle présente son optimum biologique sur la terre des bois des Deux-Choux, de Colson, de l'Alma, du Calvaire-Gros Morne, de la Médaille, de la Boutaud, de l'Ajoupa Bouillon et Fonds Saint-Denis, pour la Martinique, aux Bains-Jaunes, au Matouba, à la Madeleine pour le Guadeloupe, où d'ailleurs elle est moins développée.

Du point de vue forestier ou agricole, elles indiquent un sol léger d'éruption relativement récente, dont la perméabilité est corrigée par une forte pluviométrie et qui peut être valorisé par la reforestation.

Il existe une autre colonisation, à petit nombre d'espèces, également homogène, sur terres volcaniques, dioritiques ou andésitiques, très humides et sur les canaux d'écoulement des eaux dont ces pierres forment les revêtements extérieurs. Elle est constituée par des Bryacées uniquement.

Bryum rubrifolium Schimp.
Bryum crugeri (Hampe) C.M.
Bryum argenteum L.
Splachnobryum obtusum (Brid.) C.M.
Splachnobryum mariei Besch.

Ces espèces, dans les chemins arrosés du Morne Rouge, aux Deux-Choux au Camp de Colson, en Martinique et à Gourbeyre, au Camp Jacob, à Saint-Claude en Guadeloupe constituent le Bryetum des terres volcaniques constamment imbibées d'eau, aux Antilles françaises.

(b) Colonisation des talus argileux: Hydrargileux ou Lateritoïdes.—Les ponces légères et tuffs volcaniques, les roches mères décomposées, les dépôts rivulaires ou éoliens, facilement solubles, étant entrainés par les eaux, un processus de latéritisation, plus ou moins poussée et aboutissant parfois jusqu'à la kaolinisation du sol, s'ensuit. Des argiles diversement colorées par des oxydes de fer et de manganèse, des hydrargiles et hydrargilites ou des latéritoïdes apparaissent après décapement de la couche arable et le sol est dénudé. Avant que toute autre végétation prenne place, ce sont les Bryophytes qui apparaissent d'abord, surtout des Hépatiques contrairement à la colonisation muscinale des talus ponceux. Ces hépatiques sont fortement adhérentes au sol contre lequel elles se plaquent, s'étalent largement et s'étendent peu à peu pour former parfois de larges plaques minces. Elles sont mélées à des mousses proprement dites, dressées, au milieu desquelles elles forment une tâche plate et d'un vert plus clair ou constituent même des petits groupements d'hépatiques seules.

Ce sont surtout des Marchantiacées du genre Marchantia et des Ptilidiacées du genre Isotachis pour les Hépatiques qui caractérisent ces groupements dans lesquels des muscinées (str. sens.) de diverses familles sont electives mais dont la présence n'est pas aussi constante que les Hépatiques. Elles figurent ci-après.

Hépatiques: Marchantia chenopoda L. (Syn. M. brasiliensis Lehm. et Lindenb.)
Marchantia papillata Raddi (Syn. M. domingensis Lehm. et Lindenb.)
Manoclea gottschei Lindenb.
Isotachis erythrorhiza (Lehm. et Lindenb.) Steph.
Isotachis auberti (Schwaegr.) Steph. (Syn. I. serrulata (Sw.) Mitt.
Cephalozia obtusata Steph.
Syzygiella contigua (Gott.) Steph.
Anthoceros dussii Steph.
Anthoceros papulosus Steph.
Cyclolejeunea accedens (Gott.) Evans
Lopholejeunea sagraeana (Mont.) Schiffn.

Muscinées: Calymperes guildingii Hook. et Grév.
Funaria bonplandii (Brid.) Broth.
Dicranella herminieri Besch.
Hyophila mollis Broth.
Hookeria densiretis Broth.
Hookeria densirostris Broth.
Hookeria entodella Besch.
Pogonatum glaucinum Besch.
Bryum mnioides Broth.

