THE CARIBBEAN FORESTER

It is my pride and joy to be the shepherd of my country's trees.

TROPICAL FOREST EXPERIMENT STATION,
UNITED STATES FOREST SERVICE,
RIO PIEDRAS, PUERTO RICO

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THE CARIBBEAN FORESTER

This journal is planned as a medium of exchange of knowledge between 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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Leeward Islands
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Panama
St. Lucia
St. Vincent
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Surinam
Trinidad & Tobago
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To Our Collaborators

This first birthday number of "The Caribbean Forester" comes to you during a time of world stress. Such topics as germination per cents, plantation survival, and thinning schedules of certain species seem rather insignificant as compared with news of the great world conflicts of forces and ideas in progress which may affect profoundly our own future lives. At such a time we are glad to call your attention to a new tropical forestry publication "The Nigerian Forester" from British West Africa. If the British in the throes of the mighty struggle in which they are engaged consider that forestry is of sufficient importance to warrant launching this publication, then the least we can do is to follow such leadership and take heart that our endeavors are a definite contribution to the present and future needs of the world which will rise from the present turmoil. This welcome addition to knowledge of tropical forestry contains many interesting articles and much valuable information, and we extend our congratulations to the editors.

We have added to this number two taxonomic contributions. There is no intention of changing the nature of the journal, but rather one of increasing its utility. With the complexity of the forest floras in tropical regions, the forester working therein needs considerable botanical knowledge to know the components of the stands with which he works. We hope with this new volume to serve better the foresters and others interested in the growing problems of tropical forestry in the western hemisphere.

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NOTES ON CALOPHYLLUM LUCIDUM BENTH

J. C. Cater, Asst. Conservator of Forests
Trinidad

General.--A recent paper by Mr. Holdridge on Calophyllum antillanum Britton will have drawn the attention of Caribbean foresters to this useful genus, and some notes on the occurrence and regeneration in Trinidad of Calophyllum lucidum Benth. may be of value to foresters who contemplate the establishment of this species in plantations.

Habitat.--Galba, as the Trinidad species is locally known, is fairly widely distributed in Trinidad. It is commonest in two districts; Valencia in the North and Cap-de-Ville in the Southwest, but in both localities it has been heavily overcut in the past. It occurs in these areas on extremely poor acid sands, soils incapable of supporting any form of permanent agricultural crop with the possible exception of the tonka bean, which is, of course, really a forest crop. At Valencia, the terrain is almost dead level and is subject to severe and prolonged flooding in the rainy season, which normally occurs from June to December. At Cap-de-Ville, galba occurs on fairly shallow sands overlying heavy clay, where the soil is parched in the dry season and waterlogged in the wet season.

Galba occurs also as a rare species in the mixed evergreen forest in the central parts of the island, and is fairly common in certain forest areas along the mountains of the Northern Range, where it is found from sea level up to 2,000 feet elevation.

In its principal habitats, Valencia and Cap-de-Ville, the rainfall is about 90 inches per annum, most of which falls in the last 7 months of the year.

The tree.--Galba reaches a height of at least 120 feet and a girth of not less than 15 feet. Occasionally, exceptionally large trees up to 20 feet girth are found, but these forest veterans are invariably unsound. The form of trees which have forced their way up to the upper canopy under strong competition is extremely good, and the first branch may occur 60 or 70 feet from the ground. The stem is very cylindrical and there is little tendency to buttressing.

Leaves are opposite, simple, entire, roughly oval, glabrous, up to 6 in. by 3 in., with fine, close, parallel veining. The flowers are small, white, and scented, and usually appear in September and October, although flowering trees can usually be found throughout the year. The fruit is a green drupe, rounded, and about one inch in diameter. It contains normally one, but occasionally two seeds. Seed can usually be collected in June - July.

The wood.--Air-dried galba, which is of a pale reddish-brown color, weighs about 40 lbs. per cubic foot. It is moderately hard, but works easily enough, although owing to an interlocked grain it is sometimes difficult to obtain a perfectly smooth finish. Its chief use is in building construction, where it is used for floor and wall boarding and for scantlings, and in

properly constructed buildings it is very durable. In contact with the ground, however, its life is short. Galba is resistant to impregnation with creosote and under the open-tank hot-and-cold treatment an absorption of only 4 lbs. per cubic foot can be obtained, with penetration not exceeding $\frac{1}{4}$ inch.

Galba is moderately refractory in seasoning, scantlings in particular being liable to warp, but this difficulty can largely be overcome by proper stacking as soon as the lumber comes off the saw.

Formerly, galba poles were used as masts for sloops, but there is little market for this product today.

Natural regeneration.—Little work on the natural regeneration of galba has been carried out in Trinidad. Often, a dense clump of seedlings is found around a parent tree, and examination will show that the great majority of the seedlings, which are from 1 to 3 feet high, are 1 or 2 years old. Some such clumps of seedlings have been given increased light by the removal of trees around the parent tree, but for some unknown reason the seedlings have failed to respond to this treatment. Another reason why little work on natural regeneration has been done is that the parent trees are usually widely scattered and the heavy seed is not dispersed to any distance from the trees. At best, only natural regeneration by very scattered groups could be obtained.

Artificial regeneration.—The first galba plantations in Trinidad were formed 15 years ago, and galba has been planted regularly every year for the last 13 years. Considerable experience has been gained and a fairly satisfactory technique has been worked out.

All planting is now carried out under a shelterwood formed from the natural forest by selective fellings carried out by charcoal burners. Galba can be planted under the clear-felling system, but as tropical soils deteriorate with extreme rapidity when the forest cover is removed, and as galba does not form a closed canopy for 5 or 6 years, the planting of galba on clear felled areas is not to be recommended as the ideal method of regeneration.

The present regeneration technique is as follows:

Two years before a coupe is due to be planted all the woody vines are cut. The following year, when the vines are rotten, charcoal burners are allowed to make selective fellings of marked trees. The object of killing the woody vines in advance is to ensure that cut trees do not pull down unmarked trees in their fall. Since the forest is normally entwined with a prolific growth of heavy vines, failure to cut the vines well in advance leads to excessive gaps being formed in the shelterwood and thus, to rapid weed and grass growth.

The ideal shelterwood consists of evenly spaced trees with crowns not nearer the ground than 40 - 50 feet. This can often be obtained by cutting all the smaller trees below the dominants, and removing from one-third to half of the dominants. Small trees with dense wide crowns, and short-stemmed palms with heavy crowns, forming low shade, are particularly harmful and should be cut out before planting is begun. Galba is a moderate light demander and does

not require as heavy a shelterwood as some other species, such as Carapa guianensis. It is often surprising how light a shelterwood is effective in preventing the invasion of grass and rapid weed and vine growth, at the same time affording adequate protection to the soil.

The formation of the shelterwood should be completed by the end of April of the year of planting. When the rains have properly broken, usually towards the end of June or the beginning of July, the galba seedlings can be transplanted.

One- or two-year-old nursery plants from 12 to 36 inches high with a ball of earth are used, and the conical spade is employed. (A description of the use of the conical spade has already appeared in the Caribbean Forester.) Planting is best done on wet days, and to check the rate of transpiration it is usual to tear off half of each leaf.

Spacing of the plants can be regulated to suit local conditions. Formerly it was customary to plant at 6 ft. by 6 ft., but in view of the fact that planting with the conical spade is comparatively expensive it has become the recent practice to plant at 14 ft. by 14 ft. In order to bring the effective spacing down to 7 ft. by 7 ft., any natural forest seedling of any species, and they are plentiful, which is found between the planted galba is utilized as if it were part of the planted crop and receives the same treatment in tending. At the first thinnings, it is these intermediate trees of natural origin which are cut. Of course, where no natural seedlings are found, the spacing of the galba must be 7 ft. by 7 ft.

No success has been obtained with galba root and shoot cuttings, and wrenched seedlings give very unreliable results. Success has been obtained by sowing seed direct, using 3 seeds to each spot, but the initial growth is slow and the saving by eliminating nursery costs is probably offset by increased tending costs.

Tending.—Usually three tendings are required in the first year, which consist of cutting vines and other tree and herbaceous species which threaten to outgrow the galba. During the second year, three tendings are again necessary, and from then on two annual tendings until the fifth year. The removal of the shelterwood usually begins in the third year, when more light is required, by poisoning a number of the trees. Removal of the shelterwood must be gradual and the rate depends on the condition of the galba. If the latter makes satisfactory growth, the removal of the shelterwood can be completed in the fifth year.

Thinning.—So far only those galba plantations which were planted at 6 ft. by 6 ft. have been thinned, and much remains to be learned about the thinning technique. The first thinning was carried out when the galba was 7 years old, and in view of the danger that the side thinning had been too light, annual thinnings were carried out for the next three years. The side branches do not persist as much as had been expected and as long as the thinning is not excessively heavy the trees clean themselves well. It is probable that with an initial spacing of 6 ft. by 6 ft. a first medium thinning at 6 or 7 years, followed by a light thinning at 10 years, and then regular thinnings every 5 years will be satisfactory.

Rate of growth.—Galba grows slowly for the first 2 years but from then on makes fairly rapid progress. At 5 years the height of the dominant trees is about 26 feet, and at 10 years 45 feet.

At 10 years the volume of the main crop is about 575 cubic feet (underbark and down to 3" diameter) and of the thinnings 130 cubic feet.

Nursery work.—In view of the poverty of the soil at the plantation centres only temporary nurseries have been employed, but if a rich soil and plenty of animal manure were available, and if the plantation centre were well served by roads, it is possible that permanent nurseries might be more economical.

In the temporary nurseries, which are situated in the coupe to be planted, the trees are felled and removed by charcoal burners. The smaller stumps and roots are dug out and the beds laid out. The beds are usually long and narrow, from 3 to 4 feet wide, and are separated by deep drains, the soil from which is spread on the beds. In choosing a nursery site it is necessary to choose a locality where there is a certain amount of clay in the soil; otherwise the soil breaks away from the roots when the seedlings are being lifted with the conical spade. The seeds, or rather fruits, are collected from the best available parent trees and sown 6 inches apart, being pressed about 1 inch under the surface of the soil. Germination begins in a few weeks and is prolonged over a period up to 6 months. If care has been taken in the selection of the seed up to 90 per cent germination can be obtained. It is necessary to keep the nursery beds properly weeded throughout the year.

One drawback of galba is that it does not set fruit regularly every year, and about once in 4 years seed is unobtainable. To guard against a lack of plants from this cause, it is necessary to sow enough seeds each year to provide two years' supply. Then, should the seed supply fail one year, there are enough two-year-old plants available to carry out the planting program.

Diseases and pests.—So far, the galba plantations have kept extremely healthy, and there have been few recorded deaths from fungal or insect attack. In nurseries the leaves of young seedlings are much subject to a leaf curl, which causes the leaves to become crinkled and rolled up. This probably results in reduced rate of growth, but otherwise does no harm and the seedlings ultimately produce normal leaves.

A few trees about 5 years old have died as a result of attack by a root fungus, probably a species of Rosellina.

Probable rotation.—The rotation can only be estimated, but on the extremely poor soils which are being planted it seems probable that a rotation of 60 years will provide a final crop of marketable trees with a volume of perhaps 4,000 cubic feet per acre.

Markets.—The demand for galba has always exceeded the supply and there is no reason to believe that there will be any lack of demand for this intrinsically useful wood in 50 to 60 years.

From the age of 10 or 12 years the poles cut during thinnings find a ready market with charcoal burners. This means a considerable saving of expenditure, for it is only necessary to mark the trees and the charcoal burners do the felling. Charcoal made from such small trees is naturally rather light, but it is easily salable, nevertheless.

Resumen

Calophyllum lucidum Benth, comunmente llamado "galba," crece extensivamente en Trinidad desde el nivel del mar hasta 2,000 pies de elevación, pero se encuentra mayormente en los terrenos pobres, ácidos y arenosos en la parte suroeste y en los llanos sujetos a inundación en el norte. Los árboles alcanzan por lo menos 120 pies de altura y 15 pies o más en circunferencia. Durante quince años se ha practicado la regeneración artificial de esta especie y la técnica actual de siembra dentro de bosques protectores naturales desarrollados por tumbas selectivas es como sigue:

Dos años antes de la siembra se cortan todos los bejucos del área. Al año siguiente los carboneros dan los cortes selectivos de árboles previamente marcados. El bosque protector ideal consiste de árboles separados a igual distancia con sus copas a 40 o 50 pies del cuelo. Esto por lo general se obtiene cortando todos los árboles pequeños debajo de los dominantes y sacando de la mitad a una tercera parte de éstos últimos. Galba es moderadamente exigente en cuanto a luz. Todos los cortes deben estar terminados para fines de abril del año de siembra. Tan pronto empiezan las lluvias, se procede al trasplante.

Se utilizan plántulas de 1 o 2 años desde 12 a 36 pulgadas de alto, sacadas con su bola de tierra con una pala cónica. Se siembra en días húmedos y para reducir la transpiración se corta la mitad de cada hoja. La distancia usada es de 7 x 7 pies. Por lo general, hay que dar tres limpias durante los dos primeros años y luego dos limpias anuales hasta el quinto año. Las primeras limpias consisten del corte de bejucos y supresión de toda vegetación que compita. El bosque protector se suprime del tercero al quinto año.

Para plantaciones sembradas a 6 x 6 se sugiere un primer clareo moderado a los 6 o 7 años seguido por un clareo ligero a los 10 años y clareos subsiguientes a intervalos de 5 años. A los cinco años la altura de los árboles dominantes es de aproximadamente 26 pies y a los 10 años de 45 pies. A los diez años el volumen de la cosecha es de cerca de 575 pies cúbicos y el de la madera obtenida de los clareos de 130 pies cúbicos. Muy poco daño han causado los insectos y enfermedades. Se calculan rotaciones de 60 años.

Los viveros se preparan limpiando claros en medio de la plantación y las semillas se siembran a 6 pulgadas de separación y como a 1 pulgada de profundidad. Con semilla buena se obtiene un 90% de germinación.

AN OUTBREAK OF THE SCALE INSECT, ASTEROLECANIUM PUSTULANS COCKERELL ON MAGA, MONTEZUMA SPECIOSISSIMA

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Observations made during the past few months by the writer and Mr. L. F. Martorell indicate a surprisingly extensive infestation by Asterolecanium pustulans Cockerell on roadside specimens of maga from Dorado to Isabela. Infestations are readily noted, for even a small number of scales on a twig causes all the leaves to die and turn brown. Injury resembles fire blight of pear and apple, for the dead leaves remain attached to the dead twig for some time in a manner very different from the natural maturity of the leaves which drop as soon as they become yellow. The scale does not produce as deep a pustule as on some other hosts, but its effect is more rapidly toxic in causing prompt death of the infested twig or branch. For the most part, the trunk and the main shoot are rarely infested, but one sometimes sees as many as half of the lateral branches infested and killed at one time. This widespread infestation on maga may be a very recent development, for no old records of infestation on this host are available, and it may disappear as rapidly as it has appeared, but just at present it looks serious.

The scale insect, Asterolecanium pustulans Cockerell, is widely distributed in the neotropics, and is also present, presumably by introduction, in Hawaii. Its presence is recorded on a considerable number of hosts, some of which are merely incidental or accidental, but others are normal and habitual, and on these its occurrence is disastrous.

Serious infestations have occurred mostly on hosts not native to Puerto Rico. An apple tree at Bayamón, which had attained a height of 8 feet in a few years, was killed soon after infestation developed. Specimens of caña fistula, Cassia fistula, another foreign tree, valued mostly for the sprays of bright yellow blossoms, are almost invariably infested and quite hopeless as ornamentals because of dead and dying branches due to this scale. The Australian silk oak, Grevillea robusta, at one time extensively planted in Puerto Rico, is now very rare, largely due to lethal infestations by Asterolecanium pustulans. A few large trees on the grounds of the Insular Experiment Station at Rio Piedras proved to be foci of infection for mulberry trees. As the mulberries were being grown for the production of food for silkworms at this time, the threat of the scale seemed serious. Cutting down the silk oaks removed the source of infestation, however, and the mulberries soon recovered.

The cause of the present widespread infestations on maga may be due to a similar cause. The very rapidly growing Sciacassia siamea, another imported tree, is very susceptible to infestation by this scale, and often the entire tops and trunks of large trees are killed by mass infestations. The vegetative vigor of the tree is so great, however, that watershoots promptly develop from the still living base, and attain considerable size before they in turn become infested and are eventually killed by the scale. This tree was first extensively planted not more than 10 years ago, and plantings are still being made, despite

its known susceptibility to an early mortality. It is very difficult to prove that every case of scale infestation of maga is due to the presence of Sciacassia nearby, but some instances are so obvious as to suggest that all may be due to the same cause. Sciacassia siamea is of such limited value that its universal destruction in Puerto Rico would seem to be indicated.

Three parasites of Asterolecanium pustulans are known to occur in Puerto Rico, and even the most casual inspection of an infestation will show their exit holes from some of the scales. These minute parasitic wasps are: Aspidiotiphagus citrinus Craw, Mercetiella reticulata Dozier, and Euaphycus portoricensis Dozier. It appears likely that their combined efforts would produce commercial control of Asterolecanium pustulans on maga if constant reinfestation of the scale were prevented by the destruction of Sciacassia siamea.

Resumen

La "queresa" o cóccido, Asterolecanium pustulans Cockerell, se ha visto recientemente destruyendo las ramas laterales de la maga, Montezuma speciosissima Sessé & Moc. Previamente ha sido notada en algunas especies exóti cas, como Cassia fistula, Grevillea robusta y Sciacassia siamea. Esta última es sumamente susceptible y aparentemente sirve de foco de infección para la maga.

Aspidiotiphagus citrinus Craw, Mercetiella reticulata Dozier y Euaphycus portoricensis Dozier son tres avispas parásitas que atacan la "queresa" y probablemente serían un medio efectivo para combatirla si no fuera por la presencia de Sciacassia siamea.

NOTE ON ATTACKS OF MONANTHIA MONOTROPIDIA STÅL IN TRINIDAD

The following interesting entomological note was sent in recently by Mr. R. L. Brooks, Conservator of Forests, Trinidad and Tobago:

"I was extremely interested to read in Volume I No. 3 of the Caribbean Forester the account of infestation by the Spanish elm lacewing bug, Monanthia monotropidia Stål, in Puerto Rico during 1939.

"This pest has been recorded several times in Trinidad as attacking trees locally called 'cypre'—Cordia alliodora Cham. Previous attacks, however, do not appear to have been as severe as those experienced in 1939. Not only were the cypre trees defoliated two or three times, but in many cases branches were killed, whilst death of the whole tree was not infrequent."

POSSIBILITIES FOR FORESTRY IN THE VIRGIN ISLANDS:

ST. THOMAS, ST. JOHN, ST. CROIX

Arthur Bevan, Director
Tropical Forest Experiment Station

History.—The forests of the Virgin Islands are particularly interesting because of the tremendous past influence of man on the present composition of existing stands.

The Virgin Islands were purchased from Denmark by the United States in 1917. Prior to that date, these islands had been the property of Denmark for over two centuries, but had gone through many vicissitudes, all of which had their effect on the forest.

While there are records of previous occupations by Dutch, French, and English, St. Thomas was not actually settled until the Danes took possession in 1672. Unfortunately, historical records give no clue to the original composition of the forest except the statement that "the land had to be cleared of bush and forest before it could be planted; pockwood was sufficiently in demand in Denmark to furnish a profitable ballast for returning ships." Pockwood has been identified as Guaiacum officinale L. and records would indicate that the original forest contained considerable quantities of this species. It is probable that this was particularly true of the drier portions of the islands, comprising the eastern and southern sections. While occasional specimens of Guaiacum are found, it is now rare except on St. John, where natural reproduction of this species on drier sites is more noticeable.

St. John, except for occasional landings, was not inhabited or cultivated to any extent until 1717, when settlers from St. Thomas colonized the island. Population increased rapidly and there is every evidence that the island was at one time completely cleared of the original forest.

St. Croix was first settled by British, French, and Dutch in 1625. After many vicissitudes, the French finally took possession in 1650 and maintained a considerable colony until 1695, when the island was abandoned, and it was not again colonized until its purchase from the French by the Danes in 1733.

From that date on, all three islands and surrounding cays were under Danish rule and development of plantations progressed until little if any of the original forest remained. There was a considerable growth in population and cultivation, consisting mainly of the growing of sugar cane, tobacco, and cotton. What little forest remained was burned and largely destroyed to eliminate shelter for runaway slaves.

The emancipation of the slaves in 1848, together with economic trends adverse to the growing of these main crops, seems to have been the turning point. Thereafter, there was a gradual recession of cultivation until practically all plantations on St. Thomas and St. John were abandoned, bringing a slow and gradual return to brush and then to forest. This process, despite tropical growth, must have been rather slow, because of the almost complete clearing of the land.

Forest conditions on St. John today, largely undisturbed, are the direct result of this abandonment and the forest stands should offer an interesting study for the ecologist. In the last few decades, because of the growth of the port at Charlotte Amalie, there has been a slow return to clearing and cultivation in St. Thomas. In the eastern half of this island, almost the entire area has been cleared and planted to guinea grass to provide range for a growing cattle business. However, on the northern end of this island, the forest growth which came in following abandonment is largely extant.

Present forest stands.—A rough estimate of present forested areas follows:

	Total land area	Forested	Per cent forested
St. Thomas	28 sq. mi.	14 sq. mi.	50
St. John	20 sq. mi.	16 sq. mi.	80
St. Croix	84 sq. mi.	13 sq. mi.	16
	132 sq. mi.	43 sq. mi.	32

A large part of the forest stands are still of small stems because of the time involved in regeneration on abandoned cultivated lands and pastures, coupled with the slower growth of trees in the Virgin Islands due to low annual precipitation.

Of the estimated forest area, somewhere between 1/4 and 1/3 comprises sites so desiccated by exposure to strong northeast trade winds that tree growth is practically impossible and only low scrubs of little value except for protection are able to maintain themselves on such sites. Such areas exist mainly in the eastern portions of the Islands.

However, on favorable sites, there are found many valuable hardwood species. The following is a list of a few of the species which grow very satisfactorily in the three islands and which are valuable timber trees:

Swietenia mahagoni Jacq.
Sideroxylon foetidissimum Jacq.
Zanthoxylum flavum Vahl.
Hippomane mancinella L.
Cerdana alliodora R. & P.

There are also a great many other species which are valuable as fence posts or poles, some of the more common species of which are listed in the following table:

Krugiodendron ferreum (Vahl.) Urban
Eugenia sp.
Dipholis salicifolia (L.) A.DC.
Linociera caribaea Knobl.
Vitex divaricata Sw.
Gymnanthes lucida Sw.
Amyris elemifera L.
Canella winterana (L.) Gaertn.
Exostema caribaeum (Jacq.) R.&S.
Tabebuia sp.
Bucida buceras L.

There exist considerable areas of pole stands such as on the northwest slopes of St. Thomas, on the north slope and interior valley of St. John and on the north side of the east end ridge in St. Croix.

Forestry possibilities.—Proper care and management of existing stands would provide a great deal of the products now imported from the British Virgin Islands where conditions are practically the same. It would also supply the raw material for an enlarged furniture and wood turning industry, a nucleus of which now exists in St. Thomas. What these stands need most of all is a removal of weed species which have reproduced and thrived at the expense of the better woods. Such timber stand improvement should be followed by judicious selection cuttings of the better species in order to obtain and maintain proper composition and density.

Especially interesting are the fine mahogany trees found in St. Thomas and St. Croix as well as the natural reproduction of this species which has come up in surrounding areas. This would indicate the desirability of additional planting of this species along fence rows and as spot planting through brush areas in order to eventually provide seed sources which would seed in the remainder of the area. It would seem that planting of fewer trees with greater care over a wide area rather than the usual plantations would be desirable, since seeding from these trees should occur in less than 10 years after planting. Although the Virgin Islands get some rain in the late spring previous to the summer dry spell, most of their annual rains fall during August and September, so the planting period indicated would be August or early September for best survival. In addition, since rainfall is so low, it would seem worthwhile to use balled plants for reforestation.

Another opportunity for reforestation in St. Thomas and St. Croix is the planting of shade trees in pasture lands. Samán or the Giant Thibet tree, Samanea saman (Willd.) Merrill, makes an excellent cattle shade tree as well as providing edible pods for the livestock, and its wood could be used locally to some extent. Considerable planting of this species through pasture lands would help to solve the wood and charcoal problem as well as cutting down wind movements and the corresponding heavy evaporation.

Several trees of Divi-Divi, Libidibia coriaria (Jacq.) Schl., may be seen in St. Thomas and St. Croix and it was learned that formerly the pods were collected for sale. These pods are filled with a yellow substance that contains as much as 50% tannin of exceptional qualities, which is still sold in the United States market and is a source of export trade from Colombia, Central America, and Jamaica. A full-grown tree yields about 100 pounds of pods annually. It should be possible to rebuild this trade and expand it by pasture planting.

Another tree which might be planted is the Eugenia floribunda West, the rum berry, the fruit of which makes an excellent jam and is used in the making of guava-berry rum. Besides its possibilities for these products, the wood of the tree is hard and durable and would make a satisfactory timber.

There have been considerable plantations in the past of the bay rum tree, Amomis caryophyllata (Jacq.) Krug & Urban, but it was learned that some of these plantations are being felled for charcoal. The wood of this tree has too excellent qualities to be used for such a purpose. Efforts should be made to stimulate this industry and to prevent its further decline.

St. Thomas.—While there has been a long range trend back to forest, there is today a very definite trend in the other direction. Land is being cleared for cultivation and an extensive grazing industry. Much of the land has had decades of rest and recuperation from the erosion and misuse which was a factor in the original abandonment. Improper cultivation and overgrazing will lead to recurrence of the same cycle, except that the period in which cultivation can be continued will be of shorter duration, as recovery and soil building has not anywhere reached conditions which obtained on the virgin hillsides originally cleared. Economic conditions indicate that much of the land on St. Thomas will again be cleared and the possibilities for forestry are therefore limited. Soil conservation practices should be rigidly adhered to as well as the excellent grazing practice in evidence on parts of the east end of the Island. Every effort should be made to retain the steep slopes in forest cover. The establishment of a demonstration forest would be extremely valuable, as in addition to developing proper methods of management, such an area would provide data as to financial and labor returns to be expected from forest lands in comparison with agriculture and grazing on similar sites. The best chances for forestry in St. Thomas are on the west end of the Island, and considerable areas should be acquired for Insular or Federal forests.

St. John.—With 75% or more of the entire area covered with a dense stand of young timber, the possibilities for forestry in St. John are very great. With the exception of a portion of the east end and the south coast where drought and wind permit only the growth of a scrub stand, a strip around the coast line which is more valuable for home sites and small farms, and a few valleys where use for agriculture is indicated, the whole of the island is suitable for growing of an excellent forest and in fact is now completely forested with a thrifty growth of young stands at a stage where improvement and selection cuttings are possible with a financial return which should at least return the cost of such operations. The island is well served with an excellent network of trails, most of which could be improved with a minimum of expense as truck and logging trails. The occurrence of such a solid block of timbered land would lend itself to economical management could it be consolidated in public ownership. It would provide ultimately a considerable industry and, also, most if not all the wood-product requirements of the islands, besides furnishing considerable such materials for export to Puerto Rico, United States, and other markets. The establishment of such a forest reserve would furnish considerable employment and there are undoubtedly areas within this unbroken forest which could be set aside for homes and the growing of subsistence crops for forest workers and their families.

St. Croix.—With the exception of the east end of the island, practically the entire island is given over to agriculture, and such land will probably and should continue in such use. Most of the forest area in the eastern portion of the island is already in Federal ownership and is being developed as a recreational and forest area. This area definitely falls within the dry site type and its limitations are recognized. Those portions adaptable to good forest growth of dry site species are being developed. Ultimately, this area should make the island largely self-supporting as to charcoal and some other wood products, such as fence posts. There are not many other possibilities for forestry in this island. The planting of windbreaks, woodlots on farms, and pasture shade trees should be encouraged. In the mountains of the northwest section of the islands, there are some remnants of timber and some lands which

might be classified as forest land. Dominican mahogany planted years ago in this section shows its adaptability to these sites and even limited plantings of this species in mixture would provide the raw material for a furniture industry which could be developed to assist the economy of the island.

Resumen

Los bosques existentes en las islas de St. Thomas, St. John, y Santa Cruz son resultado del abandono de plantaciones agrícolas hace por lo menos 50 años atrás. En las áreas mejores constituyen bosques vigorosos de postes (pole stands).

Con un 32 por ciento del área de estas islas cubierto por florestas, existen posibilidades definidas para el desarrollo de la silvicultura. St. John tiene las mejores posibilidades, ya que un 80 por ciento o más de su área total está cubierto de bosques. Le sigue St. Thomas con un 50 por ciento de su área bajo bosques, particularmente la parte oeste, y como último Santa Cruz, con un 16 por ciento, la mayor parte del cual está en el este y por ser ésta la sección seca su capacidad productiva de madera es limitada.

Las siguientes son recomendaciones para el desarrollo forestal en estas islas:

(1) Adquisición por compra, si fuera necesario, y administración de las áreas pequeñas más repobladas, como unidades de bosques públicos con el objeto de suplir materiales para uso local, pero principalmente para que sirvan como bosques de demostración.

(2) Establecimiento de viveros por el gobierno para la distribución de arbolitos para la siembra de los terrenos públicos, siembras privadas y siembra de terrenos de pastoreo.

(3) Estimular el establecimiento de posibles nuevas industrias e industrias ya existentes, tales como la de alcoholado, ron de guayaba y divi-divi.

(4) La adquisición de los terrenos forestales existentes para bosques insulares o federales, particularmente en la isla de St. John y en la parte oeste de St. Thomas.

SOME NEW SPECIES AND VARIETIES OF VERBENACEAE

Harold N. Moldenke

During the course of my monographic studies of the Verbenaceae of the world the following novelties from the West Indies and neighboring islands have come to light. They will be more fully discussed in my various generic monographs, but since it may be some time before all of these are published, it has been thought advisable to formally record and describe the novelties at this time.

Citharexylum Ekmani Moldenke, Geogr. Distrib. 5, nom. nud. (1939), sp. nov.

Frutex; ramis argute tetragonis marginatis obsolete puberulis vel glabratis; petiolis gracillimis minute puberulis vel glabratis; laminis foliorum membranaceis ovato-ellipticis vel lanceolatis acuminatis vel subcaudatis plerumque sparse irregulariterque dentatis vel subintegris, supra sparsissime strigillosis glabrescentibus, subtus in venis venulisque dense strigilloso-pubescentibus.

Shrub; branches and branchlets very acutely tetragonal with margined angles, brown, striate between the angles, very obsoletely puberulent or glabrate; nodes annulate; principal internodes 2-5 cm. long; leaves decussate-opposite; petioles very slender, 5-9 mm. long, minutely puberulent or glabrate; leaf-blades membranous, very dark green on both surfaces (brunnescent or nigrescent in drying), sometimes slightly lighter beneath, ovate-elliptic or lanceolate, 2.5-8.5 cm. long, 1.5-3.5 cm. wide, acuminate or even subcaudate at apex, subentire or (usually) sparsely and irregularly coarse-dentate with 1-3 large acute or obtuse teeth on each side, very sparsely strigillose above (or glabrate in age), densely strigillose-pubescent with distichous hairs along the midrib, secondaries, and larger venation beneath (the pubescence more dense on immature leaves and then extending also to the lamina, especially toward the base, beneath); midrib very slender, flat above, very slightly prominulous beneath; secondaries very slender, 3-5 per side, arcuate-ascending, not anastomosing, very slightly prominulous beneath; vein and veinlet reticulation very fine and delicate, indiscernible above, not at all prominulous beneath; inflorescence and fruit not seen.

The type of this species was collected by Erik Leonard Ekman (no. 13889), in whose honor it is named, among steep overhanging rocks in the mountains at Loma de Siguanca, Santa Clara, Cuba, on June 4, 1922, and is deposited in the herbarium of the Naturhistoriska Riksmuseet at Stockholm.

Clerodendrum aculeatum var. gracile Griseb. & Moldenke ex Moldenke, Geogr. Distrib. 5, 6, 7, 14, & 36, nom. nud. (1939); Alph. List Common Names 9, nom. nud. (1939); Prelim. Alph. List Invalid Names 20, hyponym (1940), var. nov.

Haec varietas a forma typica speciei recedit laminis foliorum subtus plusminus pilosis vel pubescentibus.

This variety differs from the typical form of the species in its leaf-blades being more or less pilose or pubescent beneath. The type was collected by Ferdinand Rugel (no. 358) in the Yumuri Mountains, Matanzas, Cuba, in

August, 1849, and is deposited in the Rijksherbarium at Leiden. The variety occurs all through Cuba, as well as in Jamaica, Cayman Islands, Haiti, and the Dominican Republic.

Clerodendrum denticulatum Moldenke, Geogr. Distrib. 5, nom. nud. (1939), sp. nov.

Arbor; ramulis crassis subteretibus glabris; foliis oppositis vel approximatis saepe confertis; petiolis gracillimis glabris; laminis membranaceis vel chartaceis ellipticis vel obovatis rotundatis vel obtusis denticulatis, ad basin acutis, utrinque glabris areolatis; inflorescentiis axillaribus paucifloris.

Tree; branchlets stout, subterete, flattened at the nodes, light gray, glabrous, corky; twigs slender, angulate-striate, brown, glabrous, issuing from a tomentose felt around the basal leaf-scar on the adjacent branchlet; nodes not annulate; principal internodes 1-5 cm. long; leaves decussate-opposite (or approximate on young twigs), often clustered; petioles very slender, 5-12 mm. long, brown, canaliculate above, glabrous; blades membranous or chartaceous, uniformly dull green on both surfaces (the immature ones brunnescent in drying), elliptic or obovate, 2.3-5.5 cm. long, 1-2 cm. wide, rounded or obtuse (or rarely subacute) at apex, denticulate with very minute apiculate teeth along the margins from base to apex, acute at base, glabrous on both surfaces and finely areolate; midrib very slender, impressed but distinct to the apex (!) above, prominulous beneath; secondaries 4-6 per side, very slender, lightly impressed or obscure above, lightly prominulous beneath; vein and veinlet reticulation indiscernible above, often obscure beneath; inflorescence axillary, apparently small and few- (2-4 ?) flowered; peduncles obsolete or to 1 mm. long; fruiting-pedicels slender, 4-11 mm. long, glabrate, spreading; flowers and fruit not seen.

The type of this species was collected by E. L. Ekman (no. 9176) at Mogote, in the limestone hills near Palmarito de Cauto, at an altitude of 300 m., Oriente, Cuba, on April 10, 1918, and is deposited in the herbarium of the Botanisches Museum at Berlin.

Clerodendrum nipense var. pubescens Moldenke, Geogr. Distrib. 5, nom. nud. (1939), var. nov.

Haec varietas a forma typica speciei recedit laminis parvioris et ramulis petiolisque pedunculisque pedicellisque laminisque foliorum subtus dense breviterque pubescentibus.

This variety differs from the typical form of the species in having its leaves much smaller, only 2.6-3.6 cm. long in all and 9-12 mm. wide, and in being densely short-pubescent on the twigs, petioles, lower leaf-surfaces, peduncles, inflorescence-branches, and pedicels. The pubescence is quite uniform throughout.

The type was collected by George Conrad Bucher (no. 10) at Caguaneque, Sagua de Tánamo, Oriente, Cuba, and is deposited in the herbarium of the Colegio de la Salle at Havana.

Duranta arida var. domingensis (Urb.) Moldenke, Prelim. Alph. List Invalid Names 25, hyponym (1940), comb. nov.