Les Hépatiques, surtout: Marchantia chenopoda L. et M. papillata Raddi, ainsi que Isotachis erythrorhiza (Lehm. et Lindenb.) Steph. et I. auberti (Schwaegr.) Steph. sont très communes sur les sols ocracés et humides formant de larges plaques et sur les talus latéritiques suintants, les Lejeunéacées et Hookeriacées citées colonisent abondamment. Les savanes argilo-ferrugineuses et les sols forestiers latéritisés du Lamentin, la Médaille, Balata, etc., à la Martinique, hébergent ces électives qui constituent l'association à Marchantia chenopoda-Dicranella herminieri des talus latéritoïdes des Antilles françaises. Elles désignent des sols où le complexe argilo-humique est élevé, très imperméables et humides, dans lesquels la plus grande partie des matières organiques a été entrainée. Ces sols sont difficilement valorisables.

(c) Colonisation des talus forestiers humifères.—Sur les talus, au bord des traces ou chemins forestiers, dans les clairières, en sous-bois, sur les lisières ou sur les alluvions déposés par les cours d'eau torrentiels, des colonisations muscinales humicoles se développent lorsque la terre possède des brindilles, des débris fibreux de racines ou de branches. Lorsque la matière organique a été entrainée, ces groupements disparaissent également pour laisser place à l'association bryophytique des latéritoïdes. La compétition des espèces est plus intense que sur les talus ponceux et on y rencontre aussi bien des Hépatiques plaquées que des mousses dressées ou même cespiteuses.

Les relevés effectués dans les divers secteurs de la Guadeloupe et de la Martinique nous permettent de désigner comme électives les espèces suivantes:

Hépatiques: Riccardia stipatiflora (Steph.) Pagan mst. (Syn. Aneura stipatiflora Steph.)
Riccardia fucoides (Sw.) Schiffn.
Symphyogyna trivittata Spruce
Odontoschisma denudatum (Mart.) Dum.
Anthoceros cucullatus Steph.
Anthoceros flexivalvis Gottsche et Nees.

Muscinées: Floribundaria usneoides Broth.
Dicranella stenocarpa Besch.
Hyophila guadalupensis Broth.
Philonotis sphaericarpa (Sw.) Brid.
Philonotis subsphaericarpa Broth.
Philonotis minuta Schwaegr.
Pogonatum pleanum Besch.
Pogonatum laxifolium Besch.
Lepidopilum polytricoides (Hedw.) Brid.
Homalia glabella Sw.
Stereophyllum matoubae Besch.
Ectropothecium leucocladium Schimp.
Hookeria hyalina Schump.
Hookeria subsimplex Broth.

Ces terres très humifères peuvent être désignées sous le nom d'association à Riccardia stipatiflora-Floribundaria usneoides. En outre de ces électives, il y a lieu de citer quelques espèces dont le rôle colonisateur ne s'arrête pas à l'humus des talus mais qui, de celui-ci, passe sur l'humus des écorces d'arbres, en s'élevant de bas en haut le long des brindilles, des racines traçantes, puis des contreforts inclinés. Ce sont:

Calymperes donnellii Aust.
Macromitrium husnoti Schimp.
Calicostella belangeriana (Besch.) Jaeg.
Syrrhopodon flavescens C.M. (Syn. S. dussii Broth.)

Le Floribundaria usneoides Broth. possède la faculté de s'installer sur les talus non protégés, de se blottir dans les moindres cuvettes que l'écorchure des parois fait apparaitre à leur surface, de peupler progressivement ces talus et par la décomposition continue de ses feuilles usnéiformes, ténues et abondantes, de donner une quantité minima de matières organiques, permettant ainsi la recolonisation des pentes dénudées par d'autres espèces. C'est un pionnier de colonisation dont le rôle édificateur d'humus est à souligner.

(To be concluded in the October 1943 issue.)

POMARROSA, JAMBOSA JAMBOS (L.) MILLSP.

AND ITS PLACE IN PUERTO RICO

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As has been previously pointed out,1/ normally the most critically scarce forest products in Puerto Rico are fuelwood, charcoal, posts, and other small products vital to our large rural population. It is true that local lumber production is negligible, but there is no reason to suspect that importation of this product will be more difficult or more expensive in the post-war world.

Because of population density only lands clearly non-agricultural in character are available for forest production. Nearly 90,000 acres of this class of land are in government ownership under the administration of the Federal and Insular Forest Services. A much larger aggregate area, however, and one of greater potential value for this purpose because of its proximity to consumers, is in privately-owned tracts scattered throughout the island. As an overwhelming majority of forest land owners here consider these areas of negative or negligible productivity, basing their evaluation only upon the return from immediate and complete liquidation, it is the forester's responsibility to provide inducements to improved management practices through the development of silvicultural methods yielding a maximum return upon a minimum of outlay. Imperative to the achievement of this goal is the selection of rapidly-growing tree species requiring little care.