Duranta erecta var. domingensis Urb., Symb. Ant. 7:355. 1912.

Duranta Fletcheriana Moldenke, sp. nov.

Frutex spinosus; ramis ramulisque gracilibus obtuse tetragonis dense brunneo-tomentosis, senectute glabrescentibus; spinis numerosis gracillimis ternatis vel irregulariter dispositis saepe ramosis; petiolis brevissimis; laminis ellipticis vel obovatis integris, ad apicem acutis vel obtusis vel emarginatis, ad basin cuneato-attenuatis, utrinque obscure puberulis vel glaberrimis nitidis; inflorescentiis axillaribus brevibus laxe paucifloris; corollis caeruleis.

Shrub, 2-3.5 m. tall, spiny; branches and branchlets slender, obtusely and obscurely tetragonal, at first very densely brownish-tomentose throughout, later becoming glabrous; spines very numerous, very slender and sharp-pointed, varying from opposite or ternate to whorled in 4's or scattered, often branched toward the apex, sometimes leafy; leaves mostly ternate or whorled in 4's, sometimes opposite or scattered; petioles very short, about 1 mm. long, obscurely puberulent or glabrate; blades firmly chartaceous, elliptic or obovate, 4-16 mm. long, 2.5-9 mm. wide, acute or obtuse (sometimes emarginate) at apex, entire, cuneate-attenuate at base, very obscurely and sparsely puberulent on both surfaces or glabrous and shiny; midrib very slender, subimpressed above, subprominulous toward the base beneath; secondaries few, short; veinlet reticulation obscure or indiscernible; inflorescence axillary, abbreviated, 1-3.5 cm. long, loosely few-flowered or 1-flowered; peduncles and rachis very slender, densely tomentose or eventually glabrous; pedicels about 1 mm. long; calyx tubular, 4-5 mm. long, 1.5-2.5 mm. wide, sparsely strigillose, its rim densely albidous-puberulent and very shortly apiculate; corolla blue, its tube about 1 cm. long, curvate, its limb about 1 cm. in diameter.

The type of this species was collected by Joseph Silvestre Sauget, Brother León, (no. 10865) at Estribo Turquino, at an altitude of 1600 m., at the foot of Loma Regino, Oriente, Cuba, in July, 1922, and is deposited in the Britton Herbarium at the New York Botanical Garden. The species is named in honor of Dr. H. R. Fletcher, who has done such noteworthy work on the Verbenaceae of southeastern Asia. It is also known from Santa Clara.

Lantana arubensis Moldenke, sp. nov.

Fruticulus; caulis obtuse tetragonis dense brunneo-hirsutis glabrescentibus; foliis oppositis tenuiter petiolatis; laminis subcoriaceis late ellipticis vel ovatis, ad apicem rotundatis, regulariter crenulatis, ad basin truncatis, supra bullatis scaberrimis, subtus dense tomentellis; inflorescentiis axillaribus longe pedunculatis capitatis.

Probably a bush or low shrub; stems apparently not much branched, obtusely tetragonal, densely brown-hirsute when young, later becoming glabrescent; nodes not annulate; principal internodes 2.5-4.5 cm. long; leaves opposite; petioles very slender, 3-8 mm. long, densely brown-hirsute; blades subcoriaceous, dark green above (nigrescent in drying), lighter beneath, broadly elliptic or ovate, 0.8-3 cm. long, 0.5-2.5 cm. wide, rounded at apex, regularly crenulate from base to apex, truncate or subtruncate at base, conspicuously bullate and very scabrous above, densely tomentellous with sordid hairs beneath; midrib, secondaries, and veinlet reticulation deeply impressed above, the larger portions (midrib and secondaries) prominulous beneath; inflorescence axillary, solitary in the upper axils; peduncles very slender, 3.5-5 cm. long, ascending, densely short-pubescent or hirsutulous with brownish hairs; heads small, about 1 cm. wide,

many-flowered; bractlets ovate, conspicuous, the lowermost about 7 mm. long and 3 mm. wide, acute or acuminate at apex, densely short-pubescent.

The type of this species was collected by Isaac Boldingh (no. 6335) on the island of Aruba in either 1909 or 1910 and is deposited in the Britton Herbarium at the New York Botanical Garden. The species has hitherto been confused with the West Indian L. involucrata L., from which its hirsute pubescence and leaf-characters at once distinguish it.

Lantana cubensis Moldenke, sp. nov.

Frutex; ramis ramulisque obtuse tetragonis dense breviterque strigoso-pubescentibus; foliis ternatis vel oppositis; petiolis dense breviterque strigosis; laminis chartaceis ellipticis acutis dense serrulatis, ad basin cuneatis, supra scabris dense strigosis, subtus densissime sordido-tomentulosis; inflorescentiis axillaribus ternatis vel oppositis capitatis.

Shrub; branches and branchlets obtusely tetragonal, densely and shortly strigose-pubescent; nodes annulate; principal internodes 1.5-3.5 cm. long; leaves ternate or opposite; petioles slender, about 5 mm. long, densely short-strigose; blades chartaceous, somewhat lighter beneath, elliptic, 2.5-7.5 cm. long, 1.5-3 cm. wide, acute at apex, densely and regularly serrulate from base to apex, cuneate at base, scabrous and densely strigose-pubescent above, very densely sordid-tomentulose beneath, often bullate above; midrib and secondaries deeply impressed above, prominent beneath; veinlet reticulation impressed above, the larger portions prominulous beneath; inflorescence axillary, opposite or ternate, capitate; peduncles very slender, 2.5-4 cm. long, erect or ascending, densely strigose with whitish hairs; heads about 1 cm. wide, densely many-flowered, the receptacle elongating to 8 mm.; bractlets ovate, 5-6 mm. long, densely pubescent, long-acuminate; corolla-tube about 5 mm. long, its limb about 3 mm. in diameter.

The type of this species was collected by Jean Frange Lagorce, Brother Hioram, (no. 2294) at El Palmar, Guantanamo, Oriente, Cuba, on December 26, 1918, and is deposited in the Britton Herbarium at the New York Botanical Garden.

Lantana insularis Moldenke, sp. nov.

Frutex; ramulis acute tetragonis hirsutis et glanduloso-pubescentibus; foliis oppositis; petiolis hirsutis et glanduloso-pubescentibus; laminis tenuiter chartaceis ovatis acuminatis regulariter serratis, ad basin truncatis, utrinque sparsiuscule albido-hirsutis, subtus valde reticulatis; inflorescentiis axillaribus capitatis dense multifloris.

Shrub; branches and branchlets acutely tetragonal, rather densely hirsute with white spreading hairs and also densely pubescent with much shorter gland-tipped hairs; nodes annulate; principal internodes 3-5.5 cm. long; leaves opposite; petioles slender, 5-11 mm. long, densely hirsute and glandular-pubescent like the branchlets; blades thin-chartaceous, dark green above, much lighter beneath, ovate, 2.7-8 cm. long, 0.8-4 cm. wide, rather long-acuminate at apex, regularly and densely serrate from base to apex with small acute teeth, truncate at base (subacute when immature), rather sparsely white-hirsute on

both surfaces; midrib and secondaries plane above, prominulous beneath; veinlet reticulation obscure or indiscernible above, but very conspicuous beneath; inflorescence axillary, solitary, opposite, capitate; peduncles slender, about 5 cm. long, densely pubescent with spreading gland-tipped hairs and more or less scattered long-hirsute, erect or ascending; heads densely many-flowered, about 2 cm. wide; bractlets lanceolate, about 7 mm. long, rather densely hirsutulous; corolla-tube about 9 mm. long, its limb about 7 mm. in diameter.

The type of this very distinctive species was collected by William Ralph Maxon and Ellsworth Paine Killip (no. 912) along the trail from St. Helens Gap to Latimer River, at an altitude of 1400-1475 m., Jamaica, on March 9, 1920, and is deposited in the Britton Herbarium at the New York Botanical Garden. The species seems to be endemic to Jamaica and has hitherto been confused with the southern South American L. foetida Rusby.

Lantana Leonardorum Moldenke, sp. nov.

Frutex; ramis ramulisque gracilibus plusminus aculeatis tetragonis dense glanduloso-pubescentibus glabrescentibus; foliis oppositis; petiolis gracilibus dense glanduloso-pubescentibus; laminis crasse chartaceis vel subcoriaceis lanceolatis obtusis remote serratis (dentibus obtusis), supra scaberrimis strigosis, subtus dense glanduloso-hirsutulis; inflorescentiis axillaribus capitatis.

Shrub, to 1 m. tall; branches and branchlets very slender, more or less prickly, tetragonal, at first densely spreading-pubescent with brownish gland-tipped hairs, glabrescent in age; young nodes annulate, older nodes not annulate; principal internodes 2-7 cm. long; leaves opposite; petioles slender, 3-5 mm. long, densely glandular-pubescent; blades thick-chartaceous or subcoriaceous, rather grayish-green on both surfaces, lanceolate, 1-2.7 cm. long, 4-13 mm. wide, obtuse, rather coarsely and remotely serrate from the widest part to the apex with appressed obtuse teeth, acute or short-acuminate at base, very rough-scabrous and strigose above, often subbullate, very densely glandular-hirsutulous beneath; inflorescence axillary, solitary, opposite, capitate; peduncles very slender, 1.5-4 cm. long, densely spreading-pubescent with gland-tipped hairs; heads 7-17 mm. wide, few-flowered or densely many-flowered; bractlets elliptic or ovate-lanceolate, 4-6 mm. long, 1.5-2 mm. wide, densely spreading-pubescent, especially on the margins; corolla bright orange, its tube about 8 mm. long, its limb about 5 mm. in diameter.

The type of this distinctive species was collected by Emery Clarence Leonard and Genevieve M. Leonard (no. 13782)-- in whose honor it is named -- on a rocky beach east of Bord du Mer, in the vicinity of Jean Rabel, Haiti, between March 1 and 13, 1929, and is deposited in the Britton Herbarium at the New York Botanical Garden.

NOTA

Las descripciones anteriores marcan interesantes innovaciones que el Dr. Moldenke ha traído a luz en sus estudios monográficos de las Verbenáceas de las Indias Occidentales.

NOTES ON THE BIOLOGY OF MESOCONDYLA CONCORDALIS HÜBNER AND ITS PARASITES

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Mesocondyla concordalis Hübner (Family Pyralidae, Sub-fam. Pyraustinae) is a moth known as the "roble" leaf-webber. As the name implies, the larvae of the insect does damage to the host trees by webbing together and feeding on the leaves.

The adult moth (see fig. 1), with a wing expanse of 25-30 mm., is light yellow with some iridescence on its wings. The costal area of the fore wing and the anterior part of the thorax are of a purplish-brown color. The costal area of the hind wing is nearly white; a very prominent brown spot is located on the outer portion of the discal cell, just crossing the discal vein; apex marked with a brown spot. Abdomen yellow, with two small brown spots on the dorsal part of the second segment, between the end of the first and the beginning of the second abdominal segment. Eyes black, antennae filiform, yellowish, with basal part light brown.

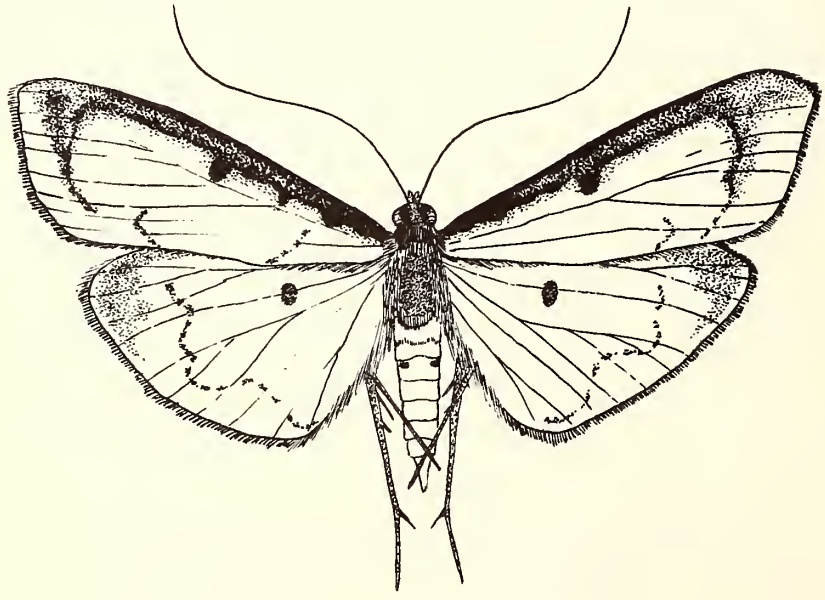

Fig. 1.—Adult of Mesocondyla concordalis Hübner. (3x)

Larva about 20 mm. long, when fully grown, of a shiny dirty-green color, its translucent body giving it a somewhat slimy appearance. The larvae eat only the epidermis of the leaves. Trees attacked show skeletonized and brownish leaves, webbed together in bunches. When the food supply is finished in this shelter, the larva moves to another place and webs more leaves until fully mature. The larva pupates inside one of these shelters. The chrysalis varies in color, from light brown to dark brown, and is about 15 mm. long. The pupation period is 8 days.

Host trees.—On the lowlands, Tabebuia pallida Miers., T. haemantha (Bert.) D.C., T. argentea (Bur. & Schum.) Britton, and Crescentia cujete Linn. are badly infested by the caterpillar. On Mona Island it attacks Tabebuia heterophylla (DC.) Britton and T. lucida Britton. At high elevations, the attack is more severe than in the lowlands. At 1,500 ft., it attacks T. pallida (Carite and Maricao Units). At 2,500 ft. and over, it has been collected on T. rigida Urban at El Yunque Range and on T. schumanniana Urban, at the Carite Forest.

Parasites.—M. concordalis is attacked by several insect parasites. The tachinid Sturmia albincisa Wiedemann (Diptera:Tachinidae) and the chalcid Brachymeria incerta Cresson (Hymenoptera:Chalcididae) had previously been recorded as parasites of the leaf-webber. Recently, a parasite not reported before has been found attacking the larvae of Mesocondyla. The insect was collected several times on the southeastern coast of Puerto Rico and also at Mona Island. It was identified by Mr. C. F. W. Muesebeck (U. S. National Museum) as Microbracon cushmani Muesebeck.

The following observations were made on the biology of the braconid. Observations were made on caterpillars found dead in the field. Small, creamy larvae, about 3 mm. in length, were crawling over the dead body of the host insect. These seemed to be ready to pupate because several hours later all of them had changed color, turning dark grey to black, and immediately starting to spin small silken cocoons. Each cocoon was attached to the "roble" leaf by very fine silken hairs. All the cocoons were very close together in a bunch of 15 to 20. The pupation period is around 8 days. Adult wasps are from 2.5 to 3 mm. long, thorax and legs reddish brown, abdomen yellowish, with light-brown markings on the dorsal part of the first three abdominal segments. Wings smoky, eyes and antennae black, making a nice contrast with the light-brown head. From 15 to 20 adults emerged from a single caterpillar.

Resumen

El pega pega del roble, Mesocondyla concordalis Hübner, es una plage que ataca a Crescentia cujete L. y a los árboles del género Tabebuia en Puerto Rico. La larva pega las hojas unas con otras y se alimenta de la epidermis de las mismas. El ataque es mayor en las montañas que en los llanos, dando a entender que quizás la humedad o el clima más frío le es beneficioso al insecto. Mesocondyla es de color amarillo, con ciertas manchas color marrón en las alas y el cuerpo. (Véase fig. 1.) Los parásitos que atacan la larva en el campo son los siguientes: la mosca Sturmia albincisa Wiedemann, el cálcido Brachymeria incerta Cresson, y el bracónido Microbracon Cushmani Muesebeck. Este último ha sido encontrado recientemente.

PRELIMINARY NOTES ON THE SILVICULTURE OF THE BIG-LEAF MAHOGANY

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General.--Although a great deal has been written about the high value of the mahogany wood and its occurrence through the American tropics, relatively little has been published on the silviculture of the genus. This paper on big-leaf mahogany includes notes on both Swietenia macrophylla King of Central America and Swietenia candollei Pitt. of northern South America. Some botanists divide the Swietenia group into several species while others restrict the division to three species and let S. macrophylla include also S. candollei, S. krukovii Gleas. & Pan, and S. tessmannii Harms. However, only the candollei and macrophylla of the big-leaf mahoganies have been introduced into Puerto Rico, and since they can be treated silviculturally as one species, there is no need to maintain any differentiation in this paper. As a matter of fact, in the younger stages, it is practically impossible to distinguish between these two species. We have noticed in the nursery that seedlings from 4 to 6 inches in height of these two species may be distinguished by the fact that S. macrophylla has more red coloration on the upper part of the stem than S. candollei, which is almost entirely green. Whether this would hold in general over the whole range of these species is not known. When the trees begin to fruit the species may again be distinguished because the cones and seeds of S. candollei are larger than those of S. macrophylla.

Seed.--Mature seeds of the big-leaf mahogany are reddish brown in color with a long wing attached to each seed. According to samples counted in Puerto Rico from introduced seed, S. candollei averages about 600 seeds per pound and S. macrophylla approximately 900 per pound. This difference in weight must be taken into account in the sowing of seeds in nursery beds.

Preliminary experiments with mahogany seeds have shown that low temperatures are extremely effective in prolonging vitality and seeds have been kept in a commercial storehouse up to one year without any considerable decline in germination. This commercial storage roughly corresponded to holding the seeds within a range of temperatures between 33° and 40° F. The purpose of this study was to work out satisfactory methods of storage so as to permit the production of proper sized stock for planting at any desired date in the year. Incidentally, it would allow the storage of seed supplies in the event that mahogany seed might not be available, although up to the present time we have been able every year to secure sufficient seeds from Central America and Venezuela. We would be interested to hear from any workers in the region who may have kept records on the annual seed crops of the big-leaf mahoganies.

The following table gives results of germination after cold storage and storage at ordinary temperatures in two types of containers, namely, ordinary sacks and sealed glass jars.

GERMINATION PER CENTS OF S. MACROPHYLLA SEEDS AFTER STORAGE UNDER TWO DIFFERENT TEMPERATURE RANGES AND IN TWO TYPES OF CONTAINERS

Storage period	Ordinary temperatures		Cold storage	
	Sack	Sealed jar	Sack	Sealed jar
0 days	54	61	55	56
2 weeks	55	59	56	65
1 month	55	50	62	57
2 months	30	50	41	62
4 months	2	9	56	58
6 months	0	0	37	51
8 months	1	1	57	49
1 year	2	0	27	42

Nursery.—Mahogany seeds are grown here in nursery beds prepared as for other species. These beds are 4 ft. wide by 100 ft. in length and raised 6 or 8 inches above the surrounding terrain in order to provide satisfactory drainage of the nursery area. Seeds may be sown broadcast or in drills. Since the mahogany seed is a fairly large seed, it is easy to sow in drills, which gives a more uniform spacing of seedlings and facilitates any weeding necessary in the nursery. Calculations of the purity and germination per cent are made to determine the amount of seed that must be sown in order to secure eight seedlings per square foot at the time of lifting. Six or eight seedlings per square foot are satisfactory where planting stock of 12 to 24 inches in height is to be used, but if much larger stock is desired a wider spacing is necessary. Growth of the seedlings varies with the quality of the nursery site and the time of year, but in general, seedlings average 12 inches in height at 4 months from seeding and 24 inches at 6 months.

A preliminary study of the proper depth for covering the seed showed that best results are obtained with a covering of approximately 1/2 inch of sand or approximately 3/4 inch if either subsoil or compost are used.

As seedlings are planted with bare roots, lifting is done with wide-toothed forks, taking care that the roots are not damaged during the lifting. Trees are then packed in sphagnum moss and burlap sacks for shipping to the field.

Planting.—The site constitutes one of the most important factors in the success or failure of big-leaf mahogany plantations, as this species shows a marked preference for certain environmental conditions. Although precise limits of such site qualities have not been determined for the species, observations in Puerto Rico indicate best growth between 1,000 and 3,000 feet above sea level, in sections having an annual precipitation of more than 75 inches, in clay or clay loam soils. It is of interest that there seems to be a very close correlation between the site factors favorable for big-leaf mahogany and the coffee grown on the island. Eroded soils or those which have been continuously farmed in annual crops are much less suitable than those which have been maintained in brush, coffee shade, or other protective cover where the higher organic-matter content, higher moisture retentivity, and more favorable texture of the soil result in much better growth of the plantations.

Two years ago, a study was established to determine the best grades for planting, using stock from small 12- to 18-inch material up to large seedlings 5 or 6 feet in height. Some of the larger grades were cut back to various heights above the root collar. This experiment showed little difference between the grades used and high significance was evident only between sites, between site preparation, that is, intercultivated or not intercultivated with agricultural crops, and in the interaction between these two factors. However, to lessen the cost of vine cutting and other subsequent tending, it seems desirable to use large planting stock. Although this means a longer time in the nursery, care of the trees during their younger stages is much cheaper than when they are scattered in the plantation. The experiment showed that 5- to 6-foot stock could be cut back to 12 or 18 inches without damage to the seedling. On good sites one leader sprout quickly assumes the lead, and between one and two years after planting the stump is completely absorbed and it is difficult to determine where the seedling had been cut back.

Where mahogany is planted under a shelterwood, best results in growth are obtained. However, the shelterwood must be opened up rapidly after the mahogany starts height growth in order to prevent mechanical injury and bending of the trees as well as to allow sufficient light to enter. Heavy shade cuts down the growth of the big-leaf mahogany considerably. A spacing of 8 by 8 feet seems most satisfactory, leaving unplanted spaces where trees of valuable native species are present.

In areas of high rainfall where compact subsoils prevent good root penetration, some blow-down of plantation trees occur. In the Puerto Rican plantations, this damage, though somewhat spectacular, has not affected a large enough per cent in any area to prevent the obtaining of a satisfactory stand.

Following establishment, a certain amount of vine cutting must be carried out. Species of Ipomoea, even though herbaceous vines, are especially troublesome in Puerto Rico as they climb very rapidly and grow so profusely that their weight is sufficient to bend over mahogany trees up to 20 feet in height. The cutting of vines and removal of the overstory, where trees are planted under shade, represent the principal jobs of tending, up until the time of thinning.

The trees grow very straight in plantations and show no inclination to early branching. The average size of 500 two-year-old trees on a good site was 10.5 feet in height and 1.1 inches in diameter, with maximum heights of 22 feet and diameters of over 2.0 inches. Surprisingly, large numbers of measurements show that where mahogany is thrifty, the height growth in feet closely approximates the diameter at breast height in tenths of inches. This is a rule of thumb which will apply until the trees have attained about 30 feet in height. The trees in Puerto Rico have put on regularly three new flushes of growth during the calendar year, distributed through the rainy season.

No diseases have been noticed attacking the tree. They appear very healthy and the only serious threat to their proper development has been the cedar shoot borer, Hypsiphylla grandella. This has attacked both the S. macrophylla and the S. candollei, and most severely in sections where old cedar plantations or native cedar trees were adjacent to provide a source of infection. Attacks of this insect appeared to be more severe in the open than under an overstory. Here, again, the importance of the site is demonstrated,

since where trees are healthy the attacks of the shoot borer are rapidly overcome by new shoot growth; whereas on poor sites with slow growth, attacks may result in a poorly formed crown and bushy head.

So far, none of our plantations of any size exceed 4 years in age, so that thinnings and subsequent management of the big-leaf mahogany has not yet been worked out. We would be very pleased to find out how these results check with findings in other sections of the region and any data as to handling of plantations of greater age would be of material assistance to us in outlining our future work.

Resumen

La caoba de hojuelas grandes procedente de Panamá y de Venezuela se ha usado para repoblación en Puerto Rico. Con la excepción del tamaño de las frutas y las semillas, no se distinguen ambas, y los mismos métodos silvícolas se aplican indistintamente.

Las temperaturas bajas son muy efectivas en prolongar la viabilidad de las semillas. Las posturas se producen en viveros corrientes, se sacan cuidadosamente con tenedores de dientes anchos y se hacen paquetes envolviéndolos en musgo y sacos para enviarse a los sitios de siembra.

La localidad es un factor de gran importancia. Aquí, esta caoba se dá mejor de 1,000 a 3,000 pies sobre el nivel del mar, en zonas con precipitaciones anuales de 75 pulgadas o más y en suelos arcillosos o lómicoarcillosos. Sitios propios para café son a la vez buenos para esta caoba.

Investigaciones hechas demuestran que plántulas grandes hasta de 5 ó 6 pies pueden cortarse a 12 y 18 pulgadas con buenos resultados para la siembra. Se usa una separación de 8 pies por 8 pies. Un bosque o sombra protectora produce un ambiente favorable, pero debe quitarse prontamente después que los árboles principian su desarrollo rápido. Otras limpias incluyen el corte de bejucos.

En localidades de subsuelos compactos ocurre alguna caída de los árboles pero en ningún sitio esto ha asumido proporciones serias.

La forma de los árboles es excelente y a los dos años un grupo de 500 árboles en una buena localidad dieron un promedio de 10.5 pies de altura y 1.1 pulgada de diámetro con un máximo de 22 pies y más de 2 pulgadas de diámetro.

No hemos observado ninguna enfermedad, aunque el taladrador del tallo del cedro causa daños considerables especialmente en sitios abiertos y donde los árboles no están muy saludables.

A CHECK-LIST OF THE SPERMATOPHYTES OF ST. BARTHOLOMEW

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Part I.

The West Indian island of St. Bartholomew or "St. Barthelemy" (sometimes abbreviated to "St. Bart's") is situated in the Lesser Antilles, near the northern end of the Leeward group, about 190 miles east of Puerto Rico and about 130 miles northwest of Guadeloupe. Its precise geographic position is 17°55' N. and 63°60' W.

The chief literature on the botany of St. Bartholomew comprises only eight titles, as follows:

Fahlberg, Samuel. Utdrag af Samlingar til Natural-Historien öfver ön St. Barthelemi i Vest-Indien. (Kgl. Vetensk. Acad. Handling. 1786, pp. 215-240 and 248-254).

Euphrasén, Bengt And. Beskrifning öfver Svenska vestindiska ön St. Barthelemi, samt öarne St. Eustache och St. Christopher. Stockholm, 1795. 8°. 207 pp., 1 map, 1 tab.

Euphrasén, Bengt And. Reise nach der schwedisch-Westindischen Insel St. Barthelemi, und den Inseln St. Eustache und St. Christoph oder Beschreibung der Sitten, Lebensart der Einwohner, Lage, Beschaffenheit und natürlichen Produkte dieser Inseln. Göttingen, 1798. 8°. 308 pp., Reg., 1 tab.

Wikström, Joh. Em. Öfversigt af ön Sanct Barthelemi's Flora. (Kgl. Vetensk. Acad. Handling. 1825, St. II, pp. 411-433. 1826).

Grisebach, August H. R. Systematische Untersuchungen über die Vegetation der Karaiben, insbesonder der Insel Guadeloupe. (Abh. Kgl. Gesellsch. Wiss. Göttingen 7: 151-286. 1857). --Separate printing, 4°. 138 pp.

Grisebach, August H. R. Flora of the British West Indian Islands, London, 1859-1864. 8°. 789 pp.

Goës, A. V. Vegetationen pá St. Barthelemy, skildrad i ett bref. (T. M. Fries, Botan. Notiser, Upsala, 1867, pp. 97-105).

Urban, Ignatius. Symbolae Antillanae Seu Fundamenta Florae Indiae Occidentalis. Vol. IV, Flora Portoricensis. Leipzig, 1903-1911.

1/ Acknowledgement is hereby gratefully made to Dr. Harold N. Moldenke, Associate Curator at the New York Botanical Garden, who made this catalogue possible and who by his constant, generous, and important suggestions, aid, and encouragement has helped vastly to bring it to its present form.

The following twelve botanists are known to have visited St. Bartholomew: J. B. du Tertre (about 1650-1656), J. B. Labat (between 1694 and 1705), N. J. Jacquin (between 1755 and 1757), S. Fahlberg (1785-1834), B. A. Euphrasén (1788), J. E. Forsström (1803-1815), E. Pursh (1810-1811), F. L. l'Herminier (1815), A. Plée (1821), J. B. Ricord-Madianna (between 1821 and 1825), A. V. Göes (1866-1870), and A. Questel (1937--). Of these, however, Urban states that du Tertre, Labat, Ricord-Madianna, and Göes left no botanical specimens in any herbaria.[2/] Two others are cited as collectors on the island in "Das Pflanzenreich"--Hjertstedt in volume IV, 134, page 95, and Hjertberg in volume IV, 141, page 624.[3/] The Wikström records cited abundantly on the following pages of the present work are based, according to Urban, in Symb. Ant. 1: 176-177 (1898), not on his own collections (for he apparently never visited the island), but on the collections of Fahlberg, Euphrasén, and Forsström.

In the Britton Herbarium of the New York Botanical Garden, where this catalogue was prepared, there are preserved the St. Bartholomew collections of Johan Eric Forsström and of Adrien Questel. These specimens are cited on the following pages under each species and variety represented. The Questel collections are mostly numbered, but those of Forsström are unnumbered and are cited "Forsström s.n." (s.n. = sine numero, without number).

Whenever a St. Bartholomew station is recorded by Urban in his "Symbolae Antillanae" it is noted on the following pages as "(Urban)." When Urban definitely credits the St. Bartholomew station to Grisebach, or to Wikström, or to a Stockholm herbarium specimen, it is noted as "(Grisebach ex Urban)," "(Wikström ex Urban)," and "(herb. Stockholm ex Urban)."

Whenever a St. Bartholomew station is recorded by Grisebach in his "Systematische Untersuchungen über die Vegetation der Karaiben" it is noted on the following pages as "(Grisebach)." Most of Grisebach's records are based on Wikström collections and these are indicated "(Wikström ex Grisebach)." Where his record is based on some other source, it is indicated in a similar fashion.

If either of these authorities record the plant under a different name from that used in the present catalogue, the name which they use is given within the same parentheses preceded by the word "as"; for instance, "(Wikström ex Urban, as P. hemisphaericum Poir.)."

Under each family a very brief artificial key is given. This is designed to identify the species appearing in this check-list by means of easily observable characters, whenever possible. The names arrived at by means of such key analyses should, however, always be checked by reference to an accurately named

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2/ H. N. Moldenke, in his "A preliminary list showing the location of the principal collections of Verbenaceae and Avicenniaceae," p. 54 (1939), states that Ricord-Madianna specimens are to be found in the herbarium of the Academy of Natural Sciences at Philadelphia, and on p. 24 that Göes specimens are deposited in the Berlin, Stockholm, and Upsala herbaria.

3/ H. N. Moldenke, in the above-quoted work, records Hjertstedt specimens as deposited in the Stockholm herbarium, but does not list any "Hjertberg." It is possible that the latter represents merely a clerical error for Hjertstedt.

herbarium, or, at least, by comparison with an authentic description of the species, to validate the determination. Unless this is done, species which do not appear as yet in this check-list and which might easily fit in a general way the key diagnoses, may be misidentified. It is urgently requested that additional records from St. Bartholomew be reported to the writer, backed up, wherever possible, by herbarium material. Such records and material may be addressed to the author in care of Dr. H. N. Moldenke at the New York Botanical Garden, Bronx Park (Fordham Branch P. O.), New York City.

The following are the essential statistics for the present check-list, but it must be remembered that this is only the first edition of this catalogue. Undoubtedly many additional species and varieties will be added later.

Families	88
Genera	298
Species and Varieties . . .	442

ZANICHELLIACEAE

Ruppia maritima L. Questel 118, 219, 314. (Wikström and Grisebach ex Urban). Grisebach says "Ruppia didyma Sw. ap. Wiks. est planta dubia."

CYMODOCEACEAE

Halodule Wrightii Aschers. Questel 330.

HYDROCHARITACEAE

Thalassia testudinum König. Questel 331.

POACEAE

1. Pedicels jointed below the spikelets; spikelets mostly with one perfect flower and that terminal.
  2. Spikelets 2-3 mm. long, with hooked prickles; inflorescence a simple raceme.. Nazia aliena.
  2a. Spikelets with straight prickles or none.
    3. Spikelets enclosed in bur-like involucres.
      4. Involucre with a ring of slender bristles at the base..Cenchrus echinatus.
      4a. Involucre with flattened spreading spines, but no ring of slender bristles .....Cenchrus tribuloides.
    3a. No bur-like involucres present.
      5. Spikelets subtended by long, persistent, minutely barbed bristles.
        6. Panicle attenuate at apex .....Setaria setosa.
        6a. Panicle somewhat tapering, but not attenuate at apex.....Setaria macrostachya.
      5a. Spikelets not subtended by an involucre of bristles.
        7. Spikelets surpassed by long silky hairs.....Trichachne insularis.
        7a. Spikelets not long-silky.
          8. Indurate first glumes united at base, forming a pseudo-involucre about 5 mm. long; inflorescence a simple terminal raceme..... Anthephora hermaphrodita.
          8a. No pseudo-involucre present.
            9. Spikelets lanceolate, with prominently muricate keels; racemes

long, on filiform peduncles borne in whorls on an elongated axis.....Anatherum zizanioides.

9a. Spikelets not muricate.

10. Spikelets lanceolate, with long appressed hairs and a conspicuous ring-like callus at base.....Eriochloa punctata.

10a. Spikelets without a ring-like callus.

11. Racemes digitate; spikelets lanceolate.

12. Rachis very narrowly winged, with sparsely scattered long hairs.....Syntherisma digitata.

12a. Rachis well winged, without long hairs..... Syntherisma sanguinalis.

11a. Racemes not digitate; spikelets not lanceolate.

13. Spikelets with lower scales wanting, arranged in spike-like racemes.

14. Racemes 1 (rarely 2); leaves filiform..Paspalum filiforme.

14a. Racemes many; leaves wider.

15. Blades narrow, stiff, involute toward the apex..... Paspalum glabrum.

15a. Blades about 1.5 cm. wide, flat...Paspalum paniculatum.

13a. Spikelets with lower scales present, mostly paniculately arranged.

16. Spikelets with outer scales hispid....Echinochloa colonum.

16a. Spikelets without hispid scales.

17. Spikelets about 1 mm. long, acute at base..... Panicum brevifolium.

17a. Spikelets about 2 mm. long or longer, blunt at base.

18. Fourth scale (chartaceous) not transversely wrinkled.

19. Leaves broad, lanceolate-elliptic, not more than 6 times as long as wide; creeping plant; fertile lemma with excavation at base..... Ichnanthus nemoralis.

19a. Leaves linear, 1-3 mm. wide; tufted plant; fertile lemma without excavation.....Panicum diffusum.

18a. Fourth scale transversely wrinkled.

20. Plant prostrate or spreading, rooting at the lower nodes; leaves less than 7 cm. long; spikelets about 2 mm. long, not reticulate-veined.....Panicum reptans.

20a. Plant erect; leaves mostly more than 7 cm. long.

21. Spikelets oblong, 3-4 mm. long, not reticulate-veined; inflorescence-axis not hispidulous..... Panicum maximum.

21a. Spikelets fusiform, 2-3 mm. long, reticulate-veined; inflorescence-axis hispidulous..... Panicum fasciculatum.

1a. Spikelets jointed above the lower empty persistent scales.

22. Spikelets more than 2 cm. long; culms bamboo-like....Arundinaria gigantea.

22a. Spikelets less than 5 mm. long; culms herbaceous.

23. Spikes digitate.

24. Spikelet-scales with conspicuous long cilia on the margins..... Chloris polydactyla.

24a. Spikelet-scales without long cilia.