One tree species which deserves careful consideration because of its high productivity of fuelwood and posts, is pomarrosa, Jambosa jambos (L.) Millsp. This species, introduced into the West Indies from the Far East many years ago (prior to 18212/), became widely distributed through natural reproduction and is now found in dense pure stands on abandoned lands throughout many parts of the island, particularly in the humid Cordillera Central. In some regions the only existing forests are composed purely of pomarrosa.

The name "pomarrosa" (rose apple) is derived from the consistency and odor of the fleshy fruit. The tree seldom grows to more than 6 inches d.b.h., although 14-inch trees have been seen. Likewise it is short, generally less than 35 feet tall. The main stem generally branches several times, the first fork usually being less than 6 feet above the ground. Following cutting a large number of sprouts are produced, giving the tree the appearance of a large shrub. Because of the intense competition between these sprouts their stems are often fairly straight for 10 feet.

1/ Wadsworth, Frank H. The evaluation of forest tree species in Puerto Rico, as affected by the local forest problem. Caribbean Forester, January 1943.
2/ Descourtilz, M. E. Flore pittoresque et médicale des Antilles. Paris, 1829.

The wood of pomarrosa is light colored, hard, and heavy. It is strong and is used in the round for various construction purposes. Its chief use is for fuel, and it makes an excellent charcoal. Because of its weight it is not highly esteemed for hoe handles. Although it is not outstanding in durability in the ground it is frequently used for fence and barn posts and vegetable stakes. It is widely used in the tobacco region for the construction of drying sheds, and an important part of our annual consumption of approximately 4,500,000 tobacco stakes[3] is supplied by this species.

Productivity

Pomarrosa deserves consideration as a species for farm forests chiefly because of its high productivity. While seedling trees grow slowly, coppice growth following clear-cutting of an established stand is phenomenal. Within a year a dense growth of sprouts will reach 12 feet in height, dominating all competing vegetation, and with proper management a rapid growth rate will continue until a very dense stand is formed. Thus production by coppice is high, and, as no weeding is necessary during the regeneration period, cost is low.

Without control of stand density pomarrosa tends to form thickets with a very regular canopy, containing no clearly dominant trees. There are indications in such stands that a marked reduction in diameter growth takes place in extreme cases possibly approaching stagnation. In a young stand in the Rio Piedras woodlot of this Station, it was found that the growth rate is decreasing even though the basal area is but little more than 50 square feet. Here some trees are still dominant and have grown as much as 0.7 inches in diameter during the past year, but the annual diameter growth of the average tree is only slightly more than 0.2 inches.

A good indication of pomarrosa growth and the character of the stands formed can be found in an old pure forest in private ownership near Cidra in east central Puerto Rico. This forest, growing at an elevation of 1400 feet and receiving an average annual rainfall of about 90 inches, is on a degraded heavy clay soil (Cialitos). It covers about 60 acres, chiefly on slopes bordering a stream. It is evident that the area has been forested for many years, for there are many old stumps more than 2 feet in diameter still sprouting. Parts of this forest have been cut periodically to supply posts, stakes, and fuel for a bakery. As cutting has generally been clear, each cutting area can be distinguished by the size of the trees.

In 1943 one-tenth-acre temporary sample plots were established and measured within this forest to determine the density of two stands of different ages. The desirability of marking permanent plots was recognized but as no control can be exercised over management practices this was considered unwise. In one part of the stand clear-cut six years ago the number of trees per acre taller than 4.5 feet and their diameter distribution were found to be as shown in Table 1.

3/ Unpublished information supplied by the Tobacco Institute, Rio Piedras.

Table 1.—Stand Per Acre in Six-year-old Pure Pomarrosa Coppice, Cidra

D.B.H. Class	Sprouts		Seedlings		Total	
	Number	Basal Area	Number	Basal Area	Number	Basal Area
Inches		Sq. Ft.		Sq. Ft.		Sq. Ft.
Below 0.6	2,544	1.0	1,945	0.8	4,489	1.8
1	9,641	57.8	1,881	11.3	11,522	69.1
2	3,676	84.6	192	4.4	3,868	89.0
3	171	8.7	128	6.5	299	15.2
4	64	5.7			64	5.7
5	21	2.9			21	2.9
Total	16,117	160.7	4,146	23.0	20,263	183.7
Per cent	79.5	87.5	20.5	12.5	100.0	100.0

Several indications of the density of the stand are to be found in Table 1. While the number of trees per acre may not be surprisingly large when tree size is also considered, the basal area is high for a stand of this age. A result of stand density is the comparatively small number of saplings of less than 0.6 inch d.b.h. This characteristic is at once apparent to the eye, as the ground is virtually bare of small plants. Also an indication of density is the subordinate position of the seedlings, which, subjected to the intense competition of the more rapidly-growing sprouts, are unable to attain a dominant position.

On the basis of the tally within the plot there are 2,159 stumps per acre, each supporting an average of 7.5 sprouts. One large stump supports 46 stems, the aggregate basal area of which is the equivalent of a single stem 11 inches in diameter. The density of this stand can be compared with high forests by assigning each stump the aggregate basal area of all its sprouts and converting this into one stem of the corresponding diameter. On this basis the average "tree" in the coppice alone is 3.7 inches d.b.h., and the average spacing between "trees" is about 4.5 feet. With the seedlings included, these figures become 2.3 inches and 2.6 feet respectively. This, coupled with an average tree height of about 25 feet, is ample evidence of density.

This stand, if cut immediately, would yield at least 12 to 15 cords of wood per acre worth $30 or $40 on the stump. If the posts were sold separately the return would be considerably increased.

Another part of this forest was older, probably having been left 12 to 15 years since the last cutting. Based on measurements in a second small sample plot, this stand was found to be as indicated in Table 2.

To the eye this stand appears fully as dense as the younger one, yet the basal area is less. The apparent density is due to the deep shade produced by profuse branching in the larger crowns of these trees. It appears that in the older stands such as this one there is a cubic volume of branchwood nearly equal to that in the main stems. Here, even more than in the younger stand, the seedlings are insignificant, making up less than 5 per cent of the basal area. Almost no seedlings reach the canopy level.

Table 2.—Stand Per Acre in 12- to 15-year-old Pure Pomarrosa Coppice, Cidra

D.B.H. Class	Sprouts		Seedlings		Total	
	Number	Basal Area	Number	Basal Area	Number	Basal Area
Inches		Sq. Ft.		Sq. Ft.		Sq. Ft.
Below 0.6	746	0.3	1,430	0.6	2,175	0.9
1	1,202	6.0	816	4.1	2,018	10.1
2	1,412	32.5	88	2.0	1,500	34.5
3	719	36.4	9	0.5	728	36.9
4	315	28.2			315	28.2
5	175	24.4			175	24.4
6	44	8.8			44	8.8
7	18	4.9			18	4.9
Total	4,631	141.5	2,343	7.2	6,974	148.7
Per cent	66.4	95.2	33.6	4.8	100.0	100.0

The stumps are spaced at an average distance of 8 feet, or 676 per acre. On the average they support 6.8 stems each. One stump with 40 stems has an aggregate basal area corresponding to a single stem of 15.6 inches d.b.h. The average aggregate stump diameter determined by this method is 6.2 inches. With the stumps considered as individual stems of a size corresponding to the total basal area of their sprouts, and with the seedlings included, the average d.b.h. is 3.0 inches and the average spacing is 3.8 feet. The total height of these older trees is only slightly more than that of the younger stand, probably averaging less than 30 feet.

Silvical Characteristics

Some of the more desirable characteristics of pomarrosa have already been mentioned. Its high productivity as a coppice makes it outstanding for private forest management in certain parts of the island. Once established, it can cope with herbaceous competition by rapid growth and immediate domination of the site following cutting. While the growth rate of seedling trees is considerably slower than that of coppice, seedlings appear to be equally able to fight through herbaceous vegetation. In many parts of the island young seedling stands can be found in brush or in dense grass, gradually attaining dominance without assistance.

Any species able to form forests on this overpopulated island must be tolerant of degraded sites considered too poor for agriculture. Pomarrosa has proven very successful in this respect. Although it is not known what effect site has upon its growth rate, even on exhausted steep slopes it flourishes without indication of chlorosis.