25. Rachis produced beyond the spikelets; scales awned..... Dactyloctenium aegyptium.

25a. Rachis not produced beyond the spikelets; scales not awned..... Eleusine indica.

23a. Spikes not digitate.

26. Second flower rudimentary, with 3 conspicuous awns..... Bouteloua americana.

26a. No awns present.

27. Spikelets 1-flowered; panicle dense and spike-like..... Sporobolus virginicus.

27a. Spikelets more than 1-flowered; panicle not dense.

28. Spikes long, 5-15 cm. in length, filiform, ascending on an elongated axis.....Leptochloa filiformis.

28a. Inflorescence a contracted or spreading panicle.

29. Panicle condensed, interruptedly spike-like; pedicels short; keels of the palea stiffly long-ciliate..Eragrostis ciliaris.

29a. Panicle widely diffuse; pedicels long, filiform; spikelets without cilia.....Eragrostis capillaris.

Anatherum zizanioides (L.) Hitchc. & Chase. (Urban, as Andropogon zizanioides (L.) Urb.).

Anthephora hermaphrodita (L.) Kuntze. (Wikström ex Urban) (Wikström ex Grisebach, as A. elegans Schreb.).

Arundinaria gigantea (Walt.) Chapm. (Wikström ex Grisebach, as A. macrosperma Michx. cf.).

Bouteloua americana (L.) Scribn. (Urban, as Aristida americana L.).

Cenchrus echinatus L. (Wikström ex Grisebach).

Cenchrus tribuloides L. (Urban).

Chloris polydactyla (L.) Sw. (Wikström ex Grisebach).

Dactyloctenium aegyptium (L.) Willd. (Urban) (Wikström ex Grisebach).

Echinochloa colonum (L.) Link. (Urban, as Panicum colonum L.).

Eleusine indica (L.) Gaertn. (Urban) (Wikström ex Grisebach).

Eragrostis capillaris (L.) Nees. (Wikström ex Grisebach).

Eragrostis ciliaris (L.) Link. (Urban).

Eriochloa punctata (L.) Desv. (Urban).

Ichnanthus nemorosus (Sw.) Doell. (Wikström ex Grisebach, as Echinolaena nemerosa Kunth).

Leptochloa filiformis (Lam.) Beauv. (Urban).

Nazia aliena (Spreng.) Scribn. (Urban, as Tragus racemosus (L.) All.).

Panicum brevifolium L. (Wikström ex Grisebach).

Panicum diffusum Sw. (Urban) (Wikström ex Grisebach).

Panicum fasciculatum Sw. (Wikström ex Grisebach).

Panicum maximum Jacq. (Urban) (Wikström ex Grisebach, as P. jumentorum Pers.).

Panicum reptans L. (Grisebach ex Urban, as P. grossarium L.) (Wikström ex Grisebach, as Brachiaria prostrata Griseb.).

Paspalum filiforme Sw. (Wikström ex Grisebach).

Paspalum glabrum Poir. (Urban).

Paspalum paniculatum L. (Wikström ex Urban, as P. hemisphaericum Poir.) Wikström ex Grisebach).

Setaria macrostachya H.B.K. (Wikström ex Grisebach).

Setaria setosa (Sw.) Beauv. (Urban).
Sporobolus virginicus (L.) Kunth. (Urban) (Wikström ex Grisebach).
Syntherisma digitata (Sw.) A. S. Hitchc. (Urban, as Panicum sanguinale var. horizontale (Willd.) Schweinf.).
Syntherisma sanguinalis (L.) Dulac. (Wikström ex Grisebach, as Digitaria ciliaris Koel.).
Trichachne insularis (L.) Nees. (Urban, as Panicum insulare (L.) G.F.W. Mey.).

CYPERACEAE

1. Rachis of the spikelets persistent.
  2. Rachis wingless or very narrowly winged; spikelets more or less yellowish, not purplish.
    3. Scales about 3 mm. long.
      4. Scales rounded and strongly mucronate at apex; basal leaves mostly more than one span long.....Cyperus elegans.
      4a. Scales acuminate at apex; basal leaves mostly less than one span long.....Cyperus compressus.
    3a. Scales about 1.5 mm. long, apiculate.....Cyperus surinamensis.
  2a. Rachis broadly winged; spikelets purplish; scales acute or obtusish, not mucronate.....Cyperus rotundus.
1a. Rachis of the spikelets deciduous above the 2 lower scales.
  5. Spikelets with 2 or 3 achenes, 3-5 mm. long, in age reflexed; scales mucronate.....Cyperus tenuis.
  5a. Spikelets with 5-10 achenes.
    6. Scales awned, yellowish; spikelets 5-7 mm. long.....Cyperus confertus.
    6a. Scales apiculate, brown; spikelets 1-2 cm. long.....Cyperus brunneus.

Cyperus brunneus Sw. (Urban, as Mariscus brizaeus (Vahl) Clarke).
Cyperus compressus L. (Wikström ex Grisebach).
Cyperus confertus Sw. (Wikström ex Grisebach).
Cyperus elegans L. Questel 930. (Urban).
Cyperus rotundus L. (Urban).
Cyperus surinamensis Rottb. (Wikström ex Grisebach).
Cyperus tenuis Sw. (Wikström ex Grisebach).

BROMELIACEAE

1. Leaves 2-4 cm. wide, the margins armed with stout hooked prickles.....Bromelia pinguin.
1a. Leaves without prickles.
  2. Plants small; leafy stem narrow, less than 2 cm. broad; leaves filiform-setaceous; flowering-stem scape-like.....Tillandsia recurvata.
  2a. Plants large; stems stout.
    3. Leaves involute and narrowly long-attenuate at the apex.....Tillandsia utriculata.
    3a. Leaves flat and merely narrowed to an acute apex.....Vriesia paniculata.

Bromelia pinguin L. Questel 340.
Tillandsia recurvata L. Questel 18, Forsström s.n. (Wikström ex Grisebach).
Tillandsia utriculata L. Questel 108, 256, 266, 607.
Vriesia paniculata (L.) Mez. (Wikström ex Grisebach, as Tillandsia paniculata L.).

COMMELINACEAE

1. Leaves 1-3.5 dm. long, about 3.5 cm. wide, in basal clusters..*Rhoeo discolor*.
1a. Leaves much smaller, scattered along a slender stem.
2. Spathes united at the base.....*Commelina elegans*.
2a. Spathes not united at the base.....*Commelina longicaulis*.

Commelina elegans H.B.K. Questel 53, 452, 453, Forström s.n.
Commelina longicaulis Jacq. (Wikström ex Grisebach, as *C. cayennensis* Rich.).
Rhoeo discolor (L'Her.) Hance. Questel 80.

LILIACEAE

1. Perianth-parts linear or linear-spatulate; leaves not scabrous-margined, 4.5-9 cm. wide.....*Cordyline guineensis*.
1a. Perianth-parts broad; leaves dagger-like, scabrous-margined, usually less than 4.5 cm. wide.....*Yucca aloifolia*.

Cordyline guineensis (L.) Britton. Questel 253, "introduced 1880; escaped."
Yucca aloifolia L. Questel 181.

AMARYLLIDACEAE

1. Leaves with large prickly teeth.....*Agave americana*.
1a. Leaves without prickles.
2. Leaves narrowly linear; scape 1-flowered.....*Atomosco* sp.
2a. Leaves broad; scape with a cluster of flowers.
3. Filaments distinct; perianth-segments more than 2 cm. wide.....*Crinum zeylanicum*.
3a. Filaments connate below into a funnel-form cup; perianth-segments less than 1 cm. wide.
4. Leaves linear-oblong; crown about 1/3 the length of the stamens.....*Hymenocallis declinata*.
4a. Leaves lanceolate-oblong; crown about 1/2 the length of the stamens...*Hymenocallis caribaea*.

Agave americana L. (Wikström ex Grisebach).
Atomosco sp. Questel 194, "introduced and escaped; perianth yellow."
Crinum zeylanicum L. Questel 297.
Hymenocallis caribaea (L.) Herb. (Wikström ex Grisebach, as *Pancratium caribaeum* L.).
Hymenocallis declinata (Jacq.) Roem. Questel 390.

MARANTACEAE

Maranta arundinacea L. Questel 726. (Wikström ex Grisebach).

ORCHIDACEAE (Questel specimens determined by C. Schweinfurth)

1. Perianth-segments linear-lanceolate, acuminate, 4-5 cm. long; lip conspicuously ciliate.....*Epidendrum ciliare*.
1a. Perianth-segments broadish, not acuminate, less than 2 cm. long.

2. Pseudobulbs absent; lip almost free from the column..Tetramicra canaliculata.
2a. Pseudobulbs present; margins of the lateral lobes of the lip connate with the column.
3. Lip longer than the sepals, the terminal lobe obovate, glabrous, smooth.... Epidendrum papilionaceum.
3a. Lip about as long as the sepals, the terminal lobe abruptly broad-reniform, pubescent, verrucose.....Epidendrum olivaceum.

Epidendrum ciliare L. Questel 408. (Urban) (Wikström ex Grisebach).
Epidendrum olivaceum Cogn. Questel 360.
Epidendrum papilionaceum Vahl. (Urban) (Wikström ex Grisebach, as E. bifidum Sw.).
Note: This may be synonymous with E. atropurpureum Willd.--cf. "The Genus Epidendrum in the U. S. and Middle America," by Oakes Ames, p. 62. 1936.
Tetramicra canaliculata (Aubl.) Urb. Questel 274, 359.

PIPERACEAE (Questel specimens determined by W. Trelease)

1. Leaves opposite, elliptic, narrowed at base.....Peperomia humilis.
1a. Leaves alternate.
2. Leaves elliptic, narrowed at base, blunt at apex.....Peperomia myrtifolia.
2a. Leaves ovate, rounded or cordate at base.
3. Pellucid; leaves deltoid-ovate, with reticulation obvious..... Peperomia pellucida.
3a. Opaque; leaves elliptic-ovate, with reticulation faint, apex acuminate... Peperomia distachya.

Peperomia distachya (L.) A. Dietr. (Wikström ex Grisebach).
Peperomia humilis var. Questeliana Trelease, ined. Questel 107, 552, 553, 554, 556, 557, 801, s.n.
Peperomia myrtifolia (Vahl) A. Dietr. Questel 804, 805, 857.
Peperomia myrtifolia var. major Trelease, ined. Questel 803 type, 833.
Peperomia pellucida (L.) H.B.K. Questel 268.

ULMACEAE

Momisia iguanaea (Jacq.) Rose & Standl. Questel 286. (Wikström ex Urban, as Celtis iguanaea (Jacq.) Sarg.) (Wikström ex Grisebach, as Celtis aculeata Sw.).

MORACEAE

Ficus laevigata Vahl. Questel 713, 865, 866, 890.

URTICACEAE

1. Leaves hairy, crenate, 3-nerved.....Pilea nummulariaefolia.
1a. Leaves glabrous, entire, 1-nerved.
2. Stem herbaceous; leaves varying from elliptic to roundish.Pilea microphylla.
2a. Stem shrubby, succulent; leaves orbicular.....Pilea margarettae.

Pilea margarettae Britton. Questel 444, 445, 446, 856.
Note: This species intergrades with P. microphylla.
Pilea microphylla (L.) Liebm. Questel 447, 448, 449, 450, 451, 483, 484, 657, 762, 764, 785, 787, 825. (herb. Stockholm ex Urban) (Wikström ex Grisebach).

Pilea nummulariaefolia (Sw.) Wedd. Questel 312, 689.

LORANTHACEAE

Phoradendron trinervium (Lam.) Griseb. Questel 213 (number indistinct) (Urban).

POLYGONACEAE

1. Vine with tendrils; leaves ovate, with an openly cordate base..... Antigonon leptopus.
1a. Trees or shrubs; leaves not ovate.
2. Leaves orbicular.....Coccolobis uvifera.
2a. Leaves elliptic, narrowed at apex and base.....Coccolobis nivea.

Antigonon leptopus Hook. & Arn. Questel 30.
Coccolobis nivea Jacq. Forsström s.n. (Urban) (Meissner ex Grisebach).
Coccolobis uvifera (L.) Jacq. Questel 82. (Urban) (Wikström ex Grisebach).

CHENOPODIACEAE

1. Leaves deltoid-ovate, not glandular.....Chenopodium murale.
1a. Leaves lanceolate-oblong, glandular beneath.....Chenopodium ambrosioides.

Chenopodium ambrosioides L. (Wikström ex Grisebach).
Chenopodium murale L. Questel 367,368.

AMARANTHACEAE

1. Leaves alternate.
2. Seeds up to 20; perianth-segments about 5 mm. long, dark-brown, strongly parallel-veined.....Celosia nitida.
2a. Seed one; perianth-segments less than 3 mm. long, not parallel-veined.
3. Flowers all axillary.
4. Peduncles obviously much thickened; utricle indehiscent..... Amaranthus crassipes.
4a. Peduncles not thickened; utricle circumscissile..Amaranthus polygonoides.
3a. Flowers mostly in terminal spikes.
5. Utricle much wrinkled, indehiscent; bracts acute, not aristate, shorter than the sepals.....Amaranthus gracilis.
5a. Utricle not wrinkled, bursting irregularly; bracts aristate, about equal to the sepals.
6. Leaf-axils with a pair of spines.....Amaranthus spinosus.
6a. Leaf-axils not spiny.....Amaranthus dubius.
1a. Leaves opposite.
7. Spikes very slender, 2-6 dm. long; calyx reflexed after anthesis; leaf blades 2-7 cm. long, orbicular to obovate-orbicular, pubescent, abruptly short-tipped.....Centrostachys indica.
7a. Spikes paniculate or short and dense; calyx not reflexed; leaf-blades not as described above.
8. Inflorescence composed of heads or slightly elongated thick spikes; cauline leaves mostly less than 4 cm. long.
9. Leaves linear to linear-spatulate; stigmas 2-lobed.
10. Leaves mostly in basal tufts; stamens 2.....Lithophila muscoides.
10a. Leaves scattered on the stem; stamens 5.....Philoxerus vermicularis.

9a. Leaf-blades broad; stigmas capitate.
11. Staminodia shorter than the filaments; sepals with rigid spinose tips.....Achyranthes repens.
11a. Staminodia equaling or longer than the filaments; sepals merely acute.....Achyranthes urbani.
8a. Inflorescence composed of diffuse paniculate spikes; cauline leaves mostly more than 4 cm. long, acute to acuminate.
12. Flowers perfect; individual spikes mostly plainly pedunculate..... Iresine angustifolia.
12a. Flowers dioecious; spikes mostly sessile on the panicle-rachis..... Iresine celosia.

Achyranthes repens L. (herb. Stockholm ex Urban, as Alternanthera repens (L.) Kuntze).
Achyranthes urbani Standl. Questel 634, 649, 664, 812.
Note: Heads sessile; staminodia equaling the filaments, laciniate at apex; pubescence of simple hairs; leaves ovate, blunt to acute, 1-2 cm. long; flowers whitish; sepals 2.75-3 mm. long; stems from a woody caudex, not creeping. Identified from the description of Alternanthera geniculata Urb. in Symb. Ant. 7:211 (1912), which is the original description of the species.
Amaranthus crassipes Schlecht. Questel 365, 454.
Amaranthus dubius Mart. Questel 234, 316.
Amaranthus gracilis Desf. Questel 235, 455, 526, 767.
Amaranthus polygonoides L. Questel 827. (herb. Stockholm ex Urban).
Amaranthus spinosus L. Questel 123, 212.
Celosia nitida Vahl. Questel 353.
Centrostachys indica (L.) Standl. Questel 430.
Iresine angustifolia Euphr. Questel 83, 98. (herb. Stockholm ex Urban, as I. elatior Rich.) (Wikström ex Grisebach, as I. elatior Rich.).
Iresine celosia L. (herb. Stockholm ex Urban, as I. paniculata (L.) Kuntze).
Lithophila muscoides Sw. Questel 3, 207, 317. (herb. Stockholm ex Urban) (Wikström ex Grisebach, as Iresine linearis Moq.).
Philoxerus vermicularis (L.) R. Br. Questel 121, 159, 596. (herb. Stockholm ex Urban) (Wikström ex Grisebach, as Iresine vermicularis Moq.).

NYCTAGINACEAE

1. Herbaceous.
2. Fruit 10-ribbed, with large glands.....Commicarpus scandens.
2a. Fruit 5-ribbed.
3. Fruit glandular-puberulent.....Boerhaavia caribaea.
3a. Fruit glabrous.....Boerhaavia erecta.
1a. Woody.
4. Fruit fleshy, drupe-like, glandless; plant not armed; leaves mostly narrowed at base.....Torrubia fragrans.
4a. Fruit dry, with 5 rows of glands.
5. Plant armed with stout recurved prickles; leaves mostly narrowed at base; glands present on fruit from apex to base.....Pisonia aculeata.
5a. Plant not armed; leaves mostly rounded to subcordate at base; glands only near apex of fruit.....Pisonia subcordata.

Boerhaavia caribaea Jacq. Questel 155, 681. (herb. Stockholm ex Urban, as B. hirsuta Willd.) (Wikström ex Grisebach, as B. paniculata Rich.).
Boerhaavia erecta L. Questel 577. (Wikström ex Grisebach).
Commicarpus scandens (L.) Standl. Questel 7, 500, 730, 876. (herb. Stockholm ex Urban, as Boerhaavia scandens L.).
Pisonia aculeata L. Questel s.n. (Wikström ex Urban) (Wikström ex Grisebach).
Pisonia subcordata Sw. Forsström s.n. (Swartz ex Urban, as P. subcordata var. typica Heimerl.) (Grisebach).
Torrubia fragrans (Dum.-Cours.) Standl. Questel 640,806. (Swartz ex Urban, as Pisonia fragrans Dum.-Cours.) (Swartz ex Grisebach, as Pisonia obtusata Sw., "in rupibus litoralibus").

BATIDACEAE

Batis maritima L. Questel 147, 148, 831.

PHYTOLACCACEAE

1. Fruit dry, achene-like, with deflexed bristles at apex; flowers subsessile.. Petiveria alliacea.
1a. Fruit a globose berry, without deflexed bristles; flowers plainly pedicellate.
2. Fruit covered with a honeycomb-like network uniting the spine-like tubercles; leaves much narrowed at the base.....Microtea debilis.
2a. Fruit not tuberculate nor reticulate; leaves a little narrowed at the base.
3. Style elongated; stigma capitate; plant herbaceous above.Rivina humilis.
3a. Style none; stigma penicillate; plant a woody vine..... Trichostigma octandrum.

Microtea debilis Sw. (Wikström ex Grisebach).
Petiveria alliacea L. Questel 6, Forsström s.n. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Rivina humilis L. Questel 9, 244, 571, 654. (herb. Stockholm ex Urban) (Wikström ex Grisebach, as R. laevis L.).
Trichostigma octandrum (L.) H. Walt. (herb. Stockholm ex Urban, as Villamilla octandra (L.) Hook. f.) (Wikström ex Grisebach, as Rivina octandra L.).

TETRAGONIACEAE

1. Cauline leaves in whorls; stem not fleshy.....Mollugo verticillata.
1a. Leaves opposite; stem fleshy.
2. Leaves of each pair about equal, narrowly oblanceolate to oblong, the bases clasping, without appendages.....Sesuvium portulacastrum.
2a. Leaves of each pair unequal, broadly obovate to orbicular, the bases united into a sheath with an interpetiolar stipule-like appendage..... Trianthema portulacastrum.

Mollugo verticillata L. Forsström s.n. (Euphrasén ex Urban) (Wikström ex Grisebach).
Sesuvium portulacastrum L. Questel 120, 169, 384. (Euphrasén ex Urban) (Wikström ex Grisebach).
Trianthema portulacastrum L. Questel 388, 662. (herb. Stockholm ex Urban).

PORTULACACEAE

1. Flowers racemose or subcorymbose; capsule 3-valved; leaves flat, obovate to oblanceolate, 1-2.5 cm. wide, glabrous.....Talinum triangulare.
1a. Flowers solitary or clustered at the ends of the branches; capsules circumscissile.
2. Leaves opposite; stem creeping, filiform, rooting at the nodes; hairs in a ring at each node.....Portulaca quadrifida.
2a. Leaves alternate; stem not as described above; hairs in tufts in the axils of the leaves or wanting.
3. Ripe seeds brown.....Portulaca phaeosperma.
3a. Ripe seeds gray or black.
4. Ripe seeds gray, without spiny tubercles; hairs at nodes inconspicuous.....Portulaca poliosperma.
4a. Ripe seeds black, granulate or tuberculate.
5. Leaves flat, obovate; hairs surrounding the flowers and in the axils of the leaves inconspicuous.....Portulaca oleracea.
5a. Leaves terete; hairs surrounding the flowers and in the axils of the leaves conspicuous.
6. Corolla white with a yellow center; stems short, with erect or diffuse branches.....Portulaca halimoides.
6a. Corolla purple-pink; stems long, prostrate or ascending..... Portulaca pilosa.

Portulaca halimoides L. Questel 171, 263, 293, 457, 511, 636, 832. (herb. Stockholm ex Urban).
Portulaca oleracea L. Questel 264, 458, 459, 631, 898, 899.
Portulaca phaeosperma Urb. Questel 37, 172, 262, 265, 639, 900, s.n.
Portulaca pilosa L. (Wikström ex Grisebach).
Portulaca quadrifida L. Questel 170, 296, 624.
Talinum triangulare (Jacq.) Willd. Questel 65, 113, 629. (herb. Stockholm ex Urban) (Wikström ex Grisebach).

BASELLACEAE

Boussingaultia leptostachys Moq. Questel 22.

ANNONACEAE

1. Petals 6, the inner 3 conspicuous; fruit with long curved spines; leaves gradually widened almost to the apex; petiole and midrib puberulent with short hairs.....Annona muricata.
1a. Inner petals reduced to minute scales or wanting; fruit tuberculate; leaves elliptic or lanceolate; petiole and midrib pubescent with long hairs beneath.....Annona squamosa.

Annona muricata L. Questel 143. (Euphrasén ex Urban) (Wikström ex Grisebach).
Annona squamosa L. Questel 195. (herb. Stockholm ex Urban) (Wikström ex Grisebach).

LAURACEAE

Cassytha filiformis L. Questel 551. (Wikström ex Grisebach, as C. americana Nees).

PAPAVERACEAE

Argemone mexicana L. (Euphrasén ex Urban) (Wikström ex Grisebach).

BRASSICACEAE

1. Plant succulent; fruit a silique, linear-lanceolate, 2-jointed..... Cakile lanceolata.
1a. Plant not succulent; fruit a silicle, orbicular, flat...Lepidium virginicum

Cakile lanceolata (Willd.) O. E. Schulz. Questel 91. (Urban, as C. lanceolata subsp. domingensis (Tuss.) O. E. Schulz).
Lepidium virginicum L. (herb. Stockholm ex Urban).

CAPPARIDACEAE

1. Leaves digitately compound; annual herbs.
  2. Capsule sessile; plant densely glandular-pubescent.....Cleome icosandra.
  2a. Capsule on slender gynophore; leaves sparsely glandular...Cleome gynandra.
1a. Leaves simple.
  3. Leaves narrowly linear, 2-5 cm. long, 1-4.5 mm. wide; glabrous annual..... Cleome stenophylla.
  3a. Leaves broader; shrubs.
    4. Leaves scaly beneath.
      5. Petals densely stellate-tomentose on the back; sepals open in bud..... Capparis indica.
      5a. Petals densely peltate-scaly on the back; sepals valvate in bud..... Capparis cynophallophora.
    4a. Leaves glabrous.
      6. Leaves prominently reticulate-veined on the upper surface.
        7. Leaves mostly rounded to acute at the base, rounded to emarginate at the apex, elliptic to oblong or lanceolate to linear, 4-12 cm. long, 1-5.5 cm. wide; stamens much longer than the petals..... Capparis flexuosa.
        7a. Leaves narrowed and subcordate at the base, acute to acuminate at the apex, 8-30 cm. long, mostly elliptic to oblanceolate, never linear or truly oblong, rarely lanceolate; stamens slightly longer than the petals.....Capparis baducca.
      6a. Leaves not prominently reticulate-veined on the upper surface, subcordate at the base.
        8. Petioles 0.5-5 cm. long; leaves narrow toward the base, acutish at apex, 8-30 cm. long.....Capparis baducca.
        8a. Petioles mostly less than 0.5 cm. long; leaves mostly little narrowed to the cordate base, mostly bluntish at apex, 2-13 cm. long, 1-7 cm. wide.....Capparis verrucosa.

Capparis baducca L. Questel 104, 736 (Euphrasén ex Urban) (Wikström ex Grisebach, as C. frondosa Jacq. and as C. cynophallophora var. baducca Wikstr., page 15 ?).
Capparis cynophallophora L. Questel 281, 547, 646, 651, 618. (herb. Stockholm ex Urban, as C. Jamaicensis Jacq.) (Wikström ex Grisebach, as C. Tortulosa Sw.)
Capparis flexuosa L. Questel 101, 230, 282, 546, 659, 706, 732, 754. (herb. Stockholm ex Urban, as C. cynophallophora var. normalis Eichl.) (Wikström

ex Grisebach, as C. cynophallophora var. saligna Willd.).
Note: Questel 101 is atypical, with leaves subcordate at the base.
Capparis indica (L.) Fawc. & Rendle. Questel 42, 93, 460, 548, 550, 893, Forsström s.n. (Urban, as C. breynia Jacq.).
Capparis verrucosa Jacq. (Wikström ex Grisebach).
Cleome gynandra L. (herb. Stockholm ex Urban, as Gynandropsis pentaphylla (L.) DC.).
Cleome icosandra L. Questel 78, 208.
Cleome stenophylla Klotzsch. Questel 661. (Urban).

AMYGDALACEAE

Chrysobalanus icaco L. Forsström s.n. (herb. Stockholm ex Urban (Wikström ex Grisebach).

MIMOSACEAE

1. Leaflets a single pair on each pinna, obliquely obovate or oblong, 1-5 cm. long.....Pithecellobium unguis-cati.
1a. Leaflets numerous on each pinna, small.
2. Leaves with straight stipular spines.
3. Ovary sessile; pods somewhat terete, pulpy within..Vachellia farnesiana.
3a. Ovary stipitate; pods dry.
4. Involucre at about the middle of the peduncle; pods flat, constricted between the seeds.....Acacia nilotica.
4a. Involucre subtending the heads of flowers; pods subterete..... Poponax tortuosa.
2a. Leaves without straight stipular spines.
5. Climbing vine, more or less armed with recurved prickles..... Senegalia riparia.
5a. Unarmed trees or shrubs.
6. Pods about 1.5 cm. wide; leaflets 8-15 mm. long; stipules short..... Leucaena glauca.
6a. Pods less than 0.5 cm. wide; leaflets 3-9 mm. long; stipules subulate, 2.5-4 mm. long.
7. Pods 6-9 cm. long; plant erect or ascending.....Acuan virgatum.
7a. Pods 2-6 cm. long; plant diffuse.....Acuan depressum.

Acacia nilotica (L.) Delile. Questel 111.
Acuan depressum (Humb. & Bonpl.) Kuntze. Questel 349, 522.
Acuan virgatum (L.) Medic. Questel 299, 300, 350. (herb. Stockholm ex Urban, as Desmanthus virgatus var. strictus (Bertol.) Griseb.).
Leucaena glauca (L.) Benth. Questel 119.
Pithecellobium unguis-cati (L.) Mart. Questel 539. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Poponax tortuosa (L.) Raf. Questel 206, 403. (Wikström ex Grisebach, as Acacia tortuosa Willd.).
Senegalia riparia (H.B.K.) Britton & Rose. Questel 614. (herb. Stockholm ex Urban, as Acacia riparia H.B.K.).
Vachellia farnesiana (L.) Wight & Arn. Questel 141. (herb. Stockholm ex Urban, as Acacia farnesiana (L.) Willd.).

CAESALPINIACEAE

1. Leaves simple, bilobed, palmately veined from the base; twigs armed with prickles.....*Bauhinia aculeata*.
1a. Leaves compound.
2. Leaflets a single complementary pair, 4-9 cm. long.....*Hymenaea courbaril*.
2a. Leaflets more than 2.
3. Leaflets 7-20 cm. long; petioles without glands.....*Cassia fistula*.
3a. Leaflets averaging less than 7 cm. long.
4. Leaflets ovate to lanceolate, acute to long-acuminate at apex, 3-7 cm. long; petioles with a large sessile gland near the base.....*Ditremexa occidentalis*.
4a. Leaflets rounded to emarginate at apex, rarely subacute.
5. Pinnae with a flat winged rachis, long and tapering; leaflets varying from none to 25 pairs, 1.5-8 mm. long; the common rachis of the bipinnate leaves very short and spine-tipped.....*Parkinsonia aculeata*.
5a. Rachis not flat and winged.
6. Rachis armed with stout recurved prickles; leaflets ovate to oval, mostly more than 1 cm. wide.
7. Stipules foliaceous, rarely wanting; bracts reflexed; seeds gray.....*Guilandina crista*.
7a. Stipules subulate or wanting; bracts erect or spreading.
8. Seeds black.....*Guilandina melanosperma*.
8a. Seeds not black.
9. Seeds yellow to orange; legume sparingly short-prickly.....*Guilandina ciliata*.
9a. Seeds brownish to yellow-gray or fading white.....*Guilandina divergens*.
6a. Rachis not armed with prickles; leaflets not as described above.
10. Leaflets of the broadly obovate type, 1 cm. wide.
11. Petioles with a conspicuous gland near the lower pair of leaflets.
12. Gland linear; stipules 1-1.5 cm. long; legume 3-5 mm. thick; herbaceous plant.....*Emelista tora*.
12a. Gland oblong; stipules minute; legume about 1 cm. thick; shrub.....*Adipera bicapsularis*.
11a. Petioles without glands; plants woody.
13. Leaflets finely many-nerved; straight stipular spines present.....*Haematoxylon campechianum*.
13a. Leaflets coarsely few-nerved; stipular spines absent.....*Nicarago vesicaria*.
10a. Leaflets averaging much less than 1 cm. in width.
14. Leaflets of the obovate type, 5-10 mm. long.....*Chamaecrista obcordata*.
14a. Leaflets of the oblong or elliptic type, longer.
15. Leaves merely pinnate; leaflets with prominent venation.
16. Leaflets prominently reticulate-veined beneath, with a marginal vein.....*Tamarindus indica*.
16a. Leaflets with many fine ascending veins beneath, not reticulate nor with marginal confluent veins.....*Chamaecrista polyadena*.
15a. Leaves bipinnate; leaflets not strongly veined.....*Poinciana pulcherrima*.

Adipera bicapsularis (L.) Britton & Rose. (herb. Stockholm ex Urban, as Cassia bicapsularis L.) (Wikström ex Grisebach, as Cassia bicapsularis L.).
Bauhinia aculeata L. (Wikström ex Grisebach).
Cassia fistula L. Questel 416. (Euphrasén ex Urban) (Wikström ex Grisebach).
Chamaecrista obcordata (Sw.) Britton. Questel 594. (Grisebach, Fl. Brit. W. I., page 208, as Cassia biflora var. angustisiliqua Lam.) (Forsström ex Kongl. Vetenskaps-Akademiens Handlingar för Ar 1825, as Cassia obcordata Sw.) (Britton & Rose, N. Am. Fl. 23: 279. 1930).
Note: St. Bartholomew is the type locality.
Chamaecrista polyadena (DC.) Britton. (Grisebach, page 62, as Cassia polyadena DC. "forma ex ins. Barth. exstat ramulis pubescentibus, foliis 4 jugis").
Ditremexa occidentalis (L.) Britton & Rose. (herb. Stockholm ex Urban, as Cassia occidentalis L.) (Wikström ex Grisebach, as Cassia occidentalis L.).
Emelista tora (L.) Britton & Rose. Questel 23, 518, 582, 683. (Wikström ex Grisebach, as Cassia obtusifolia L.).
Guilandina ciliata Berg. (Britton & Rose, N. Am. Fl. 23: 340. 1930).
Note: St. Bartholomew is the type locality.
Guilandina crista (L.) Small. Questel 145, 691, 888, 889. (Urban, as Caesalpinia crista L.).
Guilandina divergens (Urb.) Britton. Questel 438, 641.
Note: Seeds of Questel 438 in the seed collection at the New York Botanical Garden are orange-yellow, but Questel writes, "My sp. have black seeds."
Guilandina melanosperma Eggers. Questel 437.
Note: Seeds of Questel 437 in the seed collection at the New York Botanical Garden are black, but Questel writes, "My sp. have red seeds."
Guilandina sp. Questel 144 (G. crista ?), 824.
Haematoxylon campechianum L. (herb. Stockholm ex Urban).
Hymenaea courbaril L. (herb. Stockholm ex Urban).
Nicarago vesicaria (L.) Britton & Rose. (Wikström ex Grisebach, as Caesalpinia bijuga Sw.).
Parkinsonia aculeata L. (herb. Stockholm ex Urban).
Poinciana pulcherrima L. (herb. Stockholm ex Urban, as Caesalpinia pulcherrima (L.) Sw.) (Wikström ex Grisebach).
Tamarindus indica L. Questel 84. (herb. Stockholm ex Urban).

FABACEAE

1. Leaves 1-foliolate (see also single-leafleted variety of Desmodium supinum).
  2. Leaflets orbicular to oblong-lanceolate, 0.5-2 cm. long (rarely to 3.5 cm. long); stipules scarious, striate, about equal to the petiole in length. Alysicarpus vaginalis.
  2a. Leaflets more than 4 cm. long; stipules not as described above.
    3. Leaflets rounded to subcordate at base, short-acuminate at apex; woody vine.....Dalbergia ecastophyllum.
    3a. Leaflets acute to wedge-shaped at base, rounded to acutish at apex; herbaceous annuals.
      4. Stipules absent or minute; leaflets oblanceolate....Crotalaria retusa.
      4a. Stipules foliaceous-lunate; leaflets broadly ovate or ovate-elliptic. Crotalaria verrucosa.

1a. Leaves 3- to many-foliolate.
  5. Leaves 3-foliolate.
    6. Leaflets averaging less than 1.5 cm. long; diffusely branched or matted herbs (sometimes woody).
      7. Leaflets obovate, subtruncate to emarginate at apex, reticulate-veined.....Sagotia triflora.

7a. Leaflets oblong to narrowly elliptic, acutish at apex, strongly pinnately veined beneath.....Stylosanthes hamata.

6a. Leaflets averaging more than 2 cm. long.

8. Stipels glanduliform and thickish; trees, usually armed with recurved prickles; leaflets broadly rhombic-ovate....Erythrina corallodendrum.

8a. Stipels ordinary or absent; plants unarmed.

9. Leaflets oblong to oblong-lanceolate and densely covered with resinous atoms, acute at apex, pale-velvety beneath; shrubs with prominently striate branchlets.....Cajanus cajan.

9a. Leaflets not as described above--if oblong or lanceolate, then not resinous-dotted; vines or herbs.

10. Leaflets punctate with many resinous dots beneath, rhombic-ovate to rhombic-orbicular; vines.

11. Leaves prominently reticulate-veined beneath; calyx 7-12 mm. long, little surpassed by the corolla....Rhynchosia reticulata.

11a. Leaves not prominently reticulate-veined; calyx 2-3 mm. long, much surpassed by the corolla.....Rhynchosia minima.

10a. Leaflets not punctate with resinous atoms.

12. Leaflets deltoid-ovate to rhombic-ovate, 3-nerved from the base, broad, acutish at apex, the lateral leaflets inequilateral.

13. Pods about 2.5 cm. wide, the lower edge glandular-serrulate; stipules not auricled.....Dolichos lablab.

13a. Pods 7-10 mm. wide, not glandular-serrulate; stipules auricled.....Vigna unguiculata.