Fig. 1.—An old pomarrosa stump with 25 sprouts averaging 2 to 3 inches d.b.h.

A criticism of pomarrosa has been that it forms such dense shade that on steep slopes no subordinate vegetation grows on the forest floor, and thus the soil is exposed to sheet erosion. This has been observed where the soil is of an erodable type, and it takes place even on rather gentle slopes. Certainly such a forest could never be expected to retain any considerable quantity of water entering it from higher up a slope. However, it has been found that frequent light cuttings, which can be made at a profit, will maintain a sufficient open canopy to provide adequate ground cover to protect the soil. In a quarter-acre stand improvement plot a light opening resulted in quick invasion by a herbaceous ground cover, largely of Palicourea sp., which has no detrimental effect upon the stand.

Pomarrosa has been criticised also because of its massive root system which makes land-clearing very arduous. The importance of this characteristic as a "disadvantage" varies with the point of view. If pomarrosa is to be grown for but one rotation and then the land is to be cleared for cultivation, this is certainly a factor to consider. Under this policy the rapid coppice growth is not realized, as the trees are all seedlings, and therefore other species should be recommended. On the other hand, if the land supporting the forest is clearly non-agricultural, and therefore should not return to cultivation, this disadvantage disappears, and in fact might be considered an advantage, as it discourages an undesirable practice.

Natural Regeneration

If the most important factor in the development of our volunteer pomarrosa forests has been the ability of the species to fight through competing vegetation, certainly next in importance is the vigor of its seeds. The seeds are made up of several sections, one to four of which have embryos which may germinate, thus providing a safety factor. For this reason fresh seed always has a germination percentage "greater than 100". As the seeds germinate best in a shady and moist environment they are well adapted for conditions on which competing vegetation is already growing. Germination is slow, requiring 10 to 20 days to start, and continuing for as long as 120 days. The endosperm provides sufficient food for the young plant for several months, and new sprouts are produced if the first stem becomes broken off any time during this period. The natural seedlings apparently can withstand shade sufficiently dense to prevent much growth during the first few years, as many 24-inch wildings are found with very thick root collars and extensive woody root systems.

The discovery of numerous pomarrosa seeds or seedlings at some distance from the nearest parent tree is not infrequent and is rather unexpected with a species having heavy seeds (175-200 to the pound). Various speculations have been made to explain this, particularly where the seedlings come up in a compact group of 30 or more within a square foot. Although it is reasonable to suppose that bats or rodents may carry the seeds or fruits, this has not been seen by the writer.

Artificial Regeneration

The main seed production period here is in the spring, from April to June. The seeds fall gradually throughout this period, and therefore collection of a large quantity at any given time necessitates coverage of a large area, collecting a few from the ground beneath each tree. The fresh seeds have a 50 per cent moisture content and do not keep well. After unsealed storage for a month at room temperature one sample had a viability of only 18 per cent. Another lot, stored unsealed at 35-40° F., retained 50 per cent viability for 3 months.

During 1942 a plot experiment was laid out on two sites to test various methods of artificial regeneration of this species, using methods which are not difficult or costly. The results indicate that, taking advantage of the characteristics which contribute to pomarrosa's abundant natural reproduction, the artificial regeneration of this species will not prove difficult. One site used was in the Rio Abajo Insular Forest in the moist limestone region of the north coast. The elevation above sea-level is 500 feet and the annual precipitation is 80 inches. The other site was in the Toro Negro Unit of the Caribbean National Forest in the Cordillera Central, at 2,700 feet elevation, receiving an annual rainfall in excess of 100 inches. Two ground preparation treatments were tested, (1) complete clearing and burning prior to sowing or planting, and (2) cleaning only the area within 1 foot of the seeds or seedlings. A set of untreated control plots was also included. Methods of establishment included broadcasting, spot seeding, and planting. Each treatment was tested in two randomized 20 x 40-foot plots at each site. The seed spot and planting spacings were 4 x 4, permitting 50 per plot. Four seeds were sown per spot. The broadcasting was at the rate of 6, 8, and 10 seeds per square foot in the burned, weeded, and untreated plots respectively. In the broadcast-weeded plots the seeds were sown in cleared strips two feet wide.