12a. Leaflets oval to lanceolate, pinnately veined, the lateral leaflets more or less symmetrical.

14. Terminal leaflet with a stalk hardly longer than the petiolules of the lateral leaflets; branches, petioles, under surface of leaves, and racemes densely pubescent with long hairs; erect plants with inflated, oblong hairy legumes..... Crotalaria incana.

14a. Terminal leaflet with a stalk much longer than the lateral petiolules.

15. Fruits loments, with hooked hairs; plants not vines.

16. Both sutures of the twisted loment equally undulate; stipules filamentous; stems and leaves minutely puberulent or glabrous.....Desmodium procumbens.

16a. Upper suture of the loment hardly undulate; stipules lanceolate, striate; stems and under surface of leaves pubescent.....Desmodium supinum.

15a. Fruits legumes, without hooked hairs; vines.

17. Leaflets orbicular to obovate, thick, rounded at apex; pods over 1 cm. wide.....Canavali maritima.

17a. Leaflets ovate to lanceolate, narrowed at apex; pods less than 1 cm. wide.

18. Pods narrowed at apex into a long-acuminate beak; calyx-lobes linear, long-acuminate....Centrosema virginianum.

18a. Pods with a short hooked beak at apex; calyx-lobes broad, hardly surpassing the tube....Galactia striata.

5a. Leaves with more than 3 leaflets.

19. Leaflets 2 pairs; stipules conspicuous, 1-3 cm. long..... Arachis hypogaea.

19a. Leaflets more than 4.

20. Leaflets typically over 4 cm. broad, 4-12 cm. long; pods 4-membranaceous-winged.....Ichthyomethia piscipula.
20a. Leaflets typically less than 3 cm. broad and 5 cm. long; pods not winged.
21. Leaflets ovate or oval, usually 5 (sometimes 9), typically over 1.3 cm. broad, 2-3.5 cm. long; pods about 1 cm. wide.....Clitoria ternatea.
21a. Leaflets obovate to oblong or elliptic, typically less than 1.3 cm. broad.
22. Lower surface of leaves silvery-canescent with hairs affixed at their middle; pods linear; curved, 4-angled or subterete; shrubs.
23. Pods 5-15 mm. long; leaflets obtuse to acute at apex.....Indigofera suffruticosa.
23a. Pods 2.5-3.5 cm. long; leaflets rounded at apex.
24. Leaflets glabrous above.....Indigofera tinctoria.
24a. Leaflets pubescent on both surfaces.....Indigofera sumatrana.
22a. Leaves with hairs not affixed by their middle; pods flat, straight.
25. Leaflets oblong, glabrescent beneath; vine with pods about 1 cm. wide.....Abrus precatorius.
25a. Leaflets elliptic to oblong or oblanceolate, densely appressed-pubescent beneath; shrubs or herbs with pods less than 0.5 cm. wide.
26. Leaflets oblanceolate, narrowed at the base, with many fine ascending nerves beneath; legume not septate.Cracca cinerea.
26a. Leaflets oblong to elliptic, rounded at the base, with few spreading nerves beneath; legumes septate between the seeds.....Benthamantha caribaea.

Abrus precatorius L. Questel 21. (Euphrasén ex Urban) (Wikström ex Grisebach).
Alysicarpus vaginalis (L.) DC. Questel 165, 333, 512, 769. (herb. Stockholm ex Urban, as A. nummularifolius (L.) DC.).
Arachis hypogaea L. (Euphrasén ex Urban).
Benthamantha caribaea (Jacq.) Kuntze. Questel 66, 348, 584, 777. (Euphrasén ex Urban, as Cracca caribaea (Jacq.) Benth.) (Wikström ex Grisebach, as Tephrosia caribaea DC.).
Cajanus cajan (L.) Millsp. (herb. Stockholm ex Urban, as C. indicus Spreng.).
Canavali maritima (Aubl.) Thou. Questel 12.
Centrosema virginianum (L.) Benth. Questel 14, 259, 260, 456, 516, 517, 521, 526, 741. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Clitoria ternatea L. Questel 329. (herb. Stockholm ex Urban).
Cracca cinerea (L.) Morong. Questel 116. (herb. Stockholm ex Urban, as Tephrosia cinerea (L.) Pers.) (Wikström ex Grisebach, as Tephrosia cinerea (L.) Pers.).
Crotalaria incana L. Questel 362, 642. (Euphrasén ex Urban) (Wikström ex Grisebach).
Crotalaria retusa L. Questel 13. (herb. Stockholm ex Urban).
Crotalaria verrucosa L. Questel 79.
Dalbergia ecastophyllum (L.) Taub. Questel 608.
Desmodium procumbens (Mill.) A. S. Hitchc. Questel 519.
Desmodium supinum (Sw.) DC. Questel 742. (herb. Stockholm ex Urban).
Desmodium supinum var. angustifolium (Griseb.) Urb. Questel 886.
Note: Leaves unifoliolate, linear-lanceolate, the lower ones broadly elliptic or roundish.

Dolichos lablab L. Questel 530. (Euphrasén ex Urban, as Lablab vulgaris Savi).
Erythrina corallodendrum L. (Wikström ex Urban) (Wikström ex Grisebach).
Galactia striata (Jacq.) Urb. Questel 68, 626, 684.
Ichthyomethia piscipula (L.) A. S. Hitchc. (herb. Stockholm ex Urban, as Piscidia piscipula (L.) Sarg.).
Indigofera suffruticosa Mill. Questel 10. (herb. Stockholm ex Urban).
Indigofera sumatrana Gaertn. Questel 11.
Indigofera tinctoria L. Questel 115.
Rhynchosia minima (L.) DC. Questel 67. (herb. Stockholm ex Urban).
Rhynchosia reticulata (Sw.) DC. Questel 117, 355. (herb. Stockholm ex Urban).
Sagotia triflora (L.) Duchass. & Walp. Questel 25, 815. (herb. Stockholm ex Urban, as Desmodium triflorum (L.) DC.).
Stylosanthes hamata (L.) Taub. Questel 156, 217. (herb. Stockholm ex Urban).
Vigna unguiculata (L.) Walp. Questel 884.

ERYTHROXYLACEAE

Erythroxylum ovatum Cav. Questel 852. (Forsström s.n. in herb. Stockholm and Hjertstedt s.n. in herb. Stockholm ex O. E. Schulz in Urb., Symb. Ant. 5: 208) (Britton, N. Am. Fl. 25:65).
Erythroxylum ovatum var. angustifolium O. E. Schulz. (Forsström s.n. in herb. Stockholm ex O. E. Schulz in Urb., Symb. Ant. 5: 208).

ZYGOPHYLLACEAE

1. Trees; leaflets 1-3 cm. wide, leathery.....Guaiacum officinale.
1a. Herbs; leaflets mostly less than 1 cm. wide, membranaceous.
  2. Fruit glabrous; sepals lanceolate.....Kallstroemia maxima.
  2a. Fruit strigose; sepals linear-lanceolate.....Kallstroemia caribaea.

Guaiacum officinale L. Questel 150, "very scarce", Forsström s.n. (Urban) (Wikström ex Grisebach).
Kallstroemia caribaea Rydb. Questel 164, 201, 248.
Kallstroemia maxima (L.) Wight & Arn. (herb. Stockholm ex Urban) (Wikström ex Grisebach, as Tribulus maximus L.).

RUTACEAE

1. Leaves opposite; leaflets 3 (sometimes 5), ovate to lanceolate, more or less acuminate.....Amyris elemifera.
1a. Leaves alternate.
  2. Leaf-rachis less than 1 cm. long; leaflets 3, emarginate, the terminal much larger than the lateral; 2 spines at the base of the short petiole.....Triphasia trifolia.
  2a. Leaf-rachis more than 2 cm. long.
    3. Petioles and rachis winged; leaflets small, less than 3 cm. long, generally with an emarginate apex; inflorescence lateral, spike-like.. Zanthoxylum fagara.
    3a. Petioles and rachis not winged.
      4. Young growth, branches of the inflorescence, and often the petioles and lower surface of the leaves puberulent with stellate hairs..... Zanthoxylum flavum.
      4a. No stellate hairs present.

5. Inflorescence congested, scattered in the axils of the leaves, few-flowered; gynoecium 2-carpellary.....Zanthoxylum punctatum.
5a. Inflorescence terminal or lateral in the axils of the upper leaves, many-flowered; gynoecium 3-carpellary.....Zanthoxylum spinosum.

Amyris elemifera L. Questel 673. (Urban, as A. maritima Jacq.).
Note: Questel writes, "My sp. has purple flowers."
Triphasia trifolia (Burm. f.) P. Wils. Questel 62. (herb. Stockholm ex Urban, as T. trifoliata (L.) DC.).
Zanthoxylum fagara (L.) Sarg. (A specimen recorded by P. Wilson, but not now available for checking).
Zanthoxylum flavum Vahl. Questel 357, 867.
Zanthoxylum punctatum Vahl. Questel 225, 700, 771. (herb. Stockholm ex Urban, as Fagara trifoliata Sw.).
Zanthoxylum spinosum (L.) Sw. (Wikström ex Grisebach, as Z. emarginatum Sw.).

SURIANACEAE

Suriana maritima L. (herb. Stockholm ex Urban) (Wikström ex Grisebach).

SIMARUBACEAE

Picramnia pentandra Sw. (herb. Stockholm ex Urban).

BURSERACEAE

1. Petals distinct, imbricate in bud.....Elaphrium simaruba.
1a. Petals united into a short tube, valvate in bud....Tetragastris balsamifera.

Elaphrium simaruba (L.) Rose. (Euphrasén ex Urban, as Bursera simaruba (L.) Sarg.) (Wikström ex Grisebach, as Bursera gummifera L.).
Tetragastris balsamifera (Sw.) Kuntze. (Wikström ex Grisebach, as Icica hedwigia Rich.).

MELIACEAE

1. Leaves 2-pinnate; leaflets serrate.....Melia azedarach.
1a. Leaves 1-pinnate; leaflets entire.....Swietenia mahagoni.

Melia azedarach L. Forsström s.n. (herb. Stockholm ex Urban) (Wikström ex Grisebach, as M. sempervirens Sw.).
Swietenia mahagoni Jacq. Questel 799.

MALPIGHIACEAE

1. Leaves with 2 glands at apex of petiole.....Stigmaphyllon lingulatum.
1a. Leaves without glands.
2. Styles united; drupe with smooth pyrenes.....Bunchosia glandulosa.
2a. Styles free; drupe with crested pyrenes.
3. Leaves elongated, linear to elongate-elliptic.....Malpighia angustifolia.
3a. Leaves broader.

4. Umbels pedunculate; leaves mostly narrowed at apex..Malpighia glabra.
4a. Umbels subsessile; leaves mostly rounded or emarginate at apex.....
Malpighia punicifolia.

Bunchosia glandulosa (Cav.) L. C. Rich. Questel 677, 870, 871. (Urban).
Malpighia angustifolia L. Questel 775. (Wikström ex Grisebach).
Malpighia angustifolia var. linearis (Jacq.) Niedenzu. Questal 267, Forsström s.n. (Forsström s.n. and Hjertberg s.n. ex Niedenzu in Engl., Pflanzenreich IV, 141, page 624).
Malpighia glabra L. Questel 520. (Wikström ex Grisebach).
Note: The Questel collection is sterile and atypical.
Malpighia punicifolia L. Questel 232, 272.
Note: These specimens represent a form of the species in which the peduncles are much longer than the petioles, 5-10 mm. in length, and the lower leaves are acute at apex.
Malpighia punicifolia var. lancifolia Niedenzu. (Urban).
Malpighia punicifolia var. vulgaris Niedenzu. (Urban).
Stigmaphyllon lingulatum (Poir.) Small. Questel 57, 630. (Urban, as S. periplocifolium (DC.) A. Juss.).

POLYGALACEAE

Polygala paniculata L. (Wikström ex Urban).

EUPHORBIACEAE

1. Leaves opposite.
2. Leaves entire, thickish; plants shrubby.....Chamaesyce buxifolia.
2a. Leaves serrate, not thick; plants herbaceous.
3. Stems and capsules glabrous.
4. Seeds red.....Chamaesyce hypericifolia.
4a. Seeds gray.....Chamaesyce nutans.
3a. Stems and capsules pubescent.
5. Stems and capsules pubescent in lines only; involucres 1-4 together...
Chamaesyce prostrata.
5a. Stems and capsules not pubescent in lines; involucres cymose.
6. Leaves oblong, obtuse, crenulate.....Chamaesyce berteriana.
6a. Leaves ovate to lanceolate, acute, serrate.....Chamaesyce hirta.
1a. Leaves alternate.
7. Leaves palmately lobed (sometimes not lobed in Jatropha curcas, where the leaves are palmately veined, cordate, and 4-15 cm. wide).
8. Lobes not toothed (see also Jatropha gossypifolia).
9. Lobes extending only to above the middle; stipules rudimentary.....
Jatropha curcas.
9a. Lobes extending almost to the base, filamentous-tipped; stipules cut into thread-like segments.....Jatropha multifida.
8a. Lobes toothed.
10. Teeth reduced to almost mere glandular hairs; petioles with long glandular hairs; stipules cut into glandular threads.....
Jatropha gossypifolia.
10a. Teeth distinct; glandular hairs absent.
11. Leaves not peltate, evenly serrate, more or less hirsute, mostly less than 10 cm. wide.....Croton lobatus.
11a. Leaves peltate, unequally dentate, glabrous, normally more than one span wide.....Ricinus communis.

7a. Leaves not palmately lobed (see also Jatropha curcas).
12. Leaves obviously stellate-pubescent.
13. Glands at base of midrib distinct; leaves acuminate at apex.....
Croton balsamiferus.
13a. Glands at base of midrib absent; leaves not acuminate.....
Croton astroites.
12a. Leaves glabrous or with unbranched hairs.
14. Leaves less than 15 mm. long and 8 mm. wide, borne on slender branches, appearing like compound leaves.
15. Leaves oblong, rounded at both ends, symmetrical at base.....
Phyllanthus niruri.
15a. Leaves narrowed at both ends, asymmetrical at base.....
Phyllanthus mimosoides.
14a. Leaves more than 20 mm. long and 10 mm. wide.
16. Leaves fleshy, entire; petioles more than 2 mm. wide.....
Pedilanthus tithymaloides.
16a. Leaves not fleshy; petioles less than 1.5 mm. wide.
17. Leaves with an orbicular gland at the top of the petiole, entire or crenately serrulate; petioles long; trees.....
Hippomane mancinella.
17a. Leaves with no gland at the top of the petiole.
18. Herbs; upper leaves blotched with red; flowers in a cyathium; cymes terminal.....Poinsettia cyathophora.
18a. Upper leaves not blotched with red; flowers not in a cyathium, not terminal.
19. Leaves entire; glabrous tree.....Cicca disticha.
19a. Leaves toothed (faintly in Argithamnia candicans).
20. Petioles less than 5 mm. long; woody plants.
21. Leaves with purple pigment, very faintly serrulate.....
Argithamnia candicans.
21a. Leaves without purple pigment, plainly toothed, broadest at or above the middle....Bernardia corensis.
20a. Petioles mostly more than 5 mm. long; leaves plainly toothed.
22. Leaves varying from rounded to cordate at base, ovate to oblong-lanceolate; trailing or twining shrubs.....
Tragia volubilis.
22a. Leaves varying from rounded to wedge-shaped at base, ovate; erect herbs.
23. Leafy bracts in dense oblong clusters.Acalypha poiretii.
23a. Leafy bracts in distinct elongated spikes.....
Acalypha indica.

Acalypha indica L. Questel 161.
Acalypha poiretii Spreng. Questel 558, 718, 725.
Argithamnia candicans Sw. Questel 60, Forsström s.n. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Bernardia corensis (Jacq.) Müll. Arg. Questel 781. (Wikström ex Grisebach, as Polyboea corensis Klotzsch).
Chamaesyce berteriana (Balbis) Millsp. Questel 537.
Chamaesyce buxifolia (Lam.) Small. Questel 153. (herb. Stockholm ex Urban, as Euphorbia buxifolia Lam.) (Wikström ex Grisebach, as Euphorbia glabrata Sw.).
Chamaesyce hirta (L.) Millsp. Questel 122, 250, 433, 621.

Chamaesyce hypericifolia (L.) Millsp. (herb. Stockholm ex Urban, as Euphorbia hypericifolia (L.) (Wikström ex Grisebach, as Euphorbia hypericifolia L.)
Chamaesyce nutans (Lag.) Small. Questel 400.
Chamaesyce prostrata (Ait.) Small. Questel 434, 435, 480, 836. (Urban, as Euphorbia prostrata Ait.).
Cicca disticha L. (Euphrasén ex Urban, as Phyllanthus distichus (L.) Müll. Arg.) (Wikström ex Grisebach).
Croton astroites Dryand. Questel 34, 211. (Urban).
Croton balsamiferus Jacq. Questel 47, 209, 210, Forsström s.n. (Wikström ex Grisebach).
Croton lobatus L. Questel 188, 412, 579. (herb. Stockholm ex Urban).
Hippomane mancinella L. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Jatropha curcas L. (herb. Stockholm ex Urban).
Jatropha gossypifolia L. Questel 35. (herb. Stockholm ex Urban).
Jatropha multifida L. (Euphrasén, cultivated, ex Urban).
Pedilanthus tithymaloides (L.) Poit. (Euphrasén ex Urban) (Wikström ex Grisebach).
Pedilanthus tithymaloides var. padifolius (L.) Poit. Questel 220, 489, 807.
Phyllanthus mimosoides Sw. (Wikström ex Grisebach).
Phyllanthus niruri L. Questel 187, 399, 503. (herb. Stockholm ex Urban).
Poinsettia cyathophora (Murr.) Klotzsch & Garcke. Questel 81, 609.
Ricinus communis L. (Euphrasén ex Urban) (Wikström ex Grisebach).
Tragia volubilis L. Questel 342. (Wikström ex Urban) (Wikström ex Grisebach).

ANACARDIACEAE

1. Leaves pinnate, with spiny leaflets.....Comocladia dodonaea.
1a. Leaves simple, without spines.
  2. Leaves broadly elliptic or broadly oblong, with rounded apex.....
Anacardium occidentale.
  2a. Leaves elongated, with acuminate apex.....Mangifera indica.

Anacardium occidentale L. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Comocladia dodonaea (L.) Urb. Questel 224. (herb. Stockholm ex Urban) (Grisebach, as C. ilicifolia Sw.).
Mangifera indica L. (herb. Stockholm ex Urban).

CYRILLACEAE

Cyrilla racemiflora L. (Wikström ex Urban) (Wikström ex Grisebach, as C. antillana Michx.).

CELASTRACEAE

1. Leaves opposite.
  2. Upper leaves with minute subulate stipules, entire or subentire, without a mucro at apex; flowers hermaphroditic.....Gyminda latifolia.
  2a. Leaves without stipules, usually crenulate, mostly with a minute mucro at apex; flowers unisexual.....Rhacoma crossopetalum.
1a. Leaves alternate.
  3. Young branchlets finely striate with commonly more than 4 lines, greenish; leaves mostly acutish and mucronate at apex, prominently veined, bright green; fruit a drupe; flower-parts in fours.....Schaefferia frutescens.

3a. Young branchlets 4-angled, grayish; leaves obtuse at apex; veins hardly raised; leaf-color dull green to ashy; fruit a capsule; flower-parts in fives.....Maytenus elliptica.

Gyminda latifolia (Sw.) Urb. (Wikström ex Grisebach, as Myginda latifolia Sw.).
Maytenus elliptica (Lam.) Krug & Urb. Questel 849.
Rhacoma crossopetalum L. Questel 97, 103, 830, 850. (Urban).
Schaefferia frutescens Jacq. Questel 744 (herb. Stockholm ex Urban).

SAPINDACEAE

1. Seed with a heart-shaped bilobed hilum.....Cardiospermum microcarpum.
1a. Seed with a semicircular scarcely emarginate hilum...Cardiospermum corindum.

Cardiospermum corindum L. Questel 50, 51, 277, 782. (Urban).
Cardiospermum microcarpum H.B.K. (Wikström ex Grisebach).

RHAMANACEAE

1. Leaves toothed; ends of branchlets modified into tendrils..Gouania lupuloides.
1a. Leaves entire; tendrils absent.
  2. Leaves 2-6 cm. long, rounded and usually emarginate at apex; lower leaves on branchlets alternate, the upper ones subopposite; calyx-tube beneath fruit.....Krugiodendron ferreum.
  2a. Leaves larger, usually narrowed at apex, alternate; calyx-tube confluent with base of fruit.
    3. Leaves rusty-tomentose beneath when young; cupule reaching half way from base of capsule.....Colubrina ferruginosa.
    3a. Leaves minutely puberulous beneath; cupule reaching one-third the way from base of capsule.....Colubrina reclinata.

Colubrina ferruginosa Brongn. Forsström s.n.
Colubrina reclinata (L'Her.) Brongn. (Urban) (Swartz ex Grisebach).
Gouania lupuloides (L.) Urb. Questel 851.
Krugiodendron ferreum (Vahl) Urb. (Swartz ex Urban) (Swartz ex Grisebach, as Scutia ferrea Brongn.).

VITACEAE

1. Leaves simple.
  2. Leaves glabrous, serrate with distant, minute, bristle-tipped teeth..... Cissus sicyoides.
  2a. Leaves tomentose beneath, dentate with mucronate teeth...Vitis tiliifolia.
1a. Leaves trifoliate.
  3. Leaflets 1.5-5 cm. long, deeply sharp-toothed above the middle..... Cissus trifoliata.
  3a. Leaflets 0.5-2 cm. long, obscurely toothed.....Cissus obovata.

Cissus obovata Vahl. Questel 346, 667, 895.
Cissus sicyoides L. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Cissus trifoliata L. (Wikström ex Grisebach, as C. acida L.).
Vitis tiliifolia Humb. & Bonpl. (Wikström ex Urban) (Wikström ex Grisebach, as V. caribaea DC.).

[To be concluded in the January 1941 issue.]


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THE CARIBBEAN FORESTER

It is my pride and joy to be the shepherd of my country's trees.

TROPICAL FOREST EXPERIMENT STATION,
UNITED STATES FOREST SERVICE,
RIO PIEDRAS, PUERTO RICO

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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:

Bahama Islands
Barbados
Brazil
British Guiana
British Honduras
Canal Zone
Colombia
Costa Rica
Cuba
Dominica
Dominican Republic
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Honduras
Jamaica
Leeward Islands
Martinique
Mexico
Nicaragua
Panama
St. Lucia
St. Vincent
Salvador
Surinam
Trinidad & Tobago
Venezuela

The journal is presented quarterly, in January, April, July, and October. Material for publication should be submitted at least two months before publication date and be addressed to the Director, Tropical Forest Experiment Station, Rio Piedras, Puerto Rico.

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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To Our Collaborators

Since the last issue, I have had the good fortune of being able to visit Guadeloupe, Martinique, Trinidad, and the Dominican Republic, in all of which the excellent hospitality and many kindnesses shown to me by foresters, botanists, and many others brought me back to Puerto Rico in the proper spirit to enjoy the deep significance of the Christmas season. During the trip it was extremely encouraging to note the excellent progress that forestry is making in these islands, and I would like to pass on the following brief notes to other forest workers in the region.

In Guadeloupe, interesting because of its still extensive virgin forests, forestry is fast gaining recognition. M. Paul Benā, a graduate of the Nancy School of Forestry, was transferred recently from the Ivory Coast in Africa to fill the position of Chief of the Forest Service on the island. Plans are being prepared for starting rational exploitation of the high forest.

Martinique's forests have been reduced to a much greater extent than Guadeloupe's, but protection, reforestation, and accumulation of silvicultural data are being carried on actively under the direction of M. H. Stehlé, now Acting Chief of the Department of Agriculture. M. and Mme. Stehlé are both known widely for their extensive botanical investigations in the French Antilles.

In Trinidad, Conservator of Forests Brooks and four able assistants are building up a fine tradition of forestry in the island. Since my last visit nearly three years ago, remarkable advances have been made in silvicultural techniques and the integration of forestry into the economic picture of the island. The trend towards augmenting cooperative investigations by foresters and agricultural scientists on the island on broad subjects such as soils and land-use planning is of particular interest, as it is productive already of good results indicating the tremendous possibilities ahead.

The Dominican Republic is fortunate in having a forestry-minded Chief of the Department of Agriculture, Sr. Raúl Carbuccia, who with Sr. Tomás Erickson, In Charge of the Forestry Department, is pushing new legislation designed to greatly increase the area in public forests. This is a very essential step in the forestry program of the Republic and we heartily wish them success in their project.

And to all our personal friends, to those whom we know as yet only through their letters and to the many other interested workers who will read this, we of the Tropical Forest Experiment Station extend our wishes for a pleasant and progress-filled year.--L. R. Holdridge, Tropical Forest Experiment Station.

CONTENTS

A CHECK-LIST OF THE SPERMATOPHYTES OF ST. BARTHOLOMEW

Joseph Monachino
Member, Torrey Botanical Club and
American Society of Plant Taxonomists

PART II.

TILIACEAE

1. Leaves with sparse simple hairs; capsules angled, without bristles or tomentum.....Corchorus aestuans.
1a. Leaves densely stellate-pubescent.
2. Leaves 2-5 cm. long, rounded at apex, the teeth equal; capsules ellipsoidal, woolly.....Corchorus hirsutus.
2a. Leaves 4-12 cm. long, acute at apex, irregularly toothed; fruit subglobose, covered with hooked bristles.
3. Body of fruit almost glabrous; petals present.Triumfetta semitriloba.
3a. Body of fruit puberulous; petals absent.....Triumfetta lappula.

Corchorus aestuans L. Questel 48, 504.
Corchorus hirsutus L. Questel 392, 643, Forsström s.n. (Urban).
Triumfetta lappula L. (Urban).
Triumfetta semitriloba Jacq. Questel 105, 776.

MALVACEAE

1. Leaves without teeth (or obscurely crenulate), more than 5 cm. wide.
2. Stipule-scars not encircling the twigs; leaves not hoary beneath.
3. Leaves 3-5-lobed, black-dotted beneath, without peltate scales; 3 involucels cut into acuminate segments.....Gossypium barbadense.
3a. Leaves not lobed; herbaceous parts covered with peltate scales; involucels not laciniate.....Thespesia populnea.
2a. Stipule-scars encircling the twigs; leaves hoary beneath.....Paritium tiliaceum.
1a. Leaves with teeth (minutely toothed in Bastardia).
4. Involucel present, composed of bracteoles.
5. Bracteoles 5 or more; flowers mostly solitary or few per axil.
6. Bracteoles 5, united 1/3-1/4 the way up; pedicels mostly less than 5 mm. long; leaves with split glands at base of median nerves beneath.....Urena lobata.
6a. Bracteoles more than 5, hardly united at base; pedicels mostly more than 5 mm. long; leaves without glands.
7. Leaves cleft to below the middle into 3-5 elliptic-lanceolate lobes; peduncles less than 1.5 cm. long....Hibiscus cannabinus.
7a. Leaves not cleft; peduncles mostly more than 1.5 cm. long.
8. Leaves velvety beneath, lobed; capsules winged.....Hibiscus vitifolius.
8a. Leaves not velvety; capsules not winged.
9. Fruit without long spines; bracteoles linear to lanceolate, glabrescent, acute at apex.
10. Bracteoles linear, longer than the calyx.....Hibiscus brasiliensis.
10a. Bracteoles broader, shorter than the calyx.....Hibiscus rosa-sinensis.

January 1941

9a. Fruit with long spines; bracteoles narrow-spatulate, hirsute, bluntish at apex.....Pavonia spinifex.

5a. Bracteoles 3; flowers subsessile, mostly clustered.

11. Branches and petioles strigose with parallel-rayed hairs.

12. Carpels with 3 spines on the back.....Malvastrum coromandelianum.

12a. Carpels without spines.....Malvastrum corchorifolium.

11a. Branches and petioles tomentulose with minute spreading-rayed hairs.....Malvastrum spicatum.

4a. Involucel absent.

13. Flowers in dense heads with an involucre of leafy broadly cordate bracts which are prominently veined and mostly white-blotched; leaves often sinuately lobed.....Malachra capitata.

13a. Flowers without broad venose leaf-like bracts.

14. Inflorescence terminal; flowers in leafy heads; peduncles short, adherent to the stalks of narrow leafy bracts; leaves serrate with a few sharp teeth only above the middle.....Sida ciliaris.

14a. Inflorescence mostly axillary (at the ends of the branches in Abutilon umbellatum); peduncles free; leaves toothed also below the middle.

15. Calyx distinctly angled; ovules one per cell.

16. Plants procumbent; leaves cordate, ovate to rounded, rounded at apex, small, 0.5-1.8 cm. long; peduncles long.....Sida procumbens.

16a. Plants erect or ascending; leaves not as described above.

17. Calyx with many distinct, long, simple, stiff hairs; peduncles short.

18. Leaves cordate, distinctly petiolate, with mostly stellate hairs on the upper surface; stems densely hirsute; stipules not prominent.....Sida urens.

18a. Leaves roundish at base, with mostly simple hairs on the upper surface; petioles less than 6 mm. long; stems not hirsute; stipules broad, prominently several-nerved, hirsute-ciliate.....Sida glomerata.

17a. Calyx without simple hairs (or occasionally with very few).

19. Leaves distinctly cordate (see also Sida spinosa).

20. Young parts densely tomentose; leaves not acuminate; calyx densely velvety, over 5 mm. wide.....Sida cordifolia.

20a. Young parts puberulent; leaves acuminate; calyx not tomentose, less than 5 mm. wide.....Sida glabra.

19a. Leaves rounded (or slightly cordate) to narrowed at base.

21. Carpels 5.

22. Calyx-lobes acuminate, longer than wide; stellate pubescence with long rays.....Sida jamaicensis.

22a. Calyx-lobes not acuminate, about as wide at the base as long, tomentulose with short-rayed hairs.....Sida spinosa.

21a. Carpels more than 5.

23. Peduncles more than 3 times the length of the calyx...Sida rhombifolia.

23a. Peduncles less than 3 times the length of the calyx.

24. Leaves ovate to lanceolate, not velvety on the upper surface.....Sida acuta.

24a. Leaves oblong to linear, velvety.Sida salviaefolia.

15a. Calyx not distinctly angled; peduncles long.
25. Ovules (and seeds) one per cell.
26. Carpids about 30, inflated, membranaceous, about 1 cm. long; leaves cordate, denticulate; pedicels thick, almost 1 mm. thick, tomentose (see also Abutilon crispum)..Gaya occidentalis.
26a. Carpids much fewer, not inflated or hardly so, less than 5 mm. long.
27. Leaves rounded to subcordate at base, scurfy-tomentose, distinctly toothed; calyx densely brown-tomentose with long-rayed pubescence.....Sida acuminata.
27a. Leaves plainly cordate at base, not scurfy, obscurely denticulate; calyx with gray minutely stellate pubescence... Bastardia viscosa.
25a. Ovules (and seeds) 3 per cell; leaves cordate.
28. Flowers corymbose or subumbellate at the ends of the branches; fruit little inflated, hardly surpassing the calyx at maturity. Abutilon umbellatum.
28a. Flowers mostly solitary; fruit more or less inflated and much surpassing the calyx at maturity.
29. Leaves finely toothed, closely reticulate; fruit with long simple hairs; pedicels very slender, less than 0.5 mm. thick.....Abutilon crispum.
29a. Leaves coarsely unequally dentate, not closely reticulate-veined; fruit tomentose with mostly stellate hairs..... Abutilon indicum.

Abutilon crispum (L.) Medic. Questel 304, 309. (Wikström ex Urban) (Wikström ex Grisebach).
Abutilon indicum (L.) Sweet. (herb. Stockholm ex Urban).
Abutilon umbellatum (L.) Sweet. Questel 127, 284, 735. (Wikström ex Urban) (Wikström ex Grisebach).
Bastardia viscosa (L.) H.B.K. Questel 285, 310, 533, 540, 663. (Urban) (Wikström ex Grisebach).
Gaya occidentalis (L.) Griseb. (Wikström ex Grisebach, as Abutilon occidentale Sw.) (Grisebach, Fl. Brit. W. I., page 79, 1864).
Gossypium barbadense L. Questel 575.
Hibiscus brasiliensis L. Questel s.n. (herb. Stockholm ex Urban).
Hibiscus cannabinus L. Questel 565.
Hibiscus rosa-sinensis L. Questel 426.
Hibiscus vitifolius L. Questel 4.
Malachra capitata L. (Wikström ex Grisebach).
Malvastrum corchorifolium (Desr.) Britton. Questel 542, 549, 555, 561, 569, 602.
Malvastrum coromandelianum (L.) Garcke. Questel 75 (Urban).
Malvastrum spicatum (L.) A. Gray. Questel 10, 74, 126, 301, 377. (Urban) (Wikström ex Grisebach).
Paritium tiliaceum (L.) A. L. Juss. (Urban, as Hibiscus tiliaceus L.).
Pavonia spinifex (L.) Cav. Questel 505, 562, 701, 795. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Sida acuta Burm. Questel 2, 378, 599. (Urban) (Wikström ex Grisebach, as S. carpinifolia L.).
Sida acuminata DC. Questel 243, 397, 508, 510, 570, 645, 660, 665, 797. (Urban).
Sida ciliaris L. Questel 157, 298, 513. (Wikström ex Urban) (Wikström ex Grisebach).

January 1941

Sida cordifolia L. Questel 653. (Wikström ex Urban) (Wikström ex Grisebach, as S. althaeifolia Sw.).
Sida glabra Mill. Questel 541, 716. (Urban, as S. ulmifolia Cav.) (Wikström ex Grisebach, as S. arguta Sw.).
Sida glomerata Cav. Questel 568, 811.
Sida jamaicensis L. Questel 545, 566, 727. (Wikström ex Grisebach).
Sida procumbens Sw. Questel 674.
Note: This specimen represents a form with the carpels not beaked.
Sida rhombifolia L. (Wikström ex Urban).
Sida salviaefolia Presl. Questel 507.
Sida spinosa L. Questel 76, 311, 376, 601, 675.
Sida urens L. (Euphrasén ex Urban).
Thespesia populnea (L.) Soland. Questel 128.
Urena lobata L. (Wikström ex Grisebach, as U. reticulata L.).

BOMBACACEAE

Ceiba pentandra (L.) Gaertn. (Euphrasén ex Urban) (Wikström ex Grisebach, as Eriodendron anfractuosum DC.).

STERCULIACEAE

1. Capsules over 5 mm. long, pyramidal, sharply 5-angled, crowned by the beak-like style; flowers several, on distinct pedicels.
2. Leaves tomentose.....Melochia tomentosa.
2a. Leaves glabrous.....Melochia pyramidata.
1a. Capsules not pyramidal, not sharply angled.
3. Flowers solitary or 2 or 3 together on distinct pedicels; capsules spiny; leaves mostly under 3 cm. long, glabrescent....Ayenia pusilla.
3a. Flowers in dense subglobose clusters without distinct pedicels; capsules not spiny.
4. Leaves tomentose; peduncles mostly present.....Waltheria americana.
4a. Leaves sparsely pubescent; peduncles absent.....Melochia nodiflora.

Ayenia pusilla L. Questel 306, 307, 308, 581, 846.
Melochia nodiflora Sw. (Wikström ex Urban) (Wikström ex Grisebach).
Melochia pyramidata L. Questel 733, 770. (Urban) (Wikström ex Grisebach).
Melochia tomentosa L. Questel 151, 255. (Urban) (Wikström ex Grisebach).
Waltheria americana L. Questel 200, 509, 766. (Urban) (Wikström ex Grisebach).

MARCGRAVIACEAE

Marcgravia umbellata L. (Wikström ex Grisebach).

TAMARICACEAE

Tamarix gallica L. Questel 189.

VIOLACEAE

Hybanthus portoricensis Urb. Questel 632.

FLACOURTIACEAE

Samyda dodecandra Jacq. Questel 41. (Urban).

TURNERACEAE

Turnera ulmifolia L. Questel 251, 502. (Urban, as T. ulmifolia var. angustifolia (Mill.) Willd.) (Wikström ex Grisebach).

PASSIFLORACEAE

1. Stipules broad, ciliate with distinct knobbed hairs; petioles without thick glands; involucre multicleft with knobbed filaments..... Passiflora foetida.

1a. Stipules linear-lanceolate, without knobbed cilia; petioles with 2 thick glands; no involucre cleft into knobbed filaments present..... Passiflora suberosa.

Passiflora foetida L. (Euphrasén ex Urban) (Wikström ex Grisebach).
Passiflora suberosa L. Questel 370. (Wikström ex Urban, as P. suberosa var. minima (L.) M. Mast.) (Wikström ex Grisebach).

BEGONIACEAE

Begonia minor Jacq. (Wikström ex Grisebach, as B. nitida Dryand.).

CACTACEAE

1. Stem composed of oval, flattened, unribbed joints; joints 4-5 cm. long.... Opuntia curassavica.

1a. Stem not as described above.
2. Stem a short-cylindric mass; spines over 1.5 cm. long; cephalium up to 10 cm. wide, with wool and long spines.....Cactus melocactus.
2a. Stem elongated; spines less than 1 cm. long.
3. Stem less than 3 cm. wide; ribs usually more than 5; spines acicular.. Selenicereus grandiflorus.
3a. Stem more than 4 cm. wide; ribs usually 3, undulate; spines stout.... Hylocereus undatus.

Cactus melocactus L. (Euphrasén ex Urban, as Melocactus communis Link) (Wikström ex Grisebach, as Melocactus communis Link).
Hylocereus undatus (Haw.) Britton & Rose. Questel 606.
Opuntia curassavica (L.) Mill. (Wikström ex Grisebach).
Selenicereus grandiflorus (L.) Britton & Rose. Questel 794, "probably introduced from St. Eustachius and escaped."

LYTHRACEAE

Lawsonia inermis L. (Grisebach ex Urban) (Wikström ex Grisebach).

COMBRETACEAE

1. Leaves opposite.....Laguncularia racemosa.
1a. Leaves alternate.
2. Leaves 2-5 cm. long; flowers in globose heads.....Conocarpus erecta.
2a. Leaves 10-30 cm. long; flowers in spikes.....Terminalia latifolia.

Conocarpus erecta L. Questel 371. (Urban) (Wikström ex Grisebach).
Laguncularia racemosa (L.) Gaertn. Questel 146. (Urban) (Wikström ex Grisebach).
Terminalia latifolia Sw. (Wikström ex Grisebach).

MYRTACEAE

1. Leaves 4-12 cm. long, oblongish, rounded at base, the lower surface markedly pubescent and with prominent rib-like nerves....Psidium guajava.
1a. Leaves mostly wedge-shaped at base, glabrescent, with no rib-like nerves.
2. Typical leaves not acuminate at apex; average peduncles longer than 12 mm.
3. Flowers mostly solitary, borne on peduncles in the axils of the linear bracts; branchlets squamiferous at base; leaves shining above. Eugenia ligustrina.
3a. Flowers mostly in cymes of 3, centrifugal, not in the axils of linear bracts; branchlets not squamiferous; leaves dull above..... Anamomis fragrans.
2a. Typical leaves more or less acuminate at apex; average peduncle shorter than 12 mm.
4. Pedicels 4-13 mm. long.....Eugenia rhombea.
4a. Pedicels averaging less than 3 mm. long.
5. Fruit oblongish.....Eugenia glabrata.
5a. Fruit globose.....Eugenia axillaris.

Anamomis fragrans (Sw.) Griseb. (Wikström ex Urban, as Eugenia fragrans (Sw.) Willd.) (Wikström ex Grisebach, as Eugenia fragrans (Sw.) Willd.).
Eugenia axillaris (Sw.) Willd. Questel 710, 867.
Eugenia glabrata DC. (Wikström ex Grisebach).
Eugenia ligustrina (Sw.) Willd. Questel 419.
Eugenia rhombea (Berg.) Krug & Urb. Questel 341.
Psidium guajava L. Questel 351, Forsström s.n. (Urban) (Wikström ex Grisebach).

ARALIACEAE

1. Leaves digitately compound; leaflets entire, with caudate tips..... Didymopanax attenuatum.
1a. Leaves pinnately compound; leaflets toothed.....Polyscias spp.

Didymopanax attenuatum (Sw.) March. (Wikström ex Grisebach, as Panax attenuatum Sw.).
Polyscias sp. Questel 422, "in a garden."
Polyscias sp. Questel 423, "dans un jardin, Gustavia."
Polyscias sp. Questel 424, "in gardens."

THEOPHRASTACEAE

Jacquinia barbasco (Loefl.) Mez. Questel 94, 95. (herb. Stockholm ex Urban) (Wikström ex Grisebach, as J. arborea Vahl).

PLUMBAGINACEAE

Plumbago scandens L. Questel 29. (herb. Stockholm ex Urban).

SAPOTACEAE

1. Pedicels and calyx glabrescent.....Bumelia obovata.
1a. Pedicels and calyx sericeous.....Bumelia retusa.

Bumelia obovata (Lam.) A. DC. (Urban).
Bumelia retusa Sw. (Wikström ex Grisebach).

OLEACEAE

Forestiera eggersiana Krug & Urb. Questel 823.

APOCYNACEAE

1. Typical leaves over 1 span long, with more than 30 pairs of conspicuous primary veins; petioles more than 1.5 cm. long; branches stout.
  2. Leaves elliptic, glabrous.....Plumiera rubra.
  2a. Leaves elongate-lanceolate, usually tomentose beneath...Plumiera alba.
1a. Conspicuous primary veins less than 25, curved; petioles less than 1.5 cm. long.
  3. Leaves linear, 7-30 cm. long, 5-12 mm. wide, narrowed at both ends; lateral venation obscure.....Thevetia peruviana.
  3a. Leaves broad; lateral venation conspicuous.
    4. Leaves acute at apex, glabrous, often verticellate; marginal veins developed.
      5. Fruit 8-12 mm. broad; leaves shining.....Rauwolfia tetraphylla.
      5a. Fruit 5-7 mm. broad; leaves dull.....Rauwolfia lamarckii.
    4a. Leaves obtuse and mucronate at apex, pubescent beneath; marginal veins obscure.....Lochnera rosea.

Lochnera rosea (L.) Reichenb. (herb. Stockholm ex Urban).
Plumiera alba L. (Wikström ex Urban) (Wikström ex Grisebach).
Plumiera rubra L. (Euphrasén ex Urban) (Wikström ex Grisebach).
Rauwolfia lamarckii A. DC. Questel 228. (Urban).
Rauwolfia tetraphylla L. (Euphrasén ex Urban, as R. nitida Jacq.) (Wikström ex Grisebach, as R. nitida Jacq.).
Thevetia peruviana (Pers.) K. Schum. (herb. Stockholm ex Urban, as T. neriifolia Juss.) (Wikström ex Grisebach, as T. neriifolia Juss.).

ASCLEPIADACEAE

1. Erect plants.
  2. Leaves tapering to the petiole at base; corolla-lobes reflexed.....Asclepias curassavica.
  2a. Leaves deeply cordate, sessile; corolla-lobes erect.....Calotropis procera.
1a. Twining vines.
  3. Slender; stems about 1 mm. thick; leaves rounded or subcordate at base.....Metastelma parviflorum.
  3a. Stems about 2 mm. thick (or even thicker); leaves deeply cordate at base.....Ibatia maritima.

Asclepias curassavica L. Questel 99.
Calotropis procera (Ait.) R. Br. Questel 69. (herb. Stockholm ex Urban).

Ibatia maritima (Jacq.) Decaisne. Questel 20, 401. (herb. Stockholm ex Urban).

Metastelma parviflorum R. Br. Questel 64, 72, 387, 497. (Urban) (Wikström ex Grisebach).

CONVOLVULACEAE

1. Leaves pinnately parted into many linear segments.....Quamoclit vulgaris.
1a. Leaves digitately dissected or not parted.
2. Leaves 5-7 parted almost to the base, the segments coarsely toothed or pinnatifid.....Operculina dissecta.
2a. Leaves not parted, or, if parted, with the segments not coarsely toothed.
3. Leaves digitately 5-foliolate, the leaflets elliptic or lanceolate... Merremia pentaphylla.
3a. Leaves not 5-foliolate (or, if rarely so, then the lower leaflets not elliptic-lanceolate).
4. Leaves small; plants prostrate (or ascending); leaves generally less than 2.5 cm. long, orbicular to oblong, not lobed; petioles generally less than 1 cm. long.
5. Leaves mucronate at apex.....Evolvulus glaber.
5a. Leaves rounded or notched at apex, not mucronate.
6. Styles separate nearly to the base.....Evolvulus nummularius.
6a. Styles united up to the stigmas.....Jacquemontia ovalifolia.
4a. Leaves large, generally more than 2.5 cm. long; petioles more than 1 cm. long.
7. Stems prostrate; leaves suborbicular, 6-10 cm. long, usually emarginate; plants fleshy.....Ipomoea pes-caprae.
7a. Stems twining; plants not succulent.
8. Leaves about 1 span long and wide, entire; sepals over 2 cm. long, 1.5 cm. wide.....Operculina grandiflora.
8a. Leaves much smaller; sepals less than 1 cm. wide.
9. Sepals linear, over 1.5 cm. long, hirsute.....Ipomoea nil.
9a. Sepals broad, less than 1.5 cm. long.
10. Sepals with a subulate appendage below the rounded apex about as long as the sepal-body.....Quamoclit coccinea.
10a. Sepals rounded or pointed at apex, but without a long appendage (a short appendage sometimes present).
11. Stigmas oblong; leaves densely pubescent; peduncles less than 1 cm. long; sepals 2-3 mm. long..... Jacquemontia nodiflora.
11a. Stigmas globose; leaves mostly glabrous, often with short hairs; peduncles generally over 1 cm. long.
12. Stamens and style more or less exserted in mature flowers; leaves entire; sepals about 4 mm. long..... Exogonium solanifolium.
12a. Stamens and style included.
13. Flowers umbellate, yellow; sepals obtuse, glabrous, about 8 mm. long; leaves entire..... Ipomoea polyanthes.
13a. Flowers not umbellate, red to purple; sepals acute, pilose, 5-6 mm. long; leaves usually 3-5 lobed... Ipomoea triloba.

Evolvulus glaber Spreng. (Urban).
Evolvulus nummularius L. (Wikström ex Urban) (Wikström ex Grisebach).
Note: Jacquemontia ovalifolia is easily mistaken for this species.
Exogonium solanifolium (L.) Britton. (herb. Stockholm ex Urban, as Jacquemontia solanifolia (L.) Hall. f.).
Ipomoea nil (L.) Roth. (herb. Stockholm ex Urban).
Ipomoea pes-caprae (L.) Roth. (herb. Stockholm ex Urban).
Ipomoea polyanthes R. & S. (Wikström ex Urban, as Merremia umbellata (L.) Hall. f.) (Wikström ex Grisebach, as Ipomoea umbellata Mey.).
Ipomoea triloba L. (herb. Stockholm ex Urban).
Jacquemontia nodiflora (Desr.) G. Don. (herb. Stockholm ex Urban).
Jacquemontia ovalifolia (Vahl) Hall. f. Questel 373.
Merremia pentaphylla Hall. f. (herb. Stockholm ex Urban, as M. aegyptica (L.) Urb.).
Operculina dissecta (Jacq.) House. (herb. Stockholm ex Urban, as Merremia dissecta (Jacq.) Hall. f.).
Operculina grandiflora (Jacq.) House. (Choisy ex Grisebach, as Ipomoea ventricosa Choisy).
Quamoclit coccinea (L.) Moench. (herb. Stockholm ex Urban).
Quamoclit vulgaris Choisy (herb. Stockholm ex Urban, as Q. pinnata (Desr.) Boj.).

CUSCUTACEAE

1. Flowers 2-3 mm. long; capsules conic-globose, mostly 1-seeded..... Cuscuta americana.
1a. Flowers 3-4 mm. long; capsules depressed-globose, often 2-seeded..... Cuscuta globulosa.

Cuscuta americana L. Questel 487, 488, 615, 619, 622, 862. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Cuscuta globulosa Benth. Questel 560, "sp. poor but seems to be C. globulosa Benth."--T. G. Yuncker, s.n., from Gustavia, determined by T. G. Yuncker.

BORAGINACEAE

1. Densely silvery-tomentose shrub with linear-spatulate leaves..... Mallotonia gnaphalodes.
1a. Plants not tomentose.
2. Leaves linear to linear-oblong, entire, inconspicuously veined, glabrous; fleshy annual.....Heliotropium curassavicum.
2a. Leaves not linear, conspicuously veined; plants not fleshy.
3. Flowers in scorpioid spikes; plants herbaceous.
4. Nutlets ovate, ribbed, glabrous; typical leaves 5-15 cm. long, undulate, rounded at base; petioles margined, more than 3 cm. long.....Tiaridium indicum.
4a. Nutlets subglobose, seemingly rugose with stubby hairs; typical leaves 2-6 cm. long, entire, narrowed at base; petioles less than 2 cm. long.....Schobera angiosperma.
3a. Inflorescence varying from globose to paniculate; plants woody.

5. Leaves 1-2.5 cm. wide, ovate-lanceolate, acute at apex, entire; flowers secund.....Tournefortia volubilis.
5a. Leaves not as described above; flowers not secund.
6. Leaves papillose-hispid above.
7. Leaves 1-3.5 cm. wide, coarsely serrate almost to the base; inflorescence globose.....Varronia globosa.
7a. Leaves 4-15 cm. wide, coarsely serrate only toward the apex or entire, inflorescence paniculate.....Sebesten sebestena.
6a. Leaves smooth and glabrous above.
8. Calyx less than 1.5 mm. long.....Ehretia tinifolia.
8a. Calyx more than 3 mm. long.....Bourreria succulenta.

Bourreria succulenta Jacq. Questel 90, 382, Forsström s.n. (Urban) (Wikström ex Grisebach).
Ehretia tinifolia L. (Wikström ex Grisebach).
Heliotropium curassavicum L. Forsström s.n. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Mallotonia gnaphalodes (L.) Britton. Questel 612. (herb. Stockholm ex Urban, as Tournefortia gnaphalodes (L.) R. Br.) (Wikström ex Grisebach, as Tournefortia gnaphalodes (L.) R. Br.).
Schobera angiosperma (Murr.) Britton. (herb. Stockholm ex Urban, as Heliotropium parviflorum L.) (Wikström ex Grisebach, as Heliotropium parviflorum DC.).
Sebesten sebestena (L.) Britton. (herb. Stockholm ex Urban, as Cordia sebestena L.).
Tiaridium indicum (L.) Lehm. (Wikström ex Urban, as Heliotropium indicum L.).
Tournefortia volubilis L. Forsström s.n. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Varronia globosa Jacq. (Euphrasén ex Urban, as Cordia globosa (Jacq.) H.B.K.) (Wikström ex Grisebach, as Cordia bullata R. & S.).

VERBENACEAE (Questel specimens determined by H. N. Moldenke).

1. Leaves normally entire.
2. Leaves mostly more than 8 cm. long; stems unarmed.
3. Leaves coarsely and sparsely reticulate-veined; pyrenes 1-celled; flowering pedicels 2 mm. long.....Citharexylum caudatum.
3a. Leaves densely reticulate-veined; pyrenes 2-celled; flowering pedicels shorter.
4. Flowering pedicels less than 1 mm. long; drupes subglobose.....Citharexylum fruticosum.
4a. Flowering pedicels 1-1.5 mm. long; drupes obovoid-oblong.....Citharexylum spinosum.
2a. Leaves mostly less than 7 cm. long; stems often spiny.
5. Spines numerous, stout, much widened at base, mostly less than 8 mm. long; flowers in cymes.....Clerodendrum aculeatum.
5a. Spines, when present, slender, up to 2 cm. long; flowers in racemes.....Duranta repens.
1a. Leaves toothed.
6. Leaves 1-4 cm. long, crenulate, rugosely and densely reticulate, rounded at apex.....Lantana involucrata.
6a. Leaves not rugosely reticulate-veined.

7. Leaves coarsely and sharply dentate with mostly less than 20 teeth toward apex, cuneate and entire at base, mostly less than 5 cm. long; flowers in cylindric heads.....Phyla nodiflora var. reptans.
7a. Leaves with more than 20 teeth, or, if less, flowers not in cylindric heads.
8. Leaves narrowed at base, decurrent along almost the entire length of the petiole, sharply serrate; flowers embedded in rachis-furrows.....Stachytarpheta jamaicensis.
8a. Petiole little or only narrowly margined; flowers not embedded in the rachis.
9. Leaves varying from entire to irregularly serrate with few teeth; inflorescence racemose; calyx puberulent.....Duranta repens.
9a. Leaves regularly serrate with many teeth.
10. Flowers in heads; calyx with straight hairs....Lantana camara.
10a. Flowers in racemes; calyx with hooked hairs.Priva lappulacea.

Citharexylum caudatum L. (Wikström ex Grisebach).
Citharexylum fruticosum var. villosum (Jacq.) O. E. Schulz. Questel 287. (Urban).
Citharexylum spinosum L. (Wikström ex Grisebach, as C. quadangulare Jacq.).
Clerodendrum aculeatum (L.) Schlecht. Questel 130. (herb. Stockholm ex Urban).
Duranta repens L. Questel 38. (Wikström ex Urban, as D. erecta L.) (Wikström ex Grisebach, as D. plumieri Jacq.).
Lantana camara L. (Euphrasén ex Urban) (Wikström ex Grisebach).
Lantana camara var. aculeata (L.) Moldenke. Questel 325, 326.
Lantana camara var. mista (L.) L. H. Bailey. Questel 396.
Lantana involucrata L. Questel 46, 58, Forsström s.n. (Euphrasén ex Urban) (Wikström ex Grisebach).
Phyla nodiflora var. reptans (H.B.K.) Moldenke (herb. Stockholm ex Urban, as Lippia reptans H.B.K.).
Priva lappulacea (L.) Pers. Questel 15, 252, 354.
Stachytarpheta jamaicensis (L.) Vahl. Questel 238. (herb. Stockholm ex Urban) (Wikström ex Grisebach).

AVICENNIACEAE

Avicennia nitida Jacq. (Urban).

LAMIACEAE

1. Leaves 3-parted into cleft segments.....Leonurus sibiricus.
1a. Leaves merely toothed.
2. Leaves deeply crenate, typically more than 3 cm. wide.
3. Leaves softly pubescent with short hairs; flowers in large dense heads; calyx over 15 mm. long.....Leonotis nepetaefolia.
3a. Leaves pilose-tomentose; flowers in whorls, forming an elongated raceme; calyx about 2 mm. long.....Coleus amboinicus.
2a. Leaves serrate or dentate, typically less than 3 cm. wide.
4. Flowers in secund spiked cymules; calyx densely bearded at the throat, its subulate lobes almost as long as the tube.....Hyptis pectinata.

4a. Flowers in simple racemes; calyx not densely bearded at the throat, its lobes shorter.
5. Calyx prominently nervose-reticulate, the lower lobes aristate.
6. Flowers very short-pedicellate; calyx long-ciliate..... Ocimum basilicum.
6a. Flowers manifestly pedicellate; calyx puberulent..... Ocimum micranthum.
5a. Calyx with prominent parallel nerves, the lower lobes not aristate.
7. Leaves mostly cordate or rounded at base.....Salvia serotina.
7a. Leaves mostly narrowed at base.....Salvia occidentalis.

Coleus amboinicus Lour. Questel 168.
Hyptis pectinata (L.) Poit. Questel 332, Forsström s.n. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Leonotis nepetaefolia (L.) R. Br. Questel 136.
Leonurus sibiricus L. (herb. Stockholm ex Urban).
Ocimum basilicum L. Questel 328.
Ocimum micranthum Willd. Questel 327.
Salvia occidentalis Sw. (herb. Stockholm ex Urban).
Salvia serotina L. Questel 19. (Wikström ex Grisebach).

SOLANACEAE

1. Leaves pinnately divided, the segments of various sizes, stalked..... Lycopersicum esculentum.
1a. Leaves not pinnately divided.
2. Leaves sessile; plants viscid-puberulent with densely glandular hair..... Nicotiana tabacum.
2a. Leaves petiolate; plants with simple or stellate hair (somewhat glandular in Datura metel).
3. Plants markedly stellate-pubescent; stems mostly armed with prickles.
4. Leaves more than 3 times as long as wide, narrowed at the base, not tomentose.....Solanum racemosum.
4a. Leaves less than 2 times as long as wide, obtuse to cordate at base, tomentose beneath.....Solanum torvum.
3a. Plants not stellate-pubescent; stems unarmed.
5. Plants shrubby; leaves entire or slightly undulate; calyx-teeth much wider than long.
6. Leaves ovate to ovate-lanceolate, typically 2-5 cm. long; fruit borne on a long pedicel issuing from the stem; pedicels 8-30 mm. long.....Capsicum frutescens.
6a. Leaves oblong or oblong-elliptic, typically 6-11 cm. long; fruit borne in a panicle, hardly pedicellate....Cestrum diurnum.
5a. Plants herbaceous; leaves more or less dentate; calyx-teeth longer than wide.
7. Capsules spinose; corollas more than 4 cm. long.
8. Capsules erect; plants glabrous to puberulent..... Datura stramonium.
8a. Capsules nodding; plants densely pubescent.....Datura metel.
7a. Berries unarmed; corolla less than 2 cm. long.
9. Berry enclosed by the inflated calyx; flowers solitary in the leaf-axils.

10. Leaves narrowed at base.....Physalis angulata.
10a. Leaves rounded to subcordate at base.....Physalis turbinata.
9a. Berry not enclosed by an inflated calyx; peduncles lateral, umbellately several-flowered.....Solanum nigrum.

Capsicum frutescens L. (Euphrasén ex Urban) (Wikström ex Grisebach).
Cestrum diurnum L. (Wikström ex Grisebach).
Datura metel L. Questel 414.
Datura stramonium L. (herb. Stockholm ex Urban).
Lycopersicum esculentum Mill. (herb. Stockholm ex Urban).
Nicotiana tabacum L. (herb. Stockholm ex Urban).
Physalis angulata L. (Wikström ex Urban) (Wikström ex Grisebach).
Physalis turbinata Medic. Questel 524.
Solanum nigrum L. Questel 410.
Solanum racemosum Jacq. Forsström s.n. (Wikström ex Grisebach).
Solanum torvum Sw. (Urban).

SCROPHULARIACEAE

1. Leaves on branchlets alternate.....Capraria biflora.
1a. Leaves opposite.
2. Leaves mostly reduced to minute, sessile, deltoid, acute scales; flowers more than 1 cm. long, paniculate.....Russelia juncea.
2a. Leaves normal, oblanceolate, coarsely serrate, tapering into a petiole at base; flowers small, less than 1 cm. long, solitary or in pairs in the leaf-axils.....Scoparia dulcis.

Capraria biflora L. Questel 214. (Urban).
Note: The Questel collection represents a glabrous form of the species.
Russelia juncea Zucc. Questel 190.
Scoparia dulcis L. Questel 8, 216. (herb. Stockholm ex Urban).

BIGNONIACEAE

1. Leaves simple, spatulate-oblanceolate, long-tapering at base, fascicled.. Crescentia cujete.
1a. Leaves compound (rarely 1-foliolate).
2. Leaves pinnately compound; leaflets serrate.....Tecoma stans.
2a. Leaves palmately compound; leaflets entire.
3. Leaflets small, about 7 cm. long, rounded at apex; capsules 5-11 cm. long.....Tabebuia heterophylla.
3a. Leaflets large, up to 20 cm. long; capsules 9-30 cm. long.
4. Apex of leaflets acuminate.....Tabebuia pentaphylla.
4a. Apex of leaflets rounded.....Tabebuia pallida.

Crescentia cujete L. Questel 231, 868. (Euphrasén ex Urban) (Wikström ex Grisebach).
Tabebuia heterophylla (DC.) Britton. Questel 138, 220, 239. (Wikström ex Grisebach, as T. triphylla DC.).
Tabebuia pallida Miers. (Urban, as Tecoma leucoxylon (L.) Mart.) (Wikström ex Grisebach, as Tecoma leucoxylon (L.) Mart.).

Tabebuia pentaphylla Hemsl. (Wikström ex Grisebach, as Tecoma pentaphylla Juss.).

Note: T. pentaphylla Hemsl. is regarded as synonymous with T. pallida Miers by Britton & Wilson in "Scientific Survey of Porto Rico and the Virgin Islands," volume 6, part 2, page 196 (1925).

Tecoma stans (L.) H.B.K. Questel 110. (Euphrasén ex Urban, as Stenolobium stans (L.) Seem.) (Wikström ex Grisebach).

ACANTHACEAE

(Note: No material of Justicia racemulosa Wikstr. has been seen by the present writer, hence its omission from the key.)

1. Calyx-lobes long-linear, about 2 cm. long, hirsute-ciliate; perfect anthers 4.....Ruellia tuberosa.

1a. Calyx-lobes mostly less than 1 cm. long; perfect anthers 2.

2. Inflorescence in the form of a long narrow panicle; pedicels slender, about 5 mm. long; leaves 1-2 dm. long, acuminate at apex.....Odontonema nitidum.

2a. Not as described above.

3. Flowers borne on thick pedicels; leaves 4-9 cm. wide, roundish at both ends; calyx-lobes 2-3 mm. long..Pseuderanthemum atropurpureum.

3a. Flowers sessile.

4. Inflorescence composed of panicled slender spikes; calyx-lobes 1-2.5 mm. long; leaves lanceolate, less than 3 cm. wide.....Justicia pectoralis.

4a. Inflorescence a thick spike or merely a few axillary flowers.

5. Flowers borne in spikes; bracts spatulate, prominent; stems constricted at the nodes; calyx-lobes over 5 mm. long.

6. Bracts foliaceous, exceeding the calyx; leaves ovate to elliptic-lanceolate.....Justicia carthaginensis.

6a. Bracts mostly exceeded by the calyx; leaves lanceolate.....Beloperone eustachiana.

5a. Flowers single or few, axillary; petioles less than 1 cm. long; leaves not acuminate; stems not constricted at the nodes.....Justicia sessilis.

Beloperone eustachiana (Jacq.) Benth. (Wikström ex Grisebach, as Adhatoda eustachiana Nees) (Grisebach, Fl. Brit. W. I., as Amphiscopia eustachiana Nees).

Justicia carthaginensis Jacq. Questel 24.

Justicia pectoralis Jacq. (Wikström ex Urban) (Wikström ex Grisebach, as Dianthera pectoralis Griseb.).

Justicia racemulosa Wikstr. (Wikström ex Grisebach, as Tetramerium racemulosum Nees).

Justicia sessilis Jacq. Questel 345.

Odontonema nitidum (Jacq.) Kuntze. (Wikström ex Grisebach, as Thyrsacanthus nitidus Nees).

Pseuderanthemum atropurpureum (Bull) L. H. Bailey. Questel 409, "in a garden."

Ruellia tuberosa L. Questel 191. (herb. Stockholm ex Urban).

MYOPORACEAE

Bontia daphnoides L. Questel 77.

RUBIACEAE

1. Plants herbaceous; stipules fimbriate.
  2. Flowers cymose, on filiform peduncles and pedicels; cilia on stipules about 1 mm. long.....Oldenlandia corymbosa.
  2a. Flowers in sessile axillary clusters; cilia on stipules over 2 mm. long.
    3. Leaves 1.5-3 cm. long, little narrowed at base, apex aristulate..... Diodia rigida.
    3a. Leaves 2-6 cm. long, narrowed at base into the short petioles, apex not aristulate.....Spermacoce tenuior.
1a. Plants woody; stipules entire.
  4. Leaves linear, less than 3 mm. wide, coriaceous, the margins strongly revolute so as to meet and hide the under surface.Strumpfia maritima.
  4a. Leaves not linear, more than 5 mm. wide, the margins little revolute.
    5. Leaves with 3-5 raised nerves parallel to the midrib..... Ernodea litoralis.
    5a. Leaves pinnately veined.
      6. Leaves cordate (or subcordate) at base, densely reticulate-veined and finely pubescent beneath, thick-textured....Guettarda scabra.
      6a. Leaves acute at base, not conspicuously reticulate, glabrous (pubescent in Guettarda parviflora).
        7. Flowers secund, in pedunculate cymes or compound racemes.
          8. Pedicels distinct, usually more than 2 mm. long.Chiococca alba.
          8a. Pedicels absent or less than 1 mm. long.
            9. Calyx truncate or with very short lobes; flowers many; new growth not viscid.....Antirrhoea lucida.
            9a. Calyx with subulate lobes as long as the tube; flowers few; new growth viscid.....Antirrhoea acutata.
        7a. Flowers not secund (see also Antirrhoea acutata).
          10. Flowers solitary in the leaf-axils, or clustered and scarcely pedunculate.
            11. Flowers solitary; pedicels distinct, about 5 mm. long; capsules oblong, woody.....Exostema caribaeum.
            11a. Pedicels absent; fruit a more or less rounded berry.
              12. Flowers solitary (sometimes appearing fascicled because of the very much shortened branches); calyx distinctly lobed.....Randia mitis.
              12a. Flowers clustered; calyx almost truncate..Coffea arabica.
          10a. Flowers several to numerous (rarely solitary in Guettarda), pedunculate.
            13. Calyx with long and broad lobes; typical leaves more than 10 cm. long.....Ixora finlaysoniana.
            13a. Calyx truncate or denticulate; leaves less than 10 cm. long.
              14. Cymes 1-3-flowered; petioles slender, pubescent..... Guettarda parviflora.
              14a. Panicles many-flowered; petioles thick, glabrous..... Erithalis fruticosa.

Antirrhoea acutata (DC.) Urb. Questel 347.
Antirrhoea lucida (Sw.) Hook. (Wikström ex Urban) (Wikström ex Grisebach, as Stenostomum lucidum Gaertn.).
Chiococca alba (L.) A. S. Hitchc. Questel 352.
Coffea arabica L. (Euphrasén ex Urban).
Diodia rigida (H.B.K.) Cham. & Schlecht. Questel 278.
Erithalis fruticosa L. Questel 261, Forsström s.n. (herb. Stockholm ex Urban).
Note: The Questel collection is the "E. odorifera Jacq." form of the species, with anthers 3.5-4.5 mm. long, acute-tipped.
Ernodea litoralis Sw. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Exostema caribaeum (Jacq.) R. & S. Forsström s.n. (herb. Stockholm ex Urban) (Wikström ex Grisebach).
Guettarda parviflora Vahl. (herb. Stockholm ex Urban) (Swartz and Wikström ex Grisebach).
Guettarda scabra (L.) Lam. (herb. Stockholm ex Urban).
Ixora finlaysoniana Wall. Questel 425.
Oldenlandia corymbosa (L.) DC. Questel 202.
Randia mitis L. Questel 39. (herb. Stockholm ex Urban, as R. aculeata L.) (Forsström ex Grisebach, as R. aculeata L.).
Spermacoce tenuior L. Questel 283.
Strumpfia maritima Jacq. (Wikström ex Urban) (Wikström ex Grisebach).

CUCURBITACEAE

1. Leaves deeply pinnately lobed, generally longer than wide..... Citrullus vulgaris.
1a. Leaves palmately lobed, about as long as wide,
2. Leaves divided into 3-5 short-stalked leaflets, glabrous..... Anguria pedata.
2a. Leaves not palmately compound; lobules not short-stalked.
3. Leaves lobed almost to the base, averaging about 5 cm. wide, sinuate-dentate; stems slender, about 1 mm. thick, not densely hispid..... Momordica balsamina.
3a. Leaves not as deeply lobed, averaging more than 6 cm. wide; stems usually more than 1.5 mm. thick.
4. Fruits capitate, 3-10 per cluster, armed with long spines..... Sicyos angulatus.
4a. Fruits not capitate, not armed with long spines.
5. Stems hispid; fruits tuberculate.....Cucumis anguria.
5a. Stems smooth; fruits smooth.....Cayaponia americana.

Anguria pedata Jacq. (Wikström ex Grisebach).
Cayaponia americana var. vulgaris Cogn. (Cogniaux ex Urban) (Forsström 1098 in herb. Leningrad ex Cogniaux in DC., Mon. 111: 787, 1881, as C. racemosa var. vulgaris Cogn.).
Citrullus vulgaris Schrad. Questel 702.
Cucumis anguria L. (Euphrasén ex Urban) (Wikström ex Grisebach).
Momordica balsamina L. (Euphrasén, cultivated, ex Urban).
Sicyos angulatus L. (Wikström ex Grisebach).

GOODENIACEAE

Scaevola plumieri (L.) Vahl. Questel 162, 611. (herb. Stockholm ex Urban). (Wikström ex Grisebach).

CICHORIACEAE

1. Achenes rounded above, flattened, about 0.75 mm. wide..Sonchus oleraceus.
1a. Achenes tapering above into a short beak, not flattened, about 0.5 mm. wide.....Lactuca intybacea.

Lactuca intybacea Jacq. Questel 139.
Sonchus oleraceus L. (herb. Stockholm ex Urban).

CARDUACEAE

1. Leaves opposite; pappus composed of several scales or awns or absent.
2. Leaves compound.....Bidens cynapiifolia.
2a. Leaves simple (often deeply trilobed in Melampodium).
3. Leaves 3-nerved near the base, without bristles.
4. Leaves entire, fleshy.....Borrichia frutescens.
4a. Leaves toothed or lobed (sometimes entire in Melampodium), not fleshy.
5. Fruit armed with many hooked prickles.
6. Terminal prickles much longer than the rest.....Acanthospermum hispidum.
6a. Terminal prickles not elongated.....Acanthospermum australe.
5a. Fruit unarmed.
7. Young leaves woolly-sericeous beneath; leaves frequently lobed..Melampodium americanum.
7a. Leaves not woolly-sericeous nor lobed.
8. Leaves crenate-dentate; inflorescence paniculate.....Ageratum conyzoides.
8a. Leaves serrate.
9. Most of the flower-heads subsessile in the axils of the leaves.....Synedrella nodiflora.
9a. Heads all pedunculate.....Melanthera aspera.
3a. Leaves single-nerved, with fine bristles at the base.
10. Leaves linear; bristles about 2.....Pectis linifolia.
10a. Leaves elliptic-spatulate; bristles about 6.....Pectis humifusa.
1a. Leaves alternate; pappus composed of capillary bristles (except in Parthenium).
11. Leaves deeply 1- or 2-cleft; pappus of 2 or 3 scales.....Parthenium hysterophorus.
11a. Leaves not lobed.
12. Leaves auriculate at base; involucral bracts of one length.....Emilia sonchifolia.
12a. Leaves rounded or acute at base; involucral bracts of several lengths.
13. Stem-leaves linear-lanceolate; plants herbaceous.....Leptilon canadense.
13a. Stem-leaves ovate to elliptic; plants woody.

14. Pappus in 2 series, the outer series of much shorter scales.
15. Heads subtended by leaf-like bracts.....Vernonia arborescens.
15a. Heads in dense corymbs without leaf-like bracts.....
Vernonia albicaulis.
14a. Pappus in 1 series; inflorescence corymbose....Pluchea odorata.