All phases of the study have not been completed as yet, but some of the results are already clear. During the first year the seedlings have grown slowly, the tallest being about 18 inches. The nursery stock was not ready for transplanting until it was 5 months old. It was slow to recover from the shock, but now after 6 months it is starting to grow. The data are shown in Table 3.

Table 3.—Survival of Pomarrosa Sowing and Planting 1/

Treatment	Limestone			Cordillera Central		
	Block I	Block II	Average	Block I	Block II	Average
	%2/	%2/	%2/	%2/	%2/	%2/
			Broadcasting			
Burned	0	0	0	11	1	6
Weeded	0	0	0	22	5	14
Untreated	5	0	2	52	43	48
			Seed Spots			
Burned	118	90	104	79	45	62
Weeded	100	101	100	90	75	82
Untreated	110	118	114	78	104	91
			Planting			
Burned	46	52	49	96	80	88
Weeded	58	26	42	70	94	82
Untreated	40	38	39	98	94	86
General Average	53	47		66	60	

1/ Broadcasting and seed spot survival after 12 months, planting survival after 6 months.
2/ As frequently more than one seedling was produced from an individual seed, it was impossible to accurately determine which had germinated. Therefore, each plant was counted, making these percentages higher than the true germination percentage.

It will be noticed that the relationship between the results at the two sites is not consistent throughout all treatments. This difference resulted from shallow sowing in the seed spots in the Cordillera. These seeds were soon exposed by hard rains and many died as a result of insolation. It is probable that, barring this error, the survival would have been higher in all treatments at high elevation.

The results of broadcasting are not yet final, as with no care subsequent to the sowing, the seedlings must still attain dominance over the herbaceous vegetation, which is now dense in all plots. There are no signs of appreciable losses, so the results to date measure the effect of the various environments upon germination, rather than upon ultimate survival. The data from the broadcasted plots corroborate laboratory tests which show that the seeds require a very moist environment during the long germination period. The contrast between the germination in the treated and untreated plots is sharp, and is largely due to the effects of shade in the untreated plots. The losses in seeds sown in direct sunlight were obvious after only a few days. The poor survival in the untreated plots in the limestone region is probably partly due to higher temperature and lower rainfall but also to the fact that there the grass was shorter as a result of previous grazing, permitting direct exposure of many of the seeds to the sun. In these plots it was noticed that nearly all of the seedlings appeared from beneath the denser clumps of grass where the seeds had been well shaded. If future losses are not large, broadcasting without soil preparation may well prove to be the most practical method, as it is by far the cheapest, and, using the sowing density of this study, only a one per cent survival would be necessary to obtain a 4 x 4 spacing. Probably much less seed is actually necessary.

The seed spots are considered satisfactory so far at both sites despite the fact that, as has already been mentioned, the survival at the limestone site is significantly superior due to shallow sowing in the Cordillera. At least 90 per cent of the spots in every treatment have at least one seedling. No significant difference was found between ground preparation treatments and none should develop, as no more care is planned. Observations will continue in order to record the effects of competition upon survival and growth.

As it is but 6 months since the planting was done, the data indicate only actual planting loss. This loss has proved to be significantly higher in the limestone region, again bringing out the preference of this species for cool moist sites. No relationship between ground preparation treatments was anticipated, but should the trees appear unable to cope with herbaceous competition at any time in the future, some of the plots will be weeded for comparison.

With observation of the abundant wildings beneath existing pomarrosa forests came the thought that they might constitute an important source of planting stock. One hundred wildings 18 to 24 inches tall were pulled by hand at the aforementioned site in the Rio Abajo Insular Forest and in the Luquillo Unit of the Caribbean National Forest in the eastern mountains at about 1000 feet elevation (100 inches annual precipitation). These were replanted at their respective locations on sites covered with a dense stand of grass and herbaceous vegetation 2 to 4 feet tall. After 6 months without care survival is more than 90 per cent on each site, and growth is starting after a somewhat lengthy period of readjustment. With this success in mind it would seem that if the final data from the study now in progress should show that planting is to be preferred to broadcasting or spot seeding, wilding stock should be used to the fullest possible extent before inaugurating a nursery program.