Acanthospermum australe (Loefl.) Kuntze. (Wikström ex Grisebach, as A. xanthioides DC.).
Acanthospermum hispidum DC. Questel 71.
Ageratum conyzoides L. (Wikström ex Urban) (Wikström ex Grisebach).
Bidens cynapiifolia H.B.K. (herb. Stockholm ex Urban, as B. bipinnata L.).
Borrichia frutescens DC. (Wikström ex Grisebach).
Emilia sonchifolia (L.) A. DC. (herb. Stockholm ex Urban).
Leptilon canadense (L.) Britton. (herb. Stockholm ex Urban, as Erigeron canadensis L.) (Wikström ex Grisebach, as Erigeron canadensis L.).
Note: Britton in Scient. Surv. Porto Rico 4: 296 (1925) states that the Erigeron canadensis of Urban is Leptilon pusillum (Nutt.) Britton.
Melampodium americanum L. (Wikström ex Grisebach).
Melanthera aspera (Jacq.) L. C. Rich. (herb. Stockholm ex Urban).
Parthenium hysterophorus L. Forsström s.n. (herb. Stockholm ex Urban).
Pectis humifusa Sw. (Urban) (Wikström ex Grisebach).
Pectis linifolia L. (herb. Stockholm ex Urban) (Wikström ex Grisebach, as P. linifolia and P. punctata Jacq.).
Pluchea odorata (L.) Cass. (herb. Stockholm ex Urban).
Synedrella nodiflora (L.) Gaertn. (herb. Stockholm ex Urban).
Vernonia albicaulis Pers. Forsström s.n. (Urban, as V. longifolia var. vahliana (Less.) Urb.).
Vernonia arborescens (L.) Sw. (Wikström ex Grisebach).

MAHOGANY LOGGING IN BRITISH HONDURAS

W. A. Miller*, Gold Coast, Africa

This short account of a logging system applied by a large land-owning company in British Honduras is not typical of general logging practice in the colony. Too often, the substitution of mechanical road power for cattle haulage is the only important advance on the methods of half a century ago. The limitations of cattle haulage have saved for today's tractors areas which were once inaccessible, but which are so no longer. Forest, to a depth of several miles along the river banks, was so heavily overcut in the past that much of it is unlikely to produce mahogany again. A more enlightened view of exploitable size by Government (in Forest Reserves) and by the larger land-owners promises a greater degree of safety for the areas now being cut.

Mahogany, Swietenia macrophylla, occurs in "good" forest at an average rate of one mature tree to every two acres; better stocking than this alternates with areas where the distribution is much more sparse. The species is found in very mixed forest, but with the exception of occasional trees of Cedrela mexicana, no other is of much more than local importance—useful in the bush for wagon-, bridge-, and house-building.

The mahogany areas in the north of the colony cannot be termed "flat," though neither mountains nor high hills are found there. The country switch-backs gently in low hills, at most two or three hundred feet above the general level. Some of these form long ridges, sufficiently steep to constitute extraction difficulties. Small streams, many of them dry except during the heavier rains, are fairly frequent and swamps of varying type and degree are common.

The particular logging area to be described lies, at its closest point, some 19 miles from a fresh-water lagoon, out of which flows a good-sized river; this river is navigable for boats of 80 or 90 tons burden. The rafting distance from the head of this lagoon where the logs first enter the water to Belize, on the coast, where the sawmill is situated, is in the neighborhood of 200 miles. Half a dozen additional miles of rail and some creek improvement would cut this distance by half, and would also obviate the dangers of nearly 100 miles of sea rafting.

From the head of the lagoon a 3-foot-gage railway runs 14 miles to what was, a few years ago, the main logging camp. A steam locomotive provided hauling power until recently, but has now been replaced by a more efficient Diesel machine. A train of 100 logs can be hauled without difficulty.

The terminus of this line is met by a 2-foot-gage tramway, powered by two Diesel units and the original petrol machine, the latter built by the

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*Note: Just before going on active service, Mr. Miller, formerly in British Honduras, submitted this article to the Conservator of Forests, Gold Coast, who kindly forwarded the paper to this office as being more suitable for presentation in the Caribbean Forester than in a West African Journal.

chief engineer from a superannuated tractor. Each of these can haul four cars, and each car can carry from one to three logs. High lead loading is employed in the transfer from one railway to the other, while a simple cross haul by a stationary tractor loads the light-rail cars.

Originally 5 miles long, the tramway has been extended, first to 7 and then to 9 miles from the main railhead, as the felling area became more distant. Tramway extensions should take place about once in 3 years. The relation between the length of the dry season and the tractor power available sets a limit to economic road haulage.

Extensions are generally based on old but recently used main hauling roads, though modification is sometimes necessary in order to shorten distances, to reduce grades, or to lead to a new barquedier that could not be suitably sited on the old main route. Barquediers are the clearings at railhead or waterside to which logs are hauled pending the next stage in their transport, and are also usually the site of the main logging camp. As work advances, this main camp becomes the base camp, and a new barquedier is made.

The life of such a camp may be from 5 to 8 years, in all. As the base camp, it may house 700 or 800 men, women, and children. The site must be carefully chosen, and an adequate water supply assured, either directly from a good stream, or if necessary by a pipe line from a not too distant source. "Camp" does not adequately describe the housing of the community. Individual thatched huts are built, each consisting of 2 small rooms and a kitchen. An office, a commissary, and a school-church are built, generally of good "reject" mahogany lumber. A small bush sawmill at the waterside provides house and bridge material, railway sleepers (once of pine, now mainly and satisfactorily of mahogany), and truck parts.

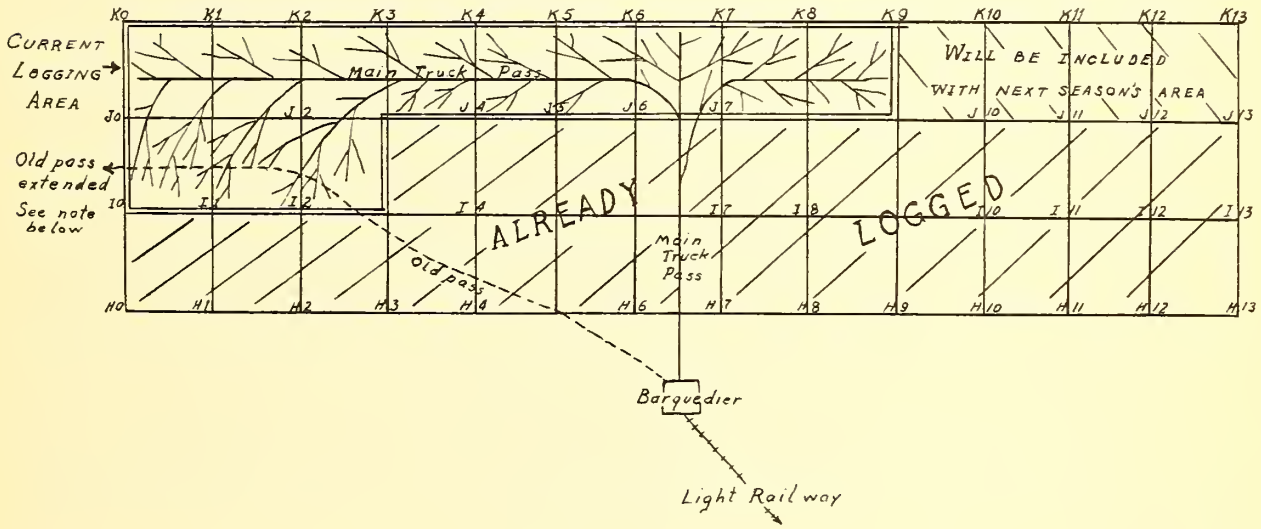
Almost all work is by task, and day labor is only resorted to when work is not of a routine nature and impossible to assess in terms of piece work. The measure of a task is, in most branches of the work, an unwritten law. For example, a road-cutting task is 50 yards in length, with a width of from 12 to 18 feet, according to the importance of the road. A felling task is 18 feet in girth, whether made up of one tree, two trees, or one tree and a half. A skilled man often finishes his work by 10 o'clock in the morning; the best of the laborers are highly skilled, but these are becoming fewer with every year that passes.

The annual requirement of the operation in question is approximately 2,000 to 2,500 trees, 5,000 to 6,500 logs. Some years ago, a little "key" cruising and gridding was done, and a rough map was prepared of the area now being worked and lying ahead. Operations today are based on an extension of this first grid. The area is divided into mile squares by cruising lines 8 feet wide, running from north to south and from east to west. The north-south lines are lettered, the east-west lines numbered. Signboards, giving the coordinates, are placed at each intersection, as for example "E7." Unfortunately, little gridding is done in advance, each year's area being cut off and added to the system as the previous year's logging is ended. Line "K" was reached in 1938, while the east-west lines numbered 0 to 13. Normally, one north-south line is added each year along this 13-mile front, but compactness of working often calls for a reduction in the length of a strip,

with an increase in its depth; irregularities creep in in other ways. The area to be worked in one season depends to some extent on the intensity of stocking, but may be estimated at approximately 10 square miles.

Old main hauling roads, which probably reached in the past year to the margin of the new area, may be extended, but light railway extensions, new barquediers, or a move from north to south of the area may make this impracticable.

In deciding extraction routes, a sketch map of the area is prepared, showing the position of the barquedier, existing main routes, and old and new cruising lines; temporarily overlooking topographical difficulties (hills and swamps) or inequality in density of stocking, a theoretical, ideal main route can be drawn. Roughly speaking, either main truck passes or main secondary passes should bisect each individual square-mile block, and the object throughout is obviously to take all wood to the barquedier by the shortest possible route—with as little cutting of expensive main pass as possible. Assuming that a new section consists of a long strip, 1 mile wide, the ideal main route inside the area would bisect the strip, running through the center of each block. Irrespective of the shape of the section, this rule can be modified to suit it. (See below).



Note.—If an old truck pass has its head near "13", it might be extended to take the wood in the three I to J blocks, thus reducing the hauling distance for these blocks without cutting much additional main road.

Meanwhile, the necessary cruising lines are extended to cut off the new blocks required, and the mahogany "hunters'" work begins. According to the direction in which the main or secondary roads will run through their centers, each block is halved by a trail rapidly cut from cruising line to cruising line by hand compass. Two hunters, each with an assistant, go into each half block in turn to find all mature mahogany trees there; they

are instructed to mark trails from all trees found to the center line, already cut. These men are experts and few trees escape their narrow quartering of the ground. In the past (and still, in many other similar operations) hunters went into vast, vaguely delimited areas to find the trees. They did not have the benefit of demarcated blocks, and the result was often extraction by unnecessarily devious routes and the complete overlooking of considerable patches and belts of forest.

As each block is reported hunted and the trees "trailed out" to the center lines, a quick, rough traverse is made of the more important trails, say those into which 50 or more trees are to be fed. The hunters are becoming accustomed to the new methods and trails are becoming straighter, though this traverse still reveals many trees going the "wrong way round" to the main trail; it also discovers the difficulties of swamps and hills. These difficulties are investigated and the minimum deviations are made from the shortest "paper" route.

Ultimately, the whole system of trails has been satisfactorily traversed, roughly plotted, and altered where necessary; the cutting of the roads based on these trails can now proceed. Leveling and grading of main roads follows, with the construction of what bridges are necessary; no metalling* or other surface treating is done, and corduroy is laid only on unavoidable soft or wet stretches, unlikely to be firm in the dry season. About November, felling commences. Accurate (max. error 2%) topographical and vegetation maps are now prepared and added to those of previous years. Every cruising line, permanent or semipermanent stream, and truck pass is traversed, form lines sketched, incidence of mature mahogany marked, and the type of vegetation indicated. As far as possible no notable feature is omitted. Traversing is accomplished with a 100-foot chain and a remarkably accurate hand compass at the rate of 5 miles or more per day. Traverses are plotted daily on 1-inch graph paper, on a scale of 1 inch to 10 chains. This paper, already scaled and with more than sufficient north parallels "ready made," makes plotting easy. It is perhaps worth noting that closing errors were always less than 1%, and that lines cut between points 2 miles or more apart, on bearings read from the map, generally finished within 50 feet of their objective.

In 3 years, a topographical and vegetation map of 80 square miles was built up in this way. Tracings were made of the maps produced each year and, later, a composite tracing was completed. Reduced photostatic copies should prove useful, and, in a country lacking accurately detailed maps, their value is obvious.

Felling starts in November and continues at intervals up till and even after logging starts in March. A well-established belief is that the quality and durability of the logs depends to a great extent on the phase of the moon at the time of felling. Even in a commercial undertaking of this size, the belief is respected, and felling is only done during some 20 days of the month, from 5 to 7 days before full moon until 12 or 14 days after it. All felling is done by the ax; good mahogany laborers are expert axmen, and an attempt to introduce saw-felling some years ago was not successful.

The exploitable size or minimum felling girth for mahogany is, in this case, 8 feet--measured above the spurs or buttresses. These buttresses

*Covering with broken stone.

may be anything from 2 or 3 feet to 12 or 15 feet in height. The general practice is to fell the trees above the buttresses (most of the timber is exported in the log), but for some years the trees in this instance have been cut at a point where the fullness of the bole cylinder tapers into the basal star of the buttresses, a point which may be roughly located at the mid-height of the spurs. The spurs remaining on the butt log are trimmed. This procedure was made possible by the acquisition of a modern sawmill and the export, not of logs, but of lumber. Market considerations have, however, caused a reversion to the older, and from a forestry viewpoint more wasteful, method of felling.

From the minimum girth of 8 feet, trees are found up to 30 feet girth in forest which has never been logged before. One 33 feet 8 inches was measured by the writer, but the tree was not felled. Besides being of very doubtful soundness, the difficulties of extracting such giants and the havoc wrought by them on equipment are seldom justified.

Before clearing the felled trees of branchwood, some time is allowed to elapse, the longer the better. The incidence of pinworm and sun-crack is definitely associated with the length of time the drying logs remain out of water. Trees from which branches and foliage have not been removed naturally dry more slowly than those cleaned immediately after felling.

Before any but the most obvious branchwood has been removed, the trees are marked for cross-cutting into logs. Accepted lengths for ultimate conversion must be correlated with the form of the tree, and marking calls for both experience and intelligence; it cannot be left to the sawyers.

Sawing follows; two-handed, cross-cut saws are used, though a strong case could be made out for the introduction of portable machine saws.

A week or two before the truck passes have dried sufficiently for hauling to start in earnest, it is usually possible to "bed" logs from the smaller, branch roads. This consists simply of dragging single logs on the ground by tractor and "choker" wire-rope from the small roads, and piling them at suitable wide points where these roads join the main truck passes.

In a normal year, trucking starts before the middle of March and continues until the end of May or the beginning of June. All logs must reach the barquedier during these ten or twelve weeks, for with the start of the rains the roads quickly become unusable. Even this short dry season may not be unbroken; sufficient rain may fall in a few hours to stop hauling for several days.

Crawler tractors of from 30 to 80 hp. are used; each pulls from two to five trucks according to its power, and each truck, under ideal conditions, is capable of carrying 2,000 super feet of mahogany logs. Tractors load their trucks by a simple system of cross haul with chains, and unload by pushing against the sides of the logs with a T-shaped bar of iron and wood. Fuel and service stations are established on the barquedier. Drivers and loaders are paid either on a trip basis or on the log measure of the loads they bring. Work starts at 2:30 a. m. and continues till nightfall or later.

As the logs come into the barquedier, they start to flow down the light railway to the main line and the water. Their progress cannot keep pace with road haulage, but unlike road haulage, railway work can go on irrespective of the seasons. Nevertheless, the shorter the time during which logs lie on the barquedier, the better; pinworm damage and sun-cracks multiply rapidly, and depreciation becomes considerable after 6 months in the sun.

At the waterside the logs are dropped into the lagoon immediately and secured inside a boom. A raft usually consists of 400 to 500 logs, and is towed under power by lagoon, river, and sea to the sawmill in Belize, where ruthless log measurement causes the bush staff to believe that wood must shrink in water.

Long before the last logs reach the mill, bush preparations for next season's harvest have started.

Resumen

El sistema de extracción de madera descrito es el explotado por una compañiá que tiene grandes tenencias de terreno en la Honduras Británica. El área donde está ubicada esta compañía se encuentra a 19 millas de una laguna desde donde las maderadas tienen que recorrer 200 millas por río y mar para llegar al aserradero. Los troncos son transportados hasta la laguna en camiones y por ferrocarriles de vía estrecha. Los campamentos principales consisten de 700 a 800 personas y se mudan cada 5 a 8 años. Casi todo el trabajo se hace por ajuste.

El área se divide en cuadrados de 1 milla por medio de líneas letradas que corren de norte a sur y de líneas numeradas que corren de este a oeste. Para determinar las rutas de extracción se hace un croquis general en donde aparecen el campamento y los caminos principales. Las vías más deseables son las más cortas, e ideales, aquellas que pasan por el medio de los cuadros. Los buscadores de caoba cuartean las áreas localizando árboles y abren brechas por el paso más corto al camino más cercano. Por último, todo el sistema es trazado y llevado al plano y entonces se efectúa la construcción de caminos.

Las tumbas empiezan en noviembre, usando el hacha solamente, y se ajustan a la creencia local de la fase apropiada de la luna. El mínimo en periferia de los árboles para la tumba es de 8 pies. Al árbol no se le quita el ramaje inmediatamente. Así se seca con más lentitud y se reduce el daño causado por los gusanos y por el agrietamiento debido al sol. Después que hombres de experiencia marcan el largo de las trozas, se corta el ramaje y los troncos son aserrados al través.

Debido a las condiciones atmosféricas, el acarreo por camiones se limita normalmente al período desde mediados de marzo hasta fines de mayo o principios de junio. Las trozas son arrastradas por tractores con cables hasta los caminos por donde pasan los camiones. Desde allí, tractores de orugo de 30 a 80 caballos de fuerza y que tiran de 2 a 5 camiones, cada uno con 2,000 pies en trozas, los arrastran hasta los ferrocarriles de vía estrecha. Entonces pasan a la línea principal y luego al agua. Al llegar a la orilla del agua son lanzadas en la laguna y remolcadas hasta el aserradero en Belize por embarcaciones de motor en maderadas de 400 a 500 trozas.

EXOTIC TREES AT A TROPICAL HILL STATION

C. Swabey
Conservator of Forests, Jamaica

To a forester accustomed to the hot, steamy lowlands and arid, rocky hills of the tropics a visit to the Hill Gardens of Jamaica is a foretaste of Paradise.

In 1868 the Government of Jamaica became interested in encouraging the cultivation of Cinchona and to this end purchased a property of 600 acres in the Blue Mountains, at an elevation of 4,500 - 6,000 feet. The cultivation of a number of species and hybrids (mainly C. ledgeriana and C. succirubra) was carried out, but after many vicissitudes the Cinchona fields were finally abandoned in 1884 and the station was put on a minimum care and maintenance basis in 1899. The invasion of the quinine market by the East Indies, aided by extremely low labor rates there, had led to such a weakening in the market value of bark that economic cultivation became no longer possible in Jamaica. Meanwhile, a considerable amount of planting of economic and ornamental trees had been carried out around the station buildings, in the adjoining abandoned cinchona fields, and along trails. The old station grounds are now maintained as a public garden and are beautiful in the extreme. The terraced lawns are bordered with rhododendrons and azaleas, while strawberries, raspberries, peaches, loquats, and tree tomatoes abound. In the gardens are many temperate and subtemperate trees, of which the following is a selection of those thriving well:

Acacia dealbata
A. decurrens—Recently planted and doing very well.
A. melanoxylon
A. molissima—Recently planted and doing very well.
Acer sp.—These maples form a beautiful avenue.
Araucaria excelsa—One large tree.
Calistemon lanceolatus
Casuarina montana
Cryptomeria japonica—Growing straight and clean in woodland; seed sometimes germinate.
Cupressus funebris
C. lawsoniana
C. lusitanica
C. sempervirens
Eucalyptus ficifolia—A few trees only, a lovely ornamental.
E. globulus—Not so straight growing, but of the same size as E. viminalis.
E. viminalis—Abundant and regenerating, up to 100 feet high and 4 feet in diameter, straight growing.
Grevillea robusta—Naturalized but does not grow to a very large tree.
Liriodendron tulipiferum—One magnificent specimen.
Melaleuca leucodendron

Morus nigra--I have not seen the mulberry fruiting, but I am told it has done so.
Pinus canariensis--Growing well.
P. massoniana--Does very well--up to 80 feet tall and 2 feet 6 inches diameter; fruits abundantly but seed sterile.
P. palustris--Slow growing.
Pittosporum undulatum--This small Australian ornamental evergreen tree regenerates profusely and dominates the woodland understory.
Podocarpus elongatus--Grows luxuriantly--a tree to 70 feet tall and 2 feet diameter; regenerates profusely.
Quercus cerris--Grows well.
Q. ilex
Q. robur--Not very happy.
Q. suber--Good cork formation.
Sapium jenmani--One of the South American rubbers, does well.
Thuya plicata

The following are represented but are not particularly vigorous, while in some cases I have not been able to find them, though previously reported as growing:

Taxodium distichum (not found)
Taxus baccata (not found)

At present this station is accessible only by narrow bridle paths, but when this part of Jamaica is developed with roads, the silvicultural lessons to be learned from these plantings will be of enormous value in planning afforestation schemes.

Resumen

En el 1868, el gobierno de Jamaica estableció una estación para experimentar con Cinchona a una altura de casi 5,000 pies en las "Blue Mountains." Más tarde, debido a una baja en el precio de la quinina, se abandonó el trabajo, pero los bellos terrenos de la vieja estación que habían sido sembrados de muchos árboles de importancia económica y de ornamentación, se conservan como un jardín público. La lista de árboles es una selección, de aquellos que crecen bien en ese sitio.

Note: Having enjoyed the pleasure of visiting these beautiful and interesting gardens, I would like to supplement this article by stating that this is one of the most attractive spots in the West Indies. Coupled with all those beautiful features of the tropics which one comes to love, such as palms, striking flowers, luxuriant foliage, steep mountain peaks, and distant vistas of blue seas, are enough patterns from the northern climes--oak leaves, conifers, peach trees, etc.--to satisfy that deep-buried longing for those familiar things which are interwoven with childhood memories. For further description of the area, see the short article in Science, Vol. XVIII, No. 450, pp. 210-211, written by Duncan S. Johnson in 1903.--L.R.H.

USE OF BRITISH HONDURAS WOODS FOR RAILWAY SLEEPERS OR CROSS TIES

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British Honduras

The British Honduras Government Railway was completed in 1908. It ran a distance of 25 miles from the coast westwards up the Stann Creek valley. The gage of the railway was 3 feet, the rails were 40-pound standard, flat bottom, 30 feet long, and the roadbed was ballasted with limestone chips of all sizes up to 6 inches. The railway was in continuous use from 1908 until 1939, when the rails were removed and the track bed converted into a metalled* road. It is difficult to give exact figures for the daily quantity of traffic that passed up and down the line, as this varied considerably over indefinite periods. On the average, it may be said that there were three trains of up to 200 tons in weight every week and intermittent motor and pump cars daily, extending over the whole 31 years. In addition, there were freight trains often running two or three times a day over short periods during timber operations and the citrus seasons.

The annual rainfall of the areas is high and ranges from approximately 84 inches in Stann Creek town, situated on the coast, to 140 inches at the head of the railway, spread fairly evenly over 7 months of the year. There is a marked dry season from the latter part of January to the beginning of May. The mean monthly relative humidity at a station about half way up the line ranged from 76% to 84.7%, with an annual average of 80.8%. Mean monthly temperatures averaged from 74 to 80.8° F., with an annual mean of 78° F.

The track was completely overgrown with grass, which was kept down by occasional cutting with machete and rare applications of chemical weedicide. In recent years, financial difficulties prevented adequate track maintenance.

Until 1914, railway sleepers of Norwegian and American pine were imported. The size of the sleepers was 7 feet by 8 inches by 6 inches. They were treated with creosote oil with an absorption of 12 lbs. to the cubic foot, and the average length of life was estimated at 12 years.

After 1914, no more sleepers were imported and up to 1933 native hardwoods were employed. From 1933 until the abandonment of the railway in 1939, all replacements were of British Honduras pine, Pinus caribaea. It is proposed to describe the hardwood and softwood sleepers separately.

Native hardwood sleepers.--The principal species used was Santa María, Calophyllum brasiliense var. rekoi, although Symphonia globulifera, Terminalia amazonia, and some other woods were also utilized. The sleepers were supplied by contractors, being hewn to 7 feet by 8 inches by 6 inches, chiefly from poles and small trees. It was the practice, largely on account of financial stringency, to arrange contracts on a short-term notice, with the result that as soon as they were cut the sleepers were required for

*Surfaced with crushed stone.

replacements and were seldom given an opportunity for seasoning. The limestone ballast tended to become mixed with dirt and to consolidate, thus inducing very poor drainage conditions. Once a sleeper was placed in the track, there was little chance of further drying out, and the very reverse was an all too common occurrence. Conditions for attack by fungi were ideal and much damage was done in this way, often followed by termites, resulting in a rapid deterioration of the sleeper and necessitating frequent renewals. Decay was most serious at the shoulder and the practice of spiking the rail directly into the sleeper caused mechanical cracking which afforded a good point of entry for the fungus. The average life of an unseasoned, untreated sleeper was approximately 3 years, though in many cases replacements were necessary after 2 years. Despite the rapid deterioration of these hardwood sleepers, their use was found to compare favorably, financially, with the imported treated ties, and timber was being utilized that might otherwise have been burnt when plantations were being made. The employment of local labor was another important point in favor of using native hardwood ties.

Tests were carried out by the railway to determine the effect of brush treatment with creosote, but the results were inconclusive, as the majority of ties were not properly seasoned at the time of treatment and the absorption of creosote was negligible. It was found that the length of life was increased by a year to 18 months, but this result cannot be taken as a fair example of the resistance of a properly treated sleeper.

Efforts were made to improve the seasoning methods used in the past. The common practice had been to stack the sleepers in a solid pile under a low thatch cover, and vegetation was usually permitted to grow up close to the pile on three sides, with the consequence that fungal attack often started during the so-called seasoning process. As a result of these tests, it was found most advantageous to pile the sleepers 8 by 1, built up on racks 18 inches above the ground at the high end and 12 inches at the low end, allowing for an interval of at least 4 months and preferably 6 months before placing the ties in the track. By this time the moisture content of the timber would be in the neighborhood of 20%. There are no track records available to show the effect of proper seasoning on the life of a sleeper, but the general indication is that there is no very great increase in life, although a total life of 4 to 5 years might reasonably be expected.

In 1928, a shipment of 1,000 native hewn hardwood ties was sent to Jamaica. Two-thirds of this number were placed in the track on a hilly section subject to heavy rainfall and used by an average of 4 trains per day. The remaining third were used on a hilly section subject to long dry periods, used by an average of 6 trains per day. The sleepers had been seasoned for 3 - 4 months before being placed in the track and were not treated in any way.

The sleepers on the wet section showed marked fungal and termite damage after 4 - 5 years and were then due for replacement. On the dry section, the termite attack was more pronounced, 80% of the ties being removed after 4 years and the remainder after another year. The Chief

Engineer of the Jamaican Government Railway reported that such sleepers were not suitable for use in Jamaica.

Softwood sleepers.--In 1933, a pine area of approximately 770 acres situated 10 miles from Stann Creek town was taken over by the Forest Department, and from that date all sleepers supplied to the railway were of Pinus caribaea. Blown, fire-killed, and small, crooked but mature trees were converted into sleepers during silvicultural operations, and the whole length of the tree was utilized. As a result of this practice, a large number of the ties were knotty, but in all cases such ties were accepted without question, and it must be pointed out that the knots were tight and the ties perfectly sound. The ties were hewn to 7 feet by 8 inches by 6 inches at the felling site and air seasoned for 4 - 6 months before being placed in the tract. The average life of these pine sleepers appeared to be rather less than that of the hardwoods, collapse at the shoulders often starting after 2 years and replacement usually necessary after 3 years, if not before. This system was still found to be economical compared with that of importing ties, and use was being made of otherwise unsalable timber, which was an important advantage, for it meant almost complete utilization of the pine.

In August 1934, a shipment of P. caribaea logs was sent to the Forest Products Research Laboratory at Princes Risborough and arrangements were made with the authorities there that they should convert a number of the logs into sleepers and carry out the necessary treatment. The size of the sleepers was to be 7 feet by 8 inches by 6 inches; they were to be cut only from the knotty tops of the logs, in order to demonstrate to the railway and also to other possible buyers that sleepers cut from such tops and treated by the open-tank method with earth-oil and creosote would give satisfactory service. In addition, this practice insured almost complete utilization of the log, as hitherto the knotty tops had been considered unsalable.

Forty sleepers, size as specified above, were cut from the smaller logs of the consignment, practically all containing boxed hearts, with sapwood on three or four sides. They were seasoned under cover for 14 months, when the moisture content of the sapwood was approximately 20%. Twenty sleepers were then treated by the open-tank process with a mixture of 45% petroleum fuel oil and 55% coal-tar creosote. The treatment consisted of heating to 180° F., maintaining this temperature for 2 hours, and then allowing to cool overnight. The average absorption was 8.2 lbs. per cubic foot, varying from 3.3 to 15.8 lbs. per cubic foot. The average percentage of sapwood present in the sleepers was 46, the lowest being 12 and the highest 75.

The ties were then returned to the colony and laid in the track in 2 separate plots, one on a level, open, dry site and the other on a 3% gradient in a cutting where damper conditions prevailed. Each plot contained 10 untreated and 10 treated sleepers, the latter being numbered so that a record could be kept of the resistance of the sleeper to fungal attack, etc., compared with the amount of absorption of preservative and the percentage of heart to sapwood.

An inspection of the ties was carried out after they had been in the track for $3\frac{1}{4}$ years and it was apparent at once that, whereas all the treated

ties were without exception perfectly sound, over 50% of the untreated ties showed signs of collapse under the rails and were due for replacement within the next 12 months. Fungal attack was more active on the wetter site.

In 1940, the railway was abandoned and the ties were removed after lying in the track for 4 years. They were stacked under cover, and later inspected, 4 months after their removal from the track. All the treated ties, regardless of their original absorption of preservative or the proportion of sap to heartwood, proved to be perfectly sound and showed no signs of collapse, spike killing, or fungal decay. All the untreated ties showed signs of fungus activity, whilst 63 per cent had collapsed at the shoulders, were badly decayed, and of no further use. The initial damage in all the condemned ties was collapse and fungal decay at the shoulders, where the sapwood had been totally destroyed and the heartwood also affected, but to a lesser degree. The sides, bottoms, and ends were for the most part only superficially attacked by the fungus, although there was a tendency for the decay to creep on either side of the affected shoulders. In three instances, the sapwood was completely decayed on the top and sides along the whole length of the sleeper. There were no cases of spike-killing that could be observed, although it is possible that such damage had occurred during the earlier decay of the now condemned sleepers.

It is now clear that hewn, untreated sleepers of some native hardwoods or pine are short-lived and suitable only for local use where the low cost of production and replacement makes them more economical in use than imported treated ties. Air-drying and sawing the sleepers adds slightly to the average length of life; however, it is much more prolonged by sawing, seasoning, and then treating the sleepers either in the open tank or under pressure with preservative. No adequate service trials have been made of treated hardwood sleepers, but the success of treated pine sleepers cut from knotty top logs and containing boxed heart as well as a considerable proportion of sapwood indicates a possible use for hitherto unsalable material. None of the woods investigated are termite resistant and are therefore useless for export without preservative treatment. The export possibilities of treated sleepers remain unexplored.

Summary

Native hardwood and coniferous timbers have been used to replace imported creosoted sleepers in the British Honduras railway. The chief species used were Santa María, Calophyllum brasiliense var. rekoi, and pine, Pinus caribaea, but Symphonia globulifera, Terminalia amazonia, and other hardwoods have been used to a more limited extent. The life of untreated, hewn hardwood sleepers is short; after 3 - 4 years they are badly damaged by fungi and termites and require replacement. Seasoning for 4 to 6 months in well-arranged piles on elevated racks under cover is believed to increase the life of such sleepers by 12 to 18 months. Similar sleepers of pine seasoned for 4 to 6 months have a shorter life of 2 to 3 years, as their resistance to fungus attack is apparently poor.

These sleepers are not termite resistant and their use locally has been encouraged in order to give local employment and to utilize material which would otherwise be wasted. The comparatively low cost of production and replacement in the line has permitted the economical use of such sleepers in place of the original imported sawn and treated sleepers.

Unseasoned, hewn hardwood sleepers have been "brush treated" with creosote on a small scale, but results were very inconclusive. The increased length of life was said to be 12 to 18 months.

Sawn, seasoned pine sleepers cut from knotty tops and containing boxed heart and sapwood on three or four sides were treated by open-tank process with a mixture of 45 per cent petroleum fuel oil and 55 per cent coal-tar creosote. Twenty of these sleepers under test in the local railway were found to be free of any defect after 4 years. Continuation of this experiment has been prevented by the conversion of the railway into a road, but the indications are that such knotty wood, hitherto unsalable, may successfully be used, with treatment, for sleepers.

Resumen

En la vía férrea de Honduras Británica se han usado maderas nativas de los coníferos y de especies de madera dura para reemplazar las traviesas creosotadas importadas. Las principales especies usadas fueron la santa maría, Calophyllum brasiliense var. rekoi, y el pino, Pinus caribaea. Symphonia globulifera, Terminalia amazonia, y otras especies de madera dura han sido usadas en menor escala. La vida de las traviesas labradas y sin tratamiento alguno es corta y después de 3 ó 4 años se deterioran malamente debido a los hongos y hormigas blancas, necesitando ser reemplazadas. Se cree que sazonando las traviesas por espacio de 4 a 6 meses en estibas bien formadas, levantadas del suelo y bajo cubierta, alarga la vida de éstas por 12 a 18 meses. Traviesas similares de pino, sazonadas durante 4 ó 6 meses, tienen una vida de 2 a 3 años más corta, puesto que su resistencia a los ataques de los hongos es aparentemente pobre.

Estas traviesas no son resistentes a la hormiga blanca y su uso local ha sido estimulado para así proporcionar trabajo y utilizar un material que de otra suerte se perdería. El costo relativamente bajo de producción y de reemplazamiento en la línea férrea ha permitido el uso económico de tales traviesas en vez de las importadas originalmente.

Algunas traviesas labradas y verdes de árboles de madera dura, se han pintado con creosota pero los resultados han sido inconclusos.

Traviesas de pino aserradas y sazonadas, cortadas de la parte nudosa de arriba del árbol, con corazón y albura en 3 ó 4 lados, fueron tratadas usando el proceso de tanques al descubierto con una mezcla de 45 por ciento de petróleo y aceite combustible y 55 por ciento de brea y creosota. Veinte de estas traviesas bajo prueba en la ferrovía local se encontraron libre de defectos después de 4 años. La continuación de este experimento ha sido impedida por la conversión de la ferrovía en una carretera, pero los indicios son que esa madera nudosa, hasta ahora invendible, puede usarse con buen resultado para traviesas después de someterla a tratamiento.

SOME NOTES ON FOREST ENTOMOLOGY IV

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Termites and Forest Trees

The common termite or "comején"—Nasutitermes costalis Holmgren (N. morio Latr.)—is the most important termite attacking forest trees in Puerto Rico. Shade and ornamental trees are also attacked. The trees on our roads and highways—especially the flamboyán, Poinciana regia Bojer; mango, Mangifera indica; algarrobo, Hymenaea courbaril; javillo, Hura crepitans; and almendro, Terminalia catappa—are very noticeably infested; the dark brown tunnels running over the trunk, often leading to a large nest on the main trunk or branch. Sometimes in smaller colonies the tunnels extend from nests on or in the ground to dead limbs or wounds in the trees. Observations show that the insect is more common on the lowlands and at altitudes less than 2,000 feet. Above this altitude the insect becomes scarcer and at 2,800 feet or more has not been noted.

For a more complete account of this pest see George N. Wolcott's Boletín 48, "Comején y Polilla," published by the Agricultural Experiment Station, Rio Piedras, P. R., March 1939.

The following is a list of the tree species on which the insect has been recorded:

Agati grandiflora (L.) Desv.
Albizzia lebbeck (L.) Benth.
Albizzia procera (Willd.) Benth.
Andira inermis H.B.K.
Annona glabra L.
Annona muricata L.
Artocarpus communis Forst.
Bixa orellana L.
Buchenavia capitata (Vahl.) Eichl.
Bucida buceras L.
Calophyllum antillanum Britton
Canangium odoratum (Lam.) King
Casearia decandra Jacq.
Cecropia peltata L.
Ceiba pentandra (L.) Gaertn.
Clusia rosea Jacq.
Coccolobis laurifolia Jacq.
Coccolobis uvifera (L.) Jacq.
Cocos nucifera L.
Cojoba arborea (L.) Britton & Rose
Cordia nitida Vahl.
Cordia sulcata DC.
Crescentia cujete L.
Dacryodes excelsa Vahl.
Dalbergia sissoo Roxb.
Poinciana regia Bojer
Dendropanax arboreum (L.) Dcne.
Didymopanax morototoni (Aubl.) Dcne.
Elaeodendrum xylocarpum (Vent.) DC.
Elaphrium simaruba (L.) Rose
Erythrina glauca Willd.
Eucalyptus robusta Smith
Eugenia monticola (Sw.) DC.
Euterpe globosa Gaertn.
Ficus elastica Roxb.
Ficus laevigata Vahl.
Ficus lyrata Warburg
Ficus stahlii Warb.
Guazuma ulmifolia Lam.
Hernandia sonora L.
Hura crepitans L.
Hyeronima clusioides (Tul.) Muell.
Hymenaea courbaril L.
Inga vera Willd.
Inga laurina (Sw.) Willd.
Jambosa jambos (L.) Millsp.

Krugiodendron ferreum (Vahl.) Urban
Leucaena glauca (L.) Benth.
Lonchocarpus glaucifolius Urban
Lucuma multiflora A. DC.
Mammea americana L.
Mangifera indica L.
Manilkara duplicata (Sessé & Moc.)Dubard
Melicocca bijuga L.
Metopium toxiferum (L.) Krug & Urban
Moringa oleifera Lam.
Persea gratissima Gaertn.
Petitia domingensis Jacq.
Pisonia albida (Heimerl.) Britton
Pisonia subcordata Sw.
Pithecellobium dulce (Roxb.) Benth.
Pithecellobium unguis-cati (L.) Mart.
Pterocarpus indicus Willd.
Quararibaea turbinata (Sw.) Poir.
Randia mitis L.
Rapanea ferruginea (R. & P.) Mez.
Sabinea florida (Vahl.) DC.
Sapota achras Mill.
Sideroxylon foetidissimum Jacq.
Spathodea campanulata Beauv.
Spondias cirouella Tussac
Spondias mombin L.
Sterculia apetala (Jacq.) Karst.
Swietenia mahagoni Jacq.
Tabebuia pallida Miers.
Tamarindus indica L.
Terminalia catappa L.
Torrubia fragrans (Dum-Cours)Standley
Trema lamarckiana (R. & S.) Blume
Trichilia hirta L.
Vitex divaricata Sw.
Zanthoxylum caribaeum Lam.
Zanthoxylum martinicense (Lam.) DC.
Z. monophyllum (Lam.) P. Wilson

In Mona Island, Kalotermes (K.) snyderi Light is the species of greatest economic importance, attacking both living trees and dead wood. This termite does not build tunnels or nests on the trunks of trees as does the preceding species. It works inside the wood, making quite a complicated system of galleries or tunnels. The following hosts have been found attacked:

Common name	Scientific name
Sanguinaria	Dipholis salicifolia (L.) A. DC.
Papayo	Metopium toxiferum (L.) Krug & Urban
Coral	Amyris elemifera L.
Almácigo	Elaphrium simaruba (L.) Rose
Uva de playa	Coccolobis uvifera (L.) Jacq.
Barbasco	Canella winterana (L.) Gaertn.
Rolón	Pithecellobium unguis-cati (L.) Mart.
Tabaco	Gymnanthes lucida Sw.

On the high altitudes (2,000 feet or more) in the island, two species are present: Kalotermes (Glyptotermes) pubescens Snyder is reported attacking Tamonea guianensis Aubl., and Cyrilla racemiflora L., at the Luquillo National Forest. In the same locality this termite infested the wood of many of the old cottages built of native wood. At the Guavate Unit, at 2,500-foot altitude, the species attacks large trees of Ocotea moschata (Pavon) Mez.

Of less important species, Nasutitermes (N.) acajutlae Holmgren (N. creolina Banks) has been recorded from algarrobo, Hymenaea courbaril L., at low altitudes and Nasutitermes (Tenuirostritermes) discolor Banks from sierra palm, Euterpe globosa Gaertn., at Guavate Unit at 2,500-foot altitude.

The "Corcho Prieto" Weevil

During the month of August 1940 a heavy outbreak of Prepodes quindecimpunctatus Olivier, the "corcho prieto" weevil, was noticed at Yabucoa. This interesting weevil previously recorded by Stahl and Gundlach was never thereafter reported or observed in the field. It was during this year that the insect was noticed feeding extensively on the foliage of corcho prieto trees, Torrubia fragrans (Dum-Cours) Standley.

P. quindecimpunctatus varies in size from 10 to 17 mm. long, is entirely of a blue-green iridescence, except for black eyes and mouth parts and several black spots on the body as follows: 15 spots on elytra and 4 on thorax. The species can be readily distinguished from any other species of weevil in Puerto Rico. Prepodes roseipes Chevr. is the nearest to it, but it is smaller in size and there are no black spots on its body.

Zethus rufinodus Latr., a Pest of Fence Posts

The eumenid wasp, Zethus rufinodus Latreille, is doing damage of considerable importance and may be considered as a pest of fence posts in the island. The insects have been noticed breeding and completely destroying fence posts of almácigo, Elaphrium simaruba. Posts of other tree species, which have not been identified, are attacked in the same manner.

Z. rufinodus is a very attractive wasp, very common around the vicinity of Tortuguero, on blossoms of Borreria verticillata and at Mona Island on flowers of Lantana camara. The adult wasps are about 18 mm. long, all black except for ochreous legs and petiole, which is ochreous with a posterior narrow band of a yellow color. The thorax shows several yellow spots and bands. Wings are smoky, with a very dark blue iridescence.

Resumen

La termita o comején que más ataca a los árboles en Puerto Rico es Nasutitermes costalis Holmgren. El artículo da una lista de árboles que este insecto ataca.

En la isla de la Mona la especie más común de termita es Kalotermes (K.) snyderi Light. Este comején ataca muchas especies de árboles. Comejenes de menor importancia y los cuales se encuentran por lo regular en las montañas altas de Puerto Rico son: Kalotermes (G.) pubescens y Nasutitermes (N.) acajutlae.

Prepodes quindecimpunctatus Olivier es un curculiónido que ataca las hojas del corcho prieto, Torrubia fragrans. Esta especie de coleóptero es muy rara en Puerto Rico.

Zethus rufinodes, una avispa bastante común, ataca a los postes de cercas en muchas partes de la isla. Actualmente se le considera como un insecto muy nocivo.

CONTRIBUCIONES AL ESTUDIO DE LA FLORA CUBANA

Gymnospermae

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A mi llegada a los Estados Unidos como becado de la Guggenheim Memorial Foundation, tuve la suerte de visitar en la Universidad de Chicago el conocido morfologista y especialista de Gymnospermae, Profesor C. J. Chamberlain, quien en más de una ocasión me había demostrado gran interés en cambiar impresiones sobre el problema taxonómico del género Zamia. En esta visita el Profesor Chamberlain no sólo tuvo la bondad de demostrarme la técnica de laboratorio, que me facilitaría grandemente el estudio de las Gymnospermae de Cuba, sino además me dió valiosos datos sobre sus observaciones de varios años, en el estudio morfológico y citológico de las Cycadaceae, todo lo cual de una manera indirecta me induce a presentar aquí unas notas provisionales sobre el género Zamia.

Al decir provisionales no lo hago con el propósito de evitar las críticas que esta parte del trabajo pudiera ocasionar; pero lo digo con el fin de aclarar que de acuerdo con el estado actual de nuestros conocimientos sobre el género Zamia, éste tendrá que ser rectificado, lo cual se puede comprobar por las condiciones actuales del tratamiento sistemático de este difícil grupo de las Cycadaceae, ya que los taxonómicos lejos del punto crítico, donde las plantas se encuentran, se han dedicado a darle nombre a individuos y no a especie, basándose en caracteres absolutamente inciertos, como son las hojas; dando esto por resultado que la mayoría de las descripciones son inaplicables, al estar basadas en un individuo con hojas un milímetro más anchas que la especie anterior, pudiendo unir así plantas con otros caracteres morfológicos muy distantes y de una distribución geográfica completamente opuesta.

Esta situación nos ha llevado a considerar seriamente las distintas razones que pudieran haber influído en el actual tratamiento del género Zamia, representado en Cuba por unas tres especies, las cuales se extienden desde las típicas sabanas de arena silícea en la Isla de Pinos y Pinar del Río a las numerosas colinas de caliza tan frecuentes en Cuba, o a las extensas sabanas de serpentina que desde la Habana llegan hasta Matanzas, Santa Clara, Camaguey y Oriente. Muchas otras veces las encontramos en las costas coralinas del Sur de Oriente, costa norte de la región central de la isla y costa del extremo oeste de Pinar del Río, entre una vegetación puramente xerofítica; o en las regiones montañosas de Oriente, donde estas plantas llegan hasta los 1,000 m. de altura y en las márgenes de los arroyos de toda la isla, junto a helechos y en un perfecto medio higrofítico.

De esta forma podríamos pasar de una localidad a otra y coleccionaríamos Zamia comprendiendo posiblemente varias especies y variedades además de un gran número de híbridos que se extienden entre una colonia y otra, resultando imposible determinar a que especie estos individuos pudieran pertenecer; no obstante estos híbridos no son un obstáculo para que podamos reconocer aquellas colonias o grupos de plantas capaces de conservar una serie de

caracteres hereditarios suficientes para constituir taxonómicamente una especie, a pesar de las variaciones geográficas y ecológicas.

Al mencionar híbridos debo aclarar que no me refiero al antiguo concepto de la Biología por el cual se consideraba como híbrido, sólo el resultado de un cruzamiento entre dos especies distintas, sin poder delinear con exactitud los límites de estas especies.

En el género Zamia, absolutamente todas las plantas son biológicamente híbridos, por ser éstas el resultado directo de un cruce entre dos individuos, uno con estrobilus o conos femenimos y el otro con conos masculinos, resultando imposible la fecundación del primero sin el concurso del segundo. Funcionalmente, podemos asegurar que hay pocas plantas tan típicamente dioicas como la Zamia o Cycadaceae.

La plasticidad del género Zamia es perfecta y las posibilidades de cruzamiento son muy grande, debido a su completa uniformidad en el número de cromosomas,* como por su sistema de polinización exclusivamente anemófila, para lo cual las plantas masculinas poseen generalmente de uno a tres conos con 100 ó 200 microsporofilos y un promedio de 25 esporangios en cada uno de los esporofilos, los cuales gradualmente dejan escapar las microsporas durante una o dos semanas que dura la dehiscencia, asegurando así la fecundación de las plantas más distantes de la colonia.

Si consideramos solamente las Zamia de Cuba, fácilmente podíamos ver tres grupos distintos y de gran afinidad, los cuales por razones geológicas, es decir, cuando Cuba estaba parcialmente sumergida en el mar, dos grupos de Zamia sufrían una evolución aislada en las dos únicas regiones no sumergidas de esta isla: una en Oriente y otra en Occidente, de donde más tarde partirían las inmigraciones que poblaron la parte llana central de Cuba, lugar al cual acababa de llegar otra corriente de Zamia procedente de las otras Antillas.

Con este punto de vista, es que me atrevo a presentar aquí el concepto de tres especies que representan tres centros de distribución de las Zamia en Cuba, sin pretender haber resuelto el intrincado problema de representar todas aquellas poblaciones de híbridos y variedades imposibles de comprender dentro de los límites actuales de las descripciones específicas.

Con esto no pretendo decir que se eliminarán combinaciones de relativo valor taxonómico; al contrario se usarán siempre que sea posible, adaptándolas no sólo a las condiciones intrínsecas de la especie o tipo, sino también a la interpretación dada al binomio en sí. Como ejemplo podemos senalar que nuestro punto de partida fué el buscar el nombre que se debía usar para aquella especie panantillana y de acuerdo perfectamente con las reglas de la nomenclatura botánica, encontramos que por prioridad, el binomio Zamia pumila L. debía ser el usado, reuniendo por suerte las condiciones de adaptarse precisamente a una planta que de manera arbitraria, podemos decir, conocíamos o interpretábamos como la especie antillana.

*Según trabajos en progreso del Profesor C. J. Chamberlain.

Esta misma suerte no la hemos tenido al seleccionar el binomio Zamia pygmaea Sims., no sólo porque éste no representa el típico grupo occidental de las Zamia de Cuba, ni por ser éste mas bien una forma de aquel, sino por la interpretación amplia que en la combinación nos vemos obligados a incluir, hasta llegar al punto donde no se puede decidir si los caracteres de Zamia pumila L. están presentes; sin embargo la combinación incluye lo que podíamos seleccionar como el verdadero centro de las Zamia occidentales de Cuba y las cuales desafortunadamente corroboramos con la idea de Z. silicea Britton, porque ese grupo procede de las sabanas silíceas de la Isla de Pinos y Pinar del Río, de donde esa especie fué descrita sin comprender en ella el verdadero sentido de la especie, como lo demuestra el tipo N. L. Britton, E. G. Britton y P. Wilson n. 14166, que es mas bien una forma de Zamia pumila L.; razón por la cual Schuster en Pflanzenreich 4(1):157 (1932) pasa esta especie a la sinonimia de Z. media Jacq. = Z. pumila L., en lugar de pasarla a la sinonimia de Z. pygmaea Sims. a la cual es tambien muy vecina.

Al presentar aquí una nueva especie de Zamia, creemos lógico el exponer las razones que nos induce a ello, ya que anteriormente he dicho que se habían hecho demasiadas especies, teniendo la nuestra casi el mismo aspecto; pero por ser este trabajo taxonómico y conociendo perfectamente esta Zamia, que es completamente distinta de las otras especies cubanas y a la cual en futuros trabajos tendré que referirme para demostrar su relación con las demás especies de Cuba y resto de las Antillas, creo es oportuno el darle en este momento un nombre, para más tarde discutir su posición.

Además con esta especie, comienzo por introducir la idea sobre la importancia de la mayor o menor pubescencia de los conos, factor que sabemos está en relación con las condiciones ecológicas, pero sin embargo en este grupo es constante, lo cual unido a la idea del color de los esporofilos nos servirá no sólo como punto de partida para una mejor y perfecta comprensión de las Zamia, pero sí como corroboración a los caracteres morfológicos fundamentales.

Por último con esta especie presentamos los tres distintos grupos o centros de mayor importancia, desde donde partiremos para un estudio más comprensivo, no sólo de los distintos grupos morfológicamente constantes, sino también de una mejor interpretación o adaptación a las variaciones ocasionadas por los distintos factores ecológicos y geográficos que le han dado a estas plantas un aspecto polimórfico haciéndolas poco menos que imposible de tratar en el campo sistemático sin la ayuda de la genética experimental.

De regreso al New York Botanical Garden, el Dr. W. H. Camp, Assistant Curator de esa institución, tuvo la delicadeza de darme unas consultas que a él le habían sido remitidas, sobre los pinos de Cuba y su importancia económica, lo cual unido a la necesidad de identificar algunos Podocarpus, coleccionados por mí ultimamente en la región oriental de Cuba, me decidí hacer esta pequeña lista de las Gymnospermae de Cuba con claves para su identificación.

Clase Cycadales

Familia Cycadaceae Lindl. Nat. Syst. 312. 1836.

Megasporofilos alargados, con varios óvulos en cada uno.....Cycas.
Megasporofilos cortos, peltados, formando un cono, con solo dos óvulos en cada uno.
  Conos de 50-70 cm. de largo; plantas arborescentes con un tronco de 3-10 m. de alto.....Microcycas.
  Conos de 1-15 cm. de largo; plantas sin tronco pero con un tallo subterráneo de 5-30 cm.....Zamia.

Cycas L. Sp. Pl. 1:1188. 1753.

Megasporofilos que parecen pequeñas hojas, extendidas, formando una corona.....C. revoluta.
Megasporofilos reducidos, compactos, convergentes en el ápice, imitando un cono.....C. circinalis.

CYCAS REVOLUTA Thunb. Fl. Japon 229. 1784. C. inermis G.A.J. Oudemans Arch. Néerl. 2.t.20:385. 1867. C. revoluta Thunb. var. inermis Miq. Prodr. Cycad. 16. 1861.
Localidad tipo: Japón.
Distribución: Indias orientales y cultivada en todos los países tropicales.
Cuba: Cultivada en paseos y jardines; persistente después de cultivada.

CYCAS CIRCINALIS L. emend. Schuster, Cycadaceae Pflanzenreich 4(1): 66. 1932. C. circinalis L. Sp. Pl. 1188. 1753. C. celebica Miq. Monogr. Cycad. 31. 1842. C. rumphii Roxb. Fl. Ind. 32. 1832. (excl. sino.) C. sphaerica Roxb. Hort. Beng. 71. 1814. C. neocaledonica Linden en Ill. Hort. 28:32. 1881. C. armstrongii Miq. en Arch. Néerl. 3:235. 1868. C. wendlandii Hort. Sander Cat. 35. 1895. C. pluma Hort. Bul. en Gard. 11. 1878. C. squarrosa Loddi. Cat. ex Loud. Hort. Brit. 403. 1830. C. squarrosa Steud. Nom. 2(1):458. 1841.
Localidad tipo: Asia.
Distribución: Asia y Africa.
Cuba: Algo cultivada en jardines.

Microcycas (Miq.) A.DC. Prodr. 16(2):538. 1868.

Género monotípico.....M. calocoma.

MICROCYCAS CALOCOMA (Miq.) A.DC. en DC. Prodr. 16(2):538. 1868. Zamia calocoma Miq. en Van Houtte Fl. Serr. et Jard. 7:141. 1851. Dendrozamia calocoma C.DC. ex Sauvalle Anales Acad. Hab. 7:562. 1871.
Localidad tipo: "Isla de Pinos."
Distribución: Pinar del Río, Sierra de los Organos, entre Guane y Consolación del Sur. En rocas calcáreas, a poca altura en la Sierra de los Organos y en el terreno ondulado de arena y cascajo que rodea dicha sierra.

Por un error esta especie fué informada de Isla de Pinos, cuando en realidad es de Pinar del Río, y podemos casi asegurar que ésta no se encuentra

en dicha isla. Es también lamentable el haberla llamado Microcycas, cuando en realidad es una de las Cycas más grandes del mundo.

Pocas plantas en Cuba han sufrido las consecuencias de la popularidad como la M. calocoma, dando origen a que varios individuos se hayan dedicado a negociar con ellas, destruyendo así un gran número de plantas.

Según la opinión de varios especialistas en Cycadaceae que han visitado nuestro país con el objeto de estudiar la M. calocoma, ésta parece estar en vías de extinguirse, pues raramente se encuentran conos fértiles, lo cual es cierto, pero no obstante esta planta es relativamente abundante aún y frecuentemente encontramos colonias de 5-15 individuos, entre los cuales se ven "seedlings."

Zamia L. Sp. Pl. 1659. 1763.

Conos color púrpura, palisandro o caoba.*
Conos femeninos de 1-8 cm. de largo (generalmente 4-5 cm.), megasporofilos completamente color púrpura, palisandro o caoba; plantas generalmente de menos de 30 cm. de alto. Pinar del Río e Isla de Pinos.....Z. pygmaea.
Conos femeninos de 10-15 cm. de largo, megasporofilos color púrpura, palisandro o caoba pero a veces con los márgenes color bayo; plantas de 3-10 dm. de alto. Muy frecuentes en Oriente, Camaguey, Santa Clara y algo raras en el resto de la isla.....Z. pumila.
Conos completamente color bayo o Isabella.**.....Z. guggenheimiana.

ZAMIA PYGMAEA Sims. Bot. Mag. 42:1741. 1815. Z. pumila Poiteau en Ann. Inst. Hort. de Fromont 1:215. 1829. Z. kickxii Miq. Monogr. Cycad. 8:71. f.a. 1842. Z. ottonis Miq. en Linnaea 17:740. 1834. Z. rotundifolia Hort. van Houtte. 1850. Z. pygmaea Sims. var. wrightii (A.DC.) en DC. Prodr. 16(2): 543. 1868. Z. silicia Britt. Bul. Torr. Club. 43:462. 1916. Z. chamberlainii Schuster en Pflanzenreich 4(1):153. 1932. Z. pygmaea Sims. var. ottonis (Miq.) Schuster l.c. Z. pygmaea Sims emend. Schuster op. c. 152. Z. pygmaea Sims. var. Kickxii (Miq.) Schuster l.c.
Localidad tipo: "Indias occidentales."
Distribución: Isla de Pinos y Pinar del Río, en sabanas de arena y cascajo.

ZAMIA PUMILA L. emend. Carabia. Z. pumila L. Sp. Pl. 1659, 1763. Z. angustifolia Jacq. Ic. Pl. Rar. 3.t.20:636. 1786-1793. Z. integrifolia L. fil. ex Aiton Hort. Kew. 3:478. 1789. Z. debilis L. fil. ex Aiton l.c. Z. humilis Salisb. Prodr. Stirp. 400. 1796. Z. media Jacq. Hort. Schoenbr. 3.77:397-398. 1798. Z. tenuis Willd. Sp. Pl. 4:846. 1805. Z. pumila Loddiges Catal. 1815. Z. media Sims. Bot. Reg. 43. 1816. Z. dentata Voigt. en Syll. Ratisb. 2:53. 1828. Z. prunifera Lodd. Cat. G. Don en Loud. Hort. Brit. 403. 1830. Z. angustissima Miq. en Verh. Nederl. Inst. 3.4:184. 1851. Z. yatesii Miq. op. c. 182. Z. stricta Miq. op. c. 183. Z. multifoliata A. DC. en DC. Prodr. 16(2):545. 1868. Z. floridana A. DC. op. c. 544.

*Véase Koster's Color Guide, New York, 1931.
**Color de la piel de Allium cepa.

Z. latifoliata Prenleoup en Bul. Soc. Vaud. Sc. Nat. 2 ser. 278. 1871. Z. angustifolia Regel var. floridana Regel Revis. 43. 1876. Z. pumila Regel l.c. Z. angustifolia Jacq. var. stricta Regel l.c. Z. linifolia Hort. Pawl. ex Regel Garternfl. 27:12. 1878. Z. linearifolia Linden en Ill. Hort. 28:32. 1881. Z. heyderi Lauche en Garten-Zeitung 457. 1884. Z. portoricensis Urb. Symb. Ant. 1:291. 1899. Z. erosa Cook et Collins en Contrb. U. S. Nat. Mus. 8:267. 1903. Z. lucayana Britton en Bul. N. York Bot. Gard. 5:311. 1920. Z. media Jacq. var. commeliniana Schuster en Pflanzenreich 4(1):155. 1932. Z. media Jacq. emend. Schuster op. c. 154. Z. media Jacq. var. jacquiniana Schuster op. c. 157. Z. media Jacq. var. tenuis (Willd.) Schuster op. c. 158. Z. media Jacq. var. portoricensis (Urban) Schuster op. c. 158. Z. angustifolia Jacq. var. angustissima (Miq.) Schuster op. c. 160. Z. angustifolia Jacq. var. yatesii (Miq.) Schuster op. c. 159.
Localidad tipo: Española.
Distribución: Antillas y Florida.
Cuba: En toda la isla, pero más frecuente desde Varadero, Cayos de Camaguey hasta Maisí; en la costa sobre rocas calizas y lomas cercanas. Holguín, Camaguey, Santa Clara y Habana en sabanas de serpentina o en terrenos calcáreos en las lomas.

El binomio Zamia pumila L. fué basado en cuatro diferentes láminas: Palma fructu clavate polypyreno Mill. Dict. 12. Palma prunifera humilis non spinosa isulae hispaniolae fructui jujubino simili; ossiculo triamgulo G. Commelino Rar. Plant. Hort. Med. Cap. 57 (3) f.58. Palma americana, folis polygonati brevibus leviter serratis & nonnihil spinosis, trunco crasso Plunk Phyt. 103. f. 2 y 309 f.5. Palmifolia femina Trew ehret 5 t. 26. Habitat in America meridionali. Spadix more fructus Cupressi divisus in flosculos.

La primera referencia no se trata de una lámina, es una nota en el Mill Gard. Dic. (Pal.12). 1763.; sobre la cuarta lámina, o sea la de Trew Plant. Select. Tab. 26. 1750-73, la cual representa una Zamia espinosa. La tercera referencia comprendo dos láminas en Plunk Phyt., de las cuales la Tab. 103 f. 2. presenta también una Zamia espinosa, pero la Tab. 309 f. 5 no es espinosa, no obstante se trata posiblemente de la misma planta, donde las pequeñas espinas del pecíolo no aparecen porque el dibujo es muy pequeño y representa una planta completa, y los detalles no pudieron ser incluídos, ya que la descripción de esa lámina dice que es una planta espinosa. Todas estas Zamia con espinas eran de un jardín botánico en Inglaterra y de procedencia desconocida.

La lámina segunda, o sea la de Commelin, representa una planta muy distinta de las anteriores y según el autor procede de Española y no es espinosa.

Algunos años después L. fil. ex Aiton, en el Hortus Kewensis 3:477-478. 1789, propusieron nuevas combinaciones, basadas en la mezcla de Zamia pumila L. y sin razón alguna no conservaron este nombre para alguna de las partes del material original. La combinación Zamia furfuracea L. fil. ex Aiton fué basada en las láminas de Plunk y Trew, dando erróneamente las Indias Occidentales como el país de origen, y hoy sabemos procede de México. Con la lámina restante, o sea la de Commelin, que representa una planta sin

espinas y según el autor era procedente de Española, éstos propusieron Zamia debilis L. fil. ex Aiton y temerosos de dejar algo de la Z. pumila L. que ya no existía, propusieron una tercera combinación, Z. integrifolia L. fil. ex Aiton, acompañándola de una pequeña descripción y pasando a la sinonimia Z. pumila L., dando la Florida como localidad; combinación que se debía haber aplicado al material de la Florida, últimamente llamado Zamia floridana A.DC.

De las dos combinaciones de L. fil. ex Aiton, basadas en el material original de Linneo, una debe ser rechazada para conservar el binomio Zamia pumila L., no existiendo razón alguna para considerarlo un nomen confusa, según propone Schuster en su monografía Cycadaceae en Pflanzenreich 4(1): 155. 1932. Entre estas combinaciones de L. fil. ex Aiton, la Zamia furfuraceae L. fil. ex Aiton no parece ser la más indicada para rechazar, pues dicho nombre se ha estado aplicando durante muchos años al material espinoso procedente de México; quedando sólo otra combinación basada en la Z. pumila L. y ésta es la Z. debilis L. fil. ex Aiton, binomio poco usado y el cual está precisamente basado en la lámina de Commelin que representa una Zamia no espinosa, procedente de Santo Domingo y la cual tipifica perfectamente la Zamia de toda las Antillas, Florida y Bahamas; razón por la cual debemos de rechazar la Z. debilis L. fil. ex Aiton, para conservar Z. pumila L.

Propongo por lo tanto, como tipo de Zamia pumila L. emend. Carabia la lámina, Palma prunifera humilis non spinosa, insulae hispaniolae, fructui jujubino simili, ossiculo triamgolu G. Commelin Rar. Plant. Hort. Med. Cap. LVIII (III) f.58. 1701; Por haber sido este tipo (pro parte) de la Zamia pumila L. y por no existir material de herbario alguno.

ZAMIA GUGGENHEIMIANA Carabia sp. nov. Folia 50-80 cm. longa; petiolus inermis, basi adpresso-pilosus, obtuse triangularis. Folia 80-100, opposita vel alterna, coriaceae vel membranaceae 6-15 cm. longa, 2 mm. lata. Strobilus masculinus cylindricus 5 cm. longus, 1-1.5 cm. latus, apice rotundatus; pedunculus 2-3 cm. longus, piloso-opace-flavescenti. Microsporophylla 100-200, 10-12 seriata, peltata; peltae 4-6 mm. latea, 3-5 mm. altae, rotundato-hexagonae, opace-flavescenti-tomentosae. Strobilus femineus crassus, cylindricus, 4-15 cm. longus, 2-4 cm. latus; pedunculus 4-8 cm. longus, 5-8 mm. crassus, pilosi-opace-flavescenti. Macrosporophylla 40-60, 8-12 seriata, peltae; peltae 1-1.5 cm. latae, 0.5-1 cm. altae, rotundato-hexagonae, opace-flavescenti-tomentosae.
Localidad tipo: Oriente, Manzanillo, Ensenada de Mora, Pilón; en Arroyo Calabaza. Coll. J. P. Carabia 1403a, 17-V-1939. (Tipo en Britton Herbarium, New York Botanical Garden.) El material masculino descrito en esta especie es J. P. Carabia 1403b, en el Britton Herbarium, New York Bot. Garden.

Dedico esta especie en honor de la John Simon Guggenheim Memorial Foundation.

Esta Zamia había sido confundida hasta la fecha con Zamia angustifolia Jacq., de las Bahamas, o con Z. yatesii Miq., que según la lámina 1 en Cycadea Quaedam Americanae, F.A.G. Miquel 1851, presenta los esporofilos carmelita rojizos con los márgenes color bayo; también frecuentemente se encontraba en los herbarios bajo el nombre de Zamia angustissima Miq. con

las cuales no tiene la Zamia guggenheimiana más relación que la que pudiera tener con cualquiera otra de las formas de Z. pumila L.

Especie excluída.

Zamia gutirrezii Sauvalle Ana. Acad. Cienc. Habana 5:54. 1869. Z. media Jacq. var. gutirrezii (Sauv.) Schuster Cycadaceae en Pflanzenreich 4(1): 154. 1932 (excluyendo sinonimias).

Esta especie fué informada por su autor como de Pinar del Río, Sierra de los Organos, Rangel, a 300 m. de altura y desde entonces esta planta ha sido incluída en la literatura de esta familia como una Zamia cubana. Ultimamente Schuster en su monografía de las Cycadaceae la pasa a variedad de la Zamia media Jacq. = Z. pumila L., con la cual ésta no tiene relación alguna, pues la Z. gutirrezii Sauvalle es de pecíolo espinoso, o sea del grupo centroamericano y no del grupo antillano, donde no hay Zamia espinosas.

Desde el primer momento que comencé a estudiar este grupo de plantas, presumía que la Z. gutirrezii no era cubana, para lo cual tuve el cuidado de ir a la localidad tipo en varias ocasiones y más tarde ayudado por los Hermanos del Colegio de La Salle, los cuales poseen una finca en la misma localidad, hicimos toda clase de investigaciones con resultados negativos, deduciendo así que dicha especie no es indígena en esa localidad y sin embargo todo parecía indicar que la procedencia de dicha planta era de el jardín de J. Blain, cuñado de Sauvalle y quien hacía años había fundado el primer jardín botánico en Cuba, importando una gran cantidad de plantas exóticas y plantándolas precisamente en la base del Rangel, localidad tipo de la Z. gutirrezii. Hoy en día no queda casi planta alguna allí y la Z. gutirrezii no es una excepción; no obstante, según antiguos horticultores y botánicos, existió allí una Zamia espinosa posiblemente traída de Mexico por Blain y la cual años después pasó al jardín de la Universidad de la Habana, donde efectivamente encontramos la Z. gutirrezii bajo otro nombre.

Familia Taxaceae Lindl. Nat. Syst. ed. 2. 316. 1836.

Podocarpus L'Herit. ex Pers. Syn. 2:580. 1807.

Receptáculo de 4-7 mm. de largo y 4-5 mm. de ancho.
- Frutos sesiles o con un pedicelo de 1 mm. de largo aproximadamente..... P. ekmanii.
- Frutos con un pedicelo de 2-5 mm. de largo.
  - Hojas lineales estrechas de 3-4 mm. de ancho y 3-7 cm. de largo; pedicelo del fruto 3-4 mm. de largo; receptáculo de 5-7 mm. de largo; fruto de 7 mm. de largo..... P. angustifolius.
  - Hojas elípticas lineales de 6-7 mm. de ancho y unos 4 cm. de largo; pedicelo del fruto 2-3 mm. de largo; receptáculo de 6-7 mm. de largo; fruto de 7-8 mm. de largo..... P. aristulatus.
  - Hojas elípticas estrechas de 7-10 mm. de ancho y 3-5 cm. de largo; pedicelo del fruto 4-5 mm. de largo; receptáculo de 4-5 mm. de largo; fruto de 8-9 mm. de largo..... P. leonii.

Receptáculo de 1.5-2 cm. de largo y 1 cm. de ancho..... P. victorinianus.

PODOCARPUS EKMANII Urban Repert. Sp. Nov. Fedd. 18:17. 1922.
Localidad tipo: Oriente, Sierra de Cristal.
Distribución: Oriente, Sierra de Cristal, Sierra de Moa y Cuchillas de Toa; en charascales cerca de los arroyos, entre 500-700 m. de altura.

PODOCARPUS ANGUSTIFOLIUS Griseb. Cat. Pl. Cub. 217. 1866. P. aristulata Parl. en DC. Prodr. 16(2):513. 1868 (ex parte).
Localidad tipo: Cuba occidental.
Distribución: Pinar del Río, Sierra de los Organos, El Retiro, Grupo de Rosario, San Diego de Tapia y San Miguel.

PODOCARPUS ARISTULATUS Parl. en DC. Prodr. 16(2):513. 1868. P. purdieanus Hook.f. parvifolia Griseb. Mem. Amer. Acad. Sci. 8(2):530. 1862 (no P. parvifolia Parl. 1868). P. purdieanus Hook. (sine Griseb.) Fl. Br. W.I. 505. 1864 (no P. purdieanus Hook.). P. angustifolius Griseb. var. wrightii Pilger en Pflanzenreich 4(5):89. 1903.
Localidad tipo: "SE. de Oriente."
Distribución: Oriente, Sierra de Nipe, Sierra de Cristal y Yunque de Baracoa.

Grisebach fué el primero en notar que el material de Wright 1461 era diferente del Podocarpus angustifolius Griseb. basado en Wright 3188, por lo cual él propuso la combinación P. purdieanus Hook. f. parvifolia Griseb. con el número 1461 Wright. Más tarde Parlatore hizo el binomio P. aristulata, basado infortunadamente en dos números distintos que pueden comprender dos especies distintas y lo cual no podemos confirmar de manera categórica porque el material tipo Wright 1461 y 3188 (este último se lee 3788 posiblemente por estar manuscrito y ser poco legible), se encuentra en Europa y por lo tanto imposible de consultar en el presente estado de cosas.