Management

Judging from observations in existing pomarrosa stands, management should be a simple matter. The stand described at Cidra has been "managed" on a clear-cutting system very successfully for at least 4 rotations and the stumps are still vigorous. The chief fault to be found with present practice in this stand is that the soil is kept bare beneath the overdense canopy, permitting sheet erosion and thus site deterioration. In a few small areas in this forest where partial cuttings have been made the greater ground cover density is obvious.

Fig. 2.—A cutover area within an old pomarrosa coppice forest, showing the large stumps and the dense stand in the background. The lack of herbaceous vegetation and sapling growth indicates the dense shade which prevailed prior to cutting.

It is difficult to make any definite statement as to optimum stand density, as thinning experiments have not been made. However, it is probable that cubic foot yield is greatest in stands containing less than 100 square feet of basal area. In the rapidly-growing coppice at Cidra limitation to this figure would require (or permit) thinning at 2 year intervals following the second or third year, and would probably admit a protective herbaceous ground cover. Thinning should be from above, as there is little reason to encourage the dominants to grow to large size, certainly not to more than 6 or 8 inches d.b.h., as the stems, being straight for only a relative short length, do not rapidly increase in value with additional growth. The most crooked stems which will serve only for fuel should be taken first, regardless of position in the canopy or potential growth rate, and then, if necessary, the dominants, working toward a uniform final crop of posts and poles. It is probable that on a rotation of 10 to 15 years this policy will provide cubic foot volume in thinnings equal to that of the final cut and will greatly increase productivity over that in dense unthinned stands.

One practice which is common here and should not be permitted in well-managed forests is that of cutting high stumps (See Fig. 2). In the Cidra forest four rotations were visible, the cuttings having been made progressively higher until some of the last poles were cut at 8 feet above the ground, resulting in waste and the exposure of dead stumpwood to termites and fungi.

It is said that pomarrosa has become a serious weed in some parts of the American tropics, as in the Pinus occidentalis forests of the Dominican Republic. There the dense understory of pomarrosa prevents reproduction of the intolerant pine. The only logical treatment under such circumstances seems to be poisoning with sodium arsenite, although this method is expensive and, to the writer's knowledge, has not been tried. Attempts at removal by frequent weedings will probably be equally costly and less certain of success because of persistent sprouting and the shade tolerance of the species. The introduction of pomarrosa into an area which is to sooner or later be converted into a high forest may well present serious problems in the future, particularly if conversion to a shade intolerant species is anticipated. For this reason its use is recommended only in regions where a permanent fuel and post market is assured.

While the products of pomarrosa are badly needed now as a result of forest depletion, it is by no means recommended, on the basis of present knowledge, that every forest acre be planted to this species. Pomarrosa forests can be of greatest service in wood-starved intensive farming regions such as the sugar and tobacco producing areas. Here only a small percentage of the land area is non-agricultural, in many places the only locations available for trees being fence rows. However, on areas with steep slope or rocky soil, many of which are now used only for poor pasture, well-managed pomarrosa forests can increase income while affording permanent protection for the soil.

Summary

The discovery of forest tree species which grow rapidly and require little care is a prerequisite to improved management of forests in private ownership in Puerto Rico. Observations and studies indicate that one species deserving consideration is pomarrosa, Jambosa jambos (L.) Millsp. Pomarrosa does not grow to a large diameter, nor very tall, and the wood is not used for lumber. However, when the high demand for posts and fuel is considered, this species can be considered of importance because of its suitability for these products. Sample plot measurements in an old coppice stand indicate that sprout growth is phenomenal, producing a very dense stand within a few years. The volume in a 6 year old coppice stand was estimated at 12 to 15 cords per acre.

Since its introduction into Puerto Rico many years ago pomarrosa has formed forests on abandoned lands throughout the moist parts of the island. This is largely due to the ability of its seedlings to fight through herbaceous vegetation and then to form such a dense shade that its dominance is assured. Also of importance is the fact that it grows well on some of our worst soils.

Natural regeneration of pomarrosa is abundant, and seedlings are often found at some distance from the nearest tree, despite the fact that the seeds are heavy. As 3 or 4 seedlings may come from each seed the "germination percentage" is high. A partially completed study of artificial regeneration, indicates that broadcasting and direct seeding will prove successful, thus obviating nursery expense. The study also brought out the importance of shade and moisture during the germination period, pointing to the desirability of leaving undisturbed the existing vegetation on the planting site. If planting is preferred, the large available supply of wilding stock in and near existing stands should be used wherever possible. In the nursery the trees grow slowly, requiring about 6 months before lifting.

Management appears to be simple. Clear cutting produces a dense coppice growth which will rapidly dominate and protect the cutover area. Pomarrosa tends to form overstocked stands and may stagnate if not occasionally thinned, possibly as often as every two years. Frequent thinning, while providing an income, will also admit a herbaceous ground cover to protect the soil on slopes. Thinning should remove deformed trees first and then dominants, working toward a uniform final crop of posts or poles of 4 to 8 inches in diameter. Such a policy should not require a coppice rotation longer than 15 years.

Pomarrosa can be a weed under certain circumstances and should not be introduced into areas as a nurse crop for other species, as it will be difficult to eliminate, because of its shade tolerance. However, where a post and fuel market is assured, well-managed pomarrosa stands can provide frequent income which will probably exceed that of pasture on the poorer lands, and can permanently protect the soil.

Resumen

Un requisito previo para lograr el mejor aprovechamiento de los bosques privados de Puerto Rico es el descubrimiento de especies forestales de crecimiento rápido y que requieran poca atención. Las observaciones y estudios efectuados indican que la pomarrosa, Jambosa jambos (L.) Millsp. es una de las especies que merece consideración especial. La pomarrosa no crece mucho ni en altura ni en diámetro y su madera no se usa en construcciones. Sin embargo cuando se toma en cuenta la gran demanda de postes y leña, la importancia de esta especie es obvia debido a lo bien que suple estas necesidades. Medidas efectuadas en cuarteles de prueba señalados en tallares de pomarrosa indican que el crecimiento de los renuevos es fenomenal, produciendo rodales muy densos en pocos años. En un tallar de 6 años se obtuvo un volumen de 12 a 15 cuerdas de madera por acre.

Desde que se introdujo en Puerto Rico hace muchos años, la pomarrosa ha formado bosques en tierras abandonadas en todas las regiones húmedas de la isla. Esto se debe esencialmente a la habilidad que tienen sus brinzales de luchar con la vegetación herbácea y formar después una sombra tan densa, que asegura su dominación. También es importante el hecho de que crece bien en algunos de nuestros peores suelos.

La regeneración natural de la pomarrosa es abundante y los brinzales se encuentran a menudo a cierta distancia del árbol más cercano aún a pesar de que la semilla es pesada. Como de cada semilla nacen 3 o 4 brinzales, la capacidad germinativa es muy alta. Un estudio en vías de terminación indica que la siembra al vuelo y la siembra directa son satisfactorias obviando así los gastos de vivero. El estudio señaló también la importancia de la sombra y de la humedad durante el período de la germinación lo cual demuestra que no debe eliminarse la vegetación existente en el sitio elegido para la siembra. Si se prefiere el trasplante deben usarse los brinzales silvestres que crecen en abundancia en y cerca de los rodales ya establecidos. En el vivero los arbolitos crecen despacio y necesitan cerca de 6 meses para poderse trasplantar.

El aprovechamiento parece ser simple. Después de la corta total, el denso brote de renuevos domina rápidamente y protege el área talada. La pomarrosa tiene la tendencia de formar rodales espesos y se estanca si no se aclara de vez en cuando, posiblemente cada dos años. El clareo frecuente, además de ser una fuente de ingreso, protege el suelo en las pendientes ya que permite también la formación de una superficie herbácea. Deben removerse primero los árboles deformes y luego los dominantes para así producir finalmente una cosecha uniforme de postes o espeques de 4 a 8 pulgadas de diámetro. Siguiendo esta política las rotaciones deben hacerse de no más de 15 años.

Bajo ciertas circunstancias, la pomarrosa puede tornarse arbusto y por lo tanto no debe utilizarse como tutor de otras especies pues será difícil de eliminar debido a su tolerancia. No obstante, en aquellos sitios donde el mercado de postes y leña está asegurado, los rodales de pomarrosa convenientemente manejados pueden proveer un ingreso frecuente que probablemente exceda al que rinde el pastoreo en los terrenos pobres y puede además proteger el suelo permanentemente.

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