Conocido de todos es el hecho, de que el material de Wright distribuído en varios herbarios europeos y americanos, comprende una serie de números que no se pueden tomar en consideración general; es decir, que el hecho de mencionar Parlatore como tipo del P. aristulata los números Wright 3188 y 1461 no significa que todo el material de Wright con los mismos números en distintos herbarios comprende el mismo material; sin embargo, Wright 3188 en el Gray Herbarium es P. angustifolius, número precisamente que Grisebach cita como tipo de esta especie, por lo tanto el material de Wright 3188 en el Gray concuerda con el de Herbar Göttigen, donde se halla el material estudiado por Grisebach y el cual es posiblemente el mismo Wright 3188 que Parlatore incluye en su referencia del binomio P. aristulata. De todas formas no hay duda que parte del material citado por Parlatore en P. aristulata es Wright 3188 o sea P. angustifolius, pues el autor declara que el número 3188 tiene hojas de 4-5 mm. de ancho, lo que es verdad en P. angustifolius y razón por la cual Pilger pasó la especies de Parlatore a la sinonimia de P. angustifolius, sin tomar en consideración el resto de la descripción que positivamente abarca otra planta distinta.

Cuando Pilger pasó por completo el P. aristulata a la sinonimia de P. angustifolius y propuso con el número de Wright 1461 la combinación P. angustifolius Griseb. var. wrightii Pilg., no sólo cometió un gran error pero confirmó a la vez que los números 3188 y 1461 consultados por él eran distintos; de lo cual deducimos que todo el material mencionado Wright 3188

es P. angustifolius lo mismo que en el de Gray y por consiguiente el número Wright 1461 representa una especie distinta de la anterior, tal como sucede en el Gray Herbarium, Herbar Göttingen y posiblemente en todos los herbarios europeos.

Si estudiamos cuidadosamente la descripción de P. aristulata Parl. notaremos que esta fué basada mayormente en un material que concuerda con Wright 1461 en el Gray Herbarium y por lo tanto debe ser igual al Wright 1461 en Europa consultado por Parlatore.

En la descripción de P. aristulata el autor dice que las hojas son lanceoladas-lineales, lo cual se puede aplicar sólo a Podocarpus angustifolius y Wright 1461, pero el ancho dado es de 6-7 mm., lo cual coincide perfectamente con el Wright 1461 en Gray. Según esta descripción el fruto es sésil o con un pedicelo muy corto, lo que sólo encontramos en el P. ekmanii, especie ésta que no tiene ninguna relación con la anterior y por eliminación la única planta con pedicelos cortos que le puede seguir al P. ekmanii es precisamente Wright 1461 con pedicelos de 2-3 mm. de largo.

Por lo tanto creemos poder tipificar P. aristulata Parl. en el material de Wright 1461 en el Gray Herbarium, que por suerte concuerda también con uno de los números dado como tipo por Parlatore al proponer dicho binomio.

Estimamos oportuno el aclarar que la hoja Wright 3146 en el Gray Herbarium comprende dos especies, una a la derecha de la hoja que es el P. aristulata y planta a la cual nos hemos estado refiriendo y otra planta a la izquierda, que por considerarla completamente distinta de la otra especie o cualquiera otra descrita hasta la fecha, nos disponemos a presentarla en este trabajo como especie nueva.

PODOCARPUS LEONII Carabia sp. nov. Frutex arborescens 6-7 m. altus; ramuli breves 2-8 cm. longi, dense foliati, internodiis 1-2 mm. longis. Folia coriacea recta vel leviter curvata, eliptica-angustiae, acuta apiculata, 2-5 cm. longa, 5-10 mm. lata, nervo medio supra impresso, subtus crassiuscule prominente. Flores feminei in axillis solitari; pedunculus 4-5 mm. longus; receptaculum 4-5 mm. longae, squame 2, basi connatis, apice liberis triangularibus. Semen ovoideum 8 mm. longum, 4 mm. crassum, apice distincte breviter obtuse productum.
Localidad tipo: Oriente, Sierra de Imías, Puntón del Mate, 500 m. de altura. Plants of Cuba—Southern Baracoa Region, Collect. Fre León 12192, 12 Agosto-4 Sept., 1924. (Tipo en el Britton Herbarium en New York Botanical Garden.)
Distribución: Sierra de Imías y Cuchillas de Catalina, región sureste de Oriente.

Nombro esta planta en honor de mi maestro y mejor consejero en mis estudios de la flora cubana, Hermano León, quien tuvo la suerte de coleccionar esta interesante especie en una de sus últimas excursiones.

PODOCARPUS VICTORINIANUS Carabia sp. nov. Frutex arborescens, ramis multis, laxis. Folia laxa, recta vel leviter curvata, elliptica, 3-5 cm. longa, 1-1.3 cm. lata, acuta, apiculata, nervo medio supra leviter impresso, subtus leviter crassiuscule. Flores feminei in axillis foliorum solitarii;

pedunculo non viso; receptaculo carnoso, 1.5 cm. longo, 1 cm. lato, ad apicem fere connato, apicibus duobus liberis, obtusis. Semen unicum, ovoideum, 1 cm. longum, 0.5 cm. latum, apice distinctissime acuminato, circiter 2 mm. longo; testa fulvo-fusca.
Localidad tipo: Oriente, Monte Verde. Plantae Cubenses Wrightianae. Coll. C. Wright, No. 1461, 1860-64. (Tipo en el Gray Herbarium de la Universidad de Harvard.)
Distribución: Conocido sólo de la localidad tipo.

De acuerdo con lo dicho anteriormente, el ejemplar de Wright 1461 en el Gray Herbarium es Podocarpus aristulatus Parl., en lo que respecta al material de la derecha en dicha hoja, pero no en el de la izquierda, que es en el cual nos basamos para proponer el binomio P. victorinianus Carabia.

En esta hoja, Wright 1461, se nota a simple vista que está formada por dos distintas especies, con dos distintas etiquetas originales de Wright, a pesar de lo cual fueron montadas como si se tratara de una sola especie. El orden en el cual están estas etiquetas pegadas no se puede tomar en consideración, pero sin embargo la etiqueta al lado derecho bajo P. aristulatus Parl. dice que es un árbol grande, lo cual es cierto para dicha especie, a pesar de que la localidad es La Perla, Monte Verde, Oriente, donde posiblemente se encuentra dicha especie, pero que nosotros solo conocemos de la Sierra de Nipe, Cristal y Moa.

La otra etiqueta que estaba suelta en el sobre de la izquierda, en la parte inferior del P. victorinianus Carabia, la he pegado en la parte superior de dicha especie, pues por eliminación le corresponde a esta planta y basado en lo que ésta dice, describo el P. victorinianus como un árbol pequeño propio de Oriente, Monte Verde.

Dedico esta especie al Profesor Marie-Victorin, Director del Jardín Botánico de Montreal, Canada, con quien tuve la suerte de compartir innumerables excursiones en Cuba, durante las cuales pudimos observar los Podocarpus de este país.

Familia Araucariaceae Stranburger, Conif. und Gnet. 25. 1872.

Araucaria Jussieu, Gen. Pl. Sec. Ord. Nat. Disp. 413. 1789.

Hojas de 2-4 cm. de largo y unos 5 mm. de ancho; escamas del cono no aladas.
  Hojas imbricadas alrededor de las ramas.....A. araucana.
  Hojas en dos filas opuestas, extendidas.....A. bidwillii.
Hojas de 5-15 mm. de largo y unos 3 mm. de ancho; escamas del cono aladas.
  Hojas ligeramente imbricadas, anchas en la base y ligeramente decurrentes, de unos 5 mm. de largo.....A. columnaris.
  Hojas algo extendidas, lateralmente comprimidas, decurrentes, de unos 10 mm. de largo.....A. excelsa.

ARAUCARIA ARAUCANA (Molina) K. Koch, Dendrologie 2(2):206. 1873. Pinus araucana Molina, Saggio Sulla Storia Naturale del Chile 182. 1782.

Araucaria imbricata Pavon, Mem. Acad. Madrid 1:197. 1795.
Localidad tipo: Chile.
Distribución: Chile, Tierra del Fuego y N. de Patagonia.
Cuba: Algo cultivada, especialmente en la Habana.

ARAUCARIA BIDWILLII Hook., Lond. Jour. Bot. 2:503. 1843.
Localidad tipo: Australia.
Distribución: Australia, Brisbane, entre Rockingham y Cleveland Bay.
Cuba: Un solo ejemplar cultivado en la Estación Experimental Agrícola.

ARAUCARIA COLUMNARIS (Forster) Hook., Bot. Mag. 4635. 1852. Cupressus columnaris Forster, Florulae Insularum Australium Prodr. 67. 1786. Araucaria cookii R. Brown ex D. Don, Trans. Linn. Soc. 18:164. 1841.
Localidad tipo: Australia.
Distribución: Australia, Nueva Caledonia, Isle of Pines y Polinesia.
Cuba: Algo cultivada.

ARAUCARIA EXCELSA Brown ex Aiton, Hort. Kew 2(5):412. 1813. Dombeya excelsa Lambert, Pinus 87-90. 1803. Eutassa heterophylla Salisb., Linn. Trans. Soc. 8:316. 1807. Colymbea excelsa Spreng., Syst. Cur. Post. 315. 1821. Eutacta excelsa Link, Linnaea 15-544. 1841.
Localidad tipo: Isla de Norfolk.
Distribución: Isla de Norfolk (entre Australia y Nueva Zelandia).
Cuba: Muy cultivada en toda la isla.

Familia Pinaceae Lindl. Nat. Syst. Bot. Sec. 313. pr. 1836.

Pinus L. Sp. Pl. 1000. 1753.

Pinos de dos hojas, raramente tres.
- Hojas de 4-15 cm. de largo, raramente 17 cm., verde oscuro; conos jóvenes con escamas mucronatas; conos algo anchos en relación con el largo, apófisis oscuro, umbo sobresaliente y grueso.....P. cubensis.
- Hojas de 20-30 cm. de largo, verde claro; conos jóvenes con escamas tuberculadas; conos estrechos en relación con el largo, apófisis color leonado, umbo comprimido.....P. tropicalis.

Pinos de tres hojas, raramente cuatro.
- Conos jóvenes generalmente laterales, retrosos; conos de 5-15 cm. de largo, umbo algo sobresaliente pero no muy agudo; hojas rígidas 1.5-2 mm. de diámetro.....P. caribaea.
- Conos jóvenes generalmente subterminales, erectos; conos de 5-8 cm. de largo, umbo muy largo y agudo; hojas suaves de 1 mm. de diámetro o menos.....P. occidentalis.

PINUS CUBENSIS Griseb. emend. Carabia. P. cubensis Griseb. Mem. Acad. Amer. Sci. 8:530. 1862. P. wrightii Engelm. Trans. St. Louis Acad. 4:185. 1880.
Localidad tipo: Oriente, abundante en las regiones montañosas.
Distribución: Oriente, en toda la región montañosa, formando grandes colonias en la Sierra de Nipe, S. de Cristal, S. de Moa y Cuchillas de Toa; lugares estos dos últimos donde llegaban hasta la costa, según las notas del primer viaje de C. Colón.

Esta especie fué basada en dos números de Wright, 598 y 1462, los cuales sin duda comprenden dos especies distintas, por lo cual Grisebach describió P. cubensis como de tres hojas y raramente de dos, cuando es todo lo contrario, es decir que éste es de dos hojas y raramente tres, explicándose esto porque el material era en parte P. caribaea Morel. Si consideramos prudente el conservar el binomio P. cubensis Griseb., es más que nada por haber explicado el autor que este procedía de la región oriental.

Según investigaciones realizadas por E. L. Ekman en distintos herbarios europeos y las llevadas a cabo por mí en los herbarios americanos, he podido conocer un gran número de ejemplares de Wright determinados por Grisebach como P. cubensis y los cuales resultan ser varias especies.

En el Herbar Göttingen los números de Wright 598, 121, 699 (en parte), 1462a, 1462b y 3190, son P. cubensis Griseb., de los cuales sólo dos números tienen localidades, el 121 San Juan de Buena Vista y el 1462a de Monte Verde. En este mismo herbario los números 700, 1052 y 3189 son P. tropicalis y P. caribaea (en parte) y el 700 es P. tropicalis.

En el Kew Herbarium los números 598, 1462a y 3190 son P. cubensis mientras que el 1462b es P. caribaea y por error la localidad dada es Monte Verde, Oriente.

En el Herbar des Naturhistorischen Reichsmuseums en Stockholm los números de Wright 1462 es P. caribaea (posiblemente el número citado por Grisebach), 3189 es P. tropicalis y el 3190 es P. cubensis.

En el Britton Herbarium del New York Botanical Garden, el número 1462 es P. caribaea, 598 P. cubensis y el 3189 es una mezcla de P. tropicalis y P. caribaea.

En el Gray Herbarium bajo el número Wright 1462 hay dos hojas, una es P. cubensis, pero la otra es P. cubensis y P. caribaea con dos localidades, San Juan de Buenavista y San Diego de los Baños. El número 3189 es también una mezcla de P. cubensis, P. tropicalis y P. caribaea; el 598 es P. cubensis y el 3190 es P. cubensis y P. tropicalis.

En vista de esta confusión tan enorme en el material de Wright, proponemos que en el futuro el tipo de Pinus cubensis Griseb. emend. Carabia sea: Wrightianae n. 598. Coll. C. Wright, 1856-57 in Cuba Orientales. (Tipo en el Britton Herbarium del New York Botanical Garden.)

G. R. Shaw en su magnífica monografía "The Genus Pinus," Publ. Arnold Arbt. 5:70. 1914, pasa el Pinus cubensis Griseb. a la sinonimia de P. occidentalis Sw., lo cual se ha debido más que nada a la coincidencia que el material en el Herbarium Arnold Arboretum procedente de Cuba, Oriente, es en realidad P. occidentalis, pero habiendo nosotros estudiado una gran cantidad de material en distintos herbarios hemos podido separar estas dos especies basándonos en distintos caracteres como las hojas, que en P. occidentalis son suaves y flexibles de 15-25 cm. de largo y 1 mm. de diámetro o menos, mientras que en P. cubensis éstas son rígidas de 4-15 cm. de largo y de más de 1 mm. de diámetro; además las escamas de conos jóvenes

en P. occidentalis son espinescentes y en P. cubensis mucronadas. Los conos de P. occidentalis son generalmente más alargados que los de P. cubensis en comparación con su diámetro; el apófisis en P. cubensis es carinado transversalmente, lo cual es también en P. occidentalis, pero no de una manera tan notable, y el umbo de P. occidentalis es visiblemente alargado y espinescente, cuando en el P. cubensis éste es más bien corto y grueso pero a veces mucronado.

PINUS TROPICALIS Morelet Rev. Hort. Cote d'Or. 1:105. 1851. P. cubensis Griseb. var. terthrocarpa Wright en Griseb. Cat. Pl. Cub. 217. 1866. (pro parte). P. terthrocarpa Shaw en Sargent Trees & Shrubs 3:149. 1903 (pro parte).
Localidad tipo: Isla de Pinos, pero no en la costa meridional de Cuba.
Distribución: Isla de Pinos y Pinar del Río; en sabanas de arena y terrenos de cascajo más o menos ondulados.

PINUS CARIBAEA Morelet Rev. Hort. Cote d'Or 1:105. 1851. P. cubensis Griseb. Mem. Amer. Acad. Sci. 8:530. 1862 (ex parte). (No P. cubensis Griseb. emend. Carabia). P. bahamensis Griseb. Fl. Br. W. I. 503. 1864. P. elliottii Engelm. en Trans. Acad. St. Louis 4:186-188. P. heterophylla Sudworth en Bul. Torr. Bot. Club 20:45. 1893. P. cubensis Griseb. var. terthrocarpa Shaw en Sargent Trees & Shrubs 1:149. 1903 (pro parte). P. cubensis Griseb. var. anomala Rowlee Bul. Torr. Bot. Club 30:108. 1903. P. recurvata Rowlee op. c. 107.
Localidad tipo: Isla de Pinos.
Distribución: Estados Unidos, desde Georgia hasta Mississippi y Florida; Bahamas, Honduras, Guatemala y Cuba.
Cuba: Isla de Pinos y Pinar del Río; en terrenos más o menos ondulados y en sabanas de arena y cascajo. Plantas raras entre el P. tropicalis.

Estas dos especies de pinos bastante bien conocidas, son sin embargo confundidas frecuentemente, lo cual se debe en parte a lo raro de la publicación donde éstas fueron publicadas y lo poco específico que los binomios son en sí, por lo cual presentamos aquí una ligera discusión que permita identificar éstas con mayor facilidad.

El número de hojas es algo variable en P. tropicalis, éste es de 2-3 pero prácticamente podemos decir es de sólo 2 hojas y en el P. caribaea es de 3-4, pero generalmente es sólo de tres. Los conos jóvenes de P. tropicalis son subterminales, erectos y con las escamas ligeramente tuberculadas y en el P. caribaea son laterales y retrosos, con las escamas mucronadas. Los conos de P. tropicalis tienen de 5-8 cm. de largo y en P. caribaea de 5-15 cm.; el apófisis es de color leonado, más largo que ancho, y el umbo es grueso pero truncado en P. tropicalis y en P. caribaea el apófisis es color gris oscuro, el mismo ancho que largo aproximadamente y el umbo es ligeramente mucronado.

PINUS OCCIDENTALIS Sw. Plant. Prodr. 103. 1788. P. cubensis Hort. ex Gordon Pinetum 234. 1858 (en sinonimia), (no P. cubensis Griseb. 1826).
Localidad tipo: Española.
Distribución: Santo Domingo, Haití y Cuba.
Cuba: Oriente, Sierra Maestra, entre P. cubensis a 1,000-2,000 m. de altura.

El P. occidentalis había sido informado de Cuba muy inciertamente, hasta que G. R. Shaw en The Genus Pinus, Publ. Arnold Arboretum 5:70. 1914, no lo refiere a Cuba solamente, sino que pasa a su sinonimia el P. cubensis Griseb. Por otra parte Ekman en R. Florin Die von Ekman in Westindien Gesammelten Koniferen, Arkiv Botanik 25(5):5-10. 1933, menciona un pino de Bayamo, Oriente, con hojas muy largas y suaves con un diámetro de 0.5-0.8 mm. el cual él confiesa que estuvo tentado de describirlo como especie nueva, no obstante en el mismo artículo afirma categóricamente que en Cuba no existe el P. occidentalis. Esta confusión no nos ofrece duda alguna, pues habiendo estudiado una gran cantidad de material procedente de Oriente, hemos tenido ejemplares difíciles de decidir a la especie que pertenecía, pues no hay la menor duda de que el P. cubensis y P. occidentalis son muy afines. La mayor dificultad que hemos encontrado en el P. occidentalis de Cuba es que éste es de tres hojas solamente cuando en Española es de tres a cinco y generalmente de cuatro o cinco.

Familia Cupressaceae F.W.Neger Konif. und Gynosp. 24:139. 1907.

Juniperus L. Sp. Pl. 1039. 1753.

Hojas de 5-10 mm. de largo, delgadas y extendidas.....J. saxicola.
Hojas de 1 mm. de largo aproximadamente, comprimidas.....J. barbadensis.

JUNIPERUS SAXICOLA Britton & P. Wilson Bul. Torr. Club. 50:35. 1923.
Localidad tipo: Oriente, Sierra Maestra, sobre rocas.
Distribución: Oriente, Sierra Maestra, a 1,000-2,000 m. de altura, alrededor del Pico Turquino.

JUNIPERUS BARBADENSIS L. emend. Carabia. Juniperus barbadensis L. Sp. Pl. 1039. 1753. J. virginiana L. var. australis Endle. Syn. Conif. 28. 1847. J. virginiana L. var. barbadensis Gordon Pinetum 1:141. 1858. J. lucayana Britton North Amer. Trees 121. 1908. J. australis (Endl.) Pilger en Urban Symb. Antill. 7:479. 1913. J. gracilior Pilger op. c. 481. J. ekmanii Florin Arkiv Botanik 25(3): 14. 1933.
Localidad tipo: Barbados.
Distribución: Panantillana y Bahamas.
Cuba: Pinar del Río, Santa Clara, Oriente e Isla de Pinos; en P. del Río e Isla de Pinos se encuentra escasamente en la desembocadura de los ríos y terrenos próximos al mar. En Santa Clara es más frecuente en las lomas de Trinidad y en Oriente es bastante abundante en la Sierra de Nipe, S. de Cristal, S. de Moa y Cuchillas de Toa.

El estado de confusión que ha prevalecido hasta la fecha sobre el Juniperus barbadensis L. se ha debido en parte a la interpretación dada a esta especie por botánicos recientes como Pilger y Britton, los cuales consideraron este nombre específico como un error geográfico de parte de Linneo y según ellos no era posible comprobar la existencia de ese Juniperus en Barbados, cuando en Bermudas éste es uno de los árboles más corrientes, opinión que no tiene fundamento alguno, pues el nombre específico dado por Linneo no sólo representaba por sí mismo la procedencia de Barbados, pero esto quedaba consolidado con la simultánea publicación de otros dos Juniperus

en la misma página, Sp. Pl. 1039. 1753: J. virginiana L. de Norte América y J. bermudiana L. de las Bermudas, separando así esas tres especies de distinta distribución geográfica. El que hoy día no se encuentre en Barbados ningún árbol de J. barbadensis no es razón para dudar que existio en dicha isla, pues Babock en la Flora Barbadensis 394-395. 1820, afirma que en esa época no era muy abundante, pero que lo había sido, además Grisebach en la Flora Brit. W. I. 503. 1864, lo reporta de Cedar Hall, Barbados y recientemente F. Watts lo coleccionó en el tope del Monte Pitones, Santa Lucía, material que se encuentra en el Kew Herbarium y en el Britton Herbarium, New York Botanical Garden.

Es verdad que Linneo refiere esta especie a dos grabados que se han interpretado de distintas formas; el de Plunkenet Alm. Bot. 201.t.197., f.4., que representa un Juniperus cualquiera y el de Miller Cat. Pl. Hort. Angl. t.l., f.l., J. bermudiana, grabado en el cual Linneo se basa para proponer el J. bermudiana L. y J. barbadensis L., pero que existiendo en el Herbarium von Linneo en Londres un ejemplar determinado por el mismo Linneo como J. barbadensis, creemos será prudente el tomar éste en consideración.

Según Pilger en Urban Symb. Antillana 7:479. 1913, el material en el Herbarium von Linneo puede ser un material mal identificado por el propio Linneo, material que pudiera haber llegado a él después de haber propuesto el binomio J. barbadensis, y por lo tanto según Pilger, debemos tomar en consideración sólo la descripción de Linneo y las láminas que él da por referencia, dando por resultado que el J. barbadensis es una sinonimia de J. bermudiana; opinión que rechazamos completamente por no tener fundamento alguno.

Por otra parte C. S. Sargent en "The Silva of North America" 14:89. 1902, después de haber estudiado el material de Linneo en Londres y compararlo con el Juníperos de la Florida y las Antillas, llega a la conclusión que éstos son completamente idénticos, por lo cual él considera el material de Linneo tipo de el J. barbadensis y usa este nombre para el Juniperus de la Florida y las Antillas, estimando como un error el que Linneo refiera dicha especie a unos grabados que no la representan; además Babock comprobó el material de Juniperus de Barbados con el de Jamaica y llegó también a la conclusión de que éstos eran la misma especie y habiendo yo estudiado el material de Santa Lucía, comparándolo con el de Jamaica, Santo Domingo, Haití, Bahamas y Cuba he notado que éstos son idénticos, no quedándonos la menor duda que el Juniperus de todas las Antillas y Bahamas no es otro que el J. barbadensis L.

De acuerdo con lo anteriormente dicho, propongo que el tipo de Juniperus barbadensis L. emend. Carabia sea el material de Barbados depositado en el Herbarium von Linneo bajo el nombre de Juniperus barbadensis L., y no las láminas de Plunkenet Alm. Bot. 201.t. 197., f.4. y la de Miller Catl. Pl. Hort. Angl. t.l., f.l., por no representar éstas dicha especie.

Respecto a que el J. barbadensis llegue hasta la Florida según C. S. Sargent, no es de dudar, pero éstas no representan la forma típica del

J. barbadensis de las Antillas, según se puede apreciar por el grabado que este autor usa, donde los frutos son redondos y con solo dos semillas.

De la afinidad entre J. barbadensis, J. bermudiana y J. virginiana no hay la menor duda, pero sin embargo el J. barbadensis se puede distinguir de los otros dos por sus ramas inferiores pendientes, carácter usado por Pilger al proponer el binomio J. australis; por ser las ramas generalmente más finas y alargadas, basado en lo cual Pilger hizo otra especie, el J. gracillior, y por sus frutos lateralmente comprimidos, en lo cual Britton se basó al hacer el J. lucayana; pudiendo nosotros agregar que el J. barbadensis tiene frutos con 3-5 semillas y generalmente 3-4, mientras que el J. virginiana y J. bermudiana sólo tiene 1-2 semillas en cada fruto.


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THE CARIBBEAN FORESTER

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Vol. 2, No. 3 APRIL 1941

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CONTENTS

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DURABILITY TESTS ON UNTREATED TIMBERS IN TRINIDAD

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Introduction

Owing to past overcutting there is today a scarcity of supplies of Trinidad's two most naturally durable timbers, namely, balata (Manilkara bidentata (A.DC.) Chev.) and poui (Tabebuia serratifolia Nichols). With a view to finding satisfactory substitutes, durability tests were started involving both treated and untreated test-pieces of the commoner local and imported species. This paper deals only with the results obtained with the untreated test-pieces: the object of this part of the tests was to ascertain the local species of fungi and termites which cause damage to timber in contact with the ground, and the relative natural resistance thereto of the selected species of timber.

In view of the possible localization of distribution of the various species of termites, graveyards were established at four centers, viz:

(1) Royal Botanic Gardens.—Soil a gravelly loam with small quartz boulders overlying the detrital schists of the Northern Range: average rainfall approximately 63 inches per annum.

(2) Arena Reserve.—Soil a pure sand overlying a hardpan, with a high water table during the rainy season: average rainfall approximately 90 inches per annum.

(3) Central Range Reserve.—Soil a heavy clay, waterlogged during the rainy season: average rainfall approximately 114 inches per annum.

(4) Southern Watershed Reserve.—Soil sandy overlying porcellanite: average rainfall approximately 70 inches per annum.

At stations (2), (3), and (4) there is a very large quantity of decaying vegetable matter in the immediate vicinity, but a very much smaller quantity at station (1).

Each graveyard was subjected to a preliminary termite survey and, after the placing of the test-pieces, was partially baited by the laying of termite-infested pieces of wood, collected in the vicinity, between some of the rows of test-pieces.

A considerable number of test pieces of each species was employed—the exact number of each is shown in table 7. These test-pieces were 3 ft. by 2 in. by 2 in. in size, cut from seasoned scantling. Each piece was numbered with an aluminum label, and a description of it was recorded showing the

amount of sapwood, the presence of splits or other defects, attacks by wood-boring insects, and any other relevant details. The inclusion of sapwood among the untreated test-pieces was an error in technique, since no species possesses durable sapwood and the records were unnecessarily complicated thereby.

The test-pieces were inserted in the ground to a depth of 1 foot: in the baited areas of each graveyard the distance between the pieces was 2 inches or less, while in the unbaited areas a wider spacing up to 2 ft. by 2 ft. was adopted. A randomized arrangement of the species was followed.

All the test-pieces at each station were examined every 6 months. Careful consideration was given to the possibility of utilizing some precise method of recording the amount of damage and of fixing a standard of rejection, the problem being complicated by the simultaneous attack on some species by both fungus and termites. Any such method, however, apart from its actual practicability, presupposed the availability of whole-time staff for the purpose, but the transfer of the Research Officer to another Colony made this impossible. It proved necessary, therefore, to have recourse to the admittedly somewhat unsatisfactory method of the use of the following terms: slightly attacked, attacked, badly attacked, destroyed. A test-piece was considered "destroyed" when it broke on being sharply tapped on an adjoining piece: the entry of the human factor here is obvious. The lack of accurate measurements, however, and other deficiencies in technique were, it is thought, adequately compensated by the large number of duplicate test-pieces of each timber.

In order to save space, in the text and in tables 1 to 6, only the vernacular names of the species of timber tested are given, but the corresponding scientific names will be found in table 7.

Attack by termites

1. Plan and scope of the tests against termites.—The plan of the trials has proved to be satisfactory for the purpose for which they were designed with regard to termite attack. It was hoped that the infestation of subterranean termites in the graveyards would be sufficiently great to subject all or most of the timbers to an adequate test, and this expectation was realized owing to the very large populations of Heterotermes which developed during the first 6 months throughout all the graveyards. The subterranean tunnels of these termites penetrated into almost every cubic foot of the topsoil. The records show that almost every test-piece was directly exposed to termite attack during the greater part of the period of the trials to date, so that absence of attack can be attributed to some degree of resistance and not to the absence of termites in the vicinity of any timber. For example, over 90 per cent of the 267 test-pieces representing 4 of the most susceptible timbers in all the graveyards collectively were attacked by termites during the first 6 months of the trials. Of 75 pieces of hog plum, all but 1 were attacked after 7 - 9 months. After 1 year 98 per cent of the 707 pieces of the 11 most susceptible timbers had been damaged by termites. On the other hand, only 6 per cent of the pieces of the 5 most resistant timbers were attacked during the first year. These figures, and others which need not be given here, show clearly that the experiments were satisfactory as regards both the intensity and the uniformity of the test to which the timbers were exposed.

It was fortunate also that two of the graveyards were heavily infested by only one kind of termite, Heterotermes, without complications due to the presence of large numbers of others, and that Coptotermes appeared in two of the graveyards, for purposes of comparison with Heterotermes attacks.

The efficacy of the tests against termites was somewhat reduced by the activities of fungi, especially by the early destruction of many pieces. The reduction in the termite populations after 18 months of the tests, as described later, made them less efficient during the second and third years than during the first. Neither of these disadvantages interfered seriously with the results.

It must be emphasized, however, that resistance of timbers to termite attack may depend on many complex factors, such as age, time of felling, degree of seasoning, and even peculiarities of individual trees. The results of these trials are believed to afford a reliable guide for the selection of timbers that may be exposed to termites, but they are not to be taken as final conclusions in every case.

The tests were all made with wood in contact with the ground and exposed to the weather, but most of the data can probably be applied with fair certainty in the choice of timbers for use in buildings and other protected situations. Fungal damage and weathering may alter the susceptibility of timber to termite attack, but many of the results were obtained within the first 6 months of the trials, before these processes of deterioration had progressed far. It is unlikely that the order in which the species of timber have been arranged by these tests would be greatly altered by the absence of agents of decay other than the termites. It should be noted, however, that timbers used in buildings are likely to escape termite damage for very much longer than they did during these experiments, in which they were exposed to exceptionally severe tests.

To supplement the results of the field trials, laboratory tests are being made, including the use of a new technique by means of which mosaics of small pieces of different kinds of wood are offered to termites in observation colonies under glass. These experiments are not yet complete.

2. The termites.—The following 10 species of termites were found attacking test-pieces of timber during the first 3 years of the durability trials:

Heterotermes tenuis (Hagen) - Very abundant at all four graveyards.
Coptotermes testaceus (L.) - Very abundant at two graveyards during the first year.
Nasutitermes costalis (Holmgren) - Fairly abundant at three graveyards.
Subulitermes sp. - Rare.
Microcerotermes arboreus Emerson - Rare.
Termes hispaniolae (Banks) - Very rare.
Neocapritermes angusticeps Emerson - Very rare.
Armitermes holmgreni Snyder - Very rare.
Nasutitermes guayanae (Holmgren) - Very rare.
Anoplotermes sp. - Rare.

All of these are soil-dwelling termites, whose chief means of invading dead wood is by way of subterranean tunnels. The nests of Heterotermes tenuis

and Coptotermes testaceus are subterranean, and those of Nasutitermes are usually built on trees high above the ground. No attempt was made to discover the nests of the termite colonies invading the graveyards, as this would have involved extensive excavation in the case of Heterotermes and Coptotermes, and would have interfered with the progress of the trials. The point of invasion of the test-pieces was generally within about 2 inches of the surface of the soil. It very rarely occurred at the lowest surface of the timber, which was at a depth of about 1 foot. From the points of invasion, the termites extended their galleries to about the same extent above as below ground level. Covered passages were commonly built on the exposed surface of the test-pieces by Nasutitermes, rarely by Heterotermes, and never by Coptotermes.

Heterotermes tenuis is the most destructive of the subterranean termites in many if not most parts of the New World tropics. In some of them, its place is taken by related species of similar habits. In Trinidad, it is extremely abundant everywhere and all dead wood in contact with the ground is likely to be subjected to its attack within periods of a few months. Damage to wood in buildings is widespread and severe. In all 4 sites of the durability trials Heterotermes tenuis has occurred constantly and continuously and most of the records of termite damage refer to this species. It was responsible, solely or in conjunction with fungi, for the destruction of 320 test-pieces.

Coptotermes testaceus belongs to the most destructive of all the genera of termites. This species, however, which occurs in many South American countries and in Trinidad, Tobago and Grenada in the West Indies, is responsible for much less damage than Heterotermes, because it is less widespread. In Trinidad, it is not uncommon in forests, but it has been found in relatively few buildings, all of which were suffering from very severe damage. Coptotermes occurred at only 2 of the graveyards and only for short periods, but during these it was even more destructive than Heterotermes. At the Southern Watershed Reserve it attacked 66 test-pieces, destroying 34 of them, during the first 6 months of the trials, but on the second examination, 1 year after the start, not a single Coptotermes was found. At the Royal Botanic Gardens, it attacked 131 test-pieces, destroying 78 of them during the first 6 months; after 12 months its numbers had decreased slightly and after 18 months only two test-pieces were found to contain live specimens of this species. None was found on the fourth and following examinations. It appears likely that each of these graveyards was invaded by a small number of very large and vigorous colonies of Coptotermes, possibly by a single colony, which subsequently died out completely and was not replaced by others.

Nasutitermes costalis is the commonest builder of "carton" nests on tree-trunks, etc., throughout the West Indies and probably in many parts of South America. It is reported as destructive in buildings in Puerto Rico, though in Trinidad it is rarely found attacking sound wood in buildings except in those which are suffering from extreme neglect. This species appeared in all graveyards, except at the Royal Botanic Gardens, and occurred irregularly and in small numbers as compared to Heterotermes. The largest number of test-pieces attacked by it at one time was 49, at Arena after 6 months of the trials—the number attacked then by Heterotermes was 158. Nasutitermes was involved in the destruction of a total of 46 test-pieces during the 3 years' test at the 3 graveyards combined, against 260

destroyed by Heterotermes, and most of the timbers destroyed by Nasutitermes had been damaged by other termites or by fungi. The tests show, however, that Nasutitermes costalis is capable of doing extensive damage to sound timber, though its attacks are much less severe than those of Heterotermes and Coptotermes.

The last seven species of termites in the above list were present in negligible numbers, none of them being found in more than 20 test-pieces at all graveyards combined. This was surprising in the case of Microcerotermes arboreus, which is extremely abundant in dead tree stumps, logs, fence posts, etc., in Trinidad. It was found in only one graveyard, at the Southern Watershed Reserve, in relatively small numbers, in 1939 and 1940. It was expected also that the graveyards would be invaded by larger numbers both of species and individuals of Termitidae feeding on decaying wood.

No members of the Kalotermitidae or "dry-wood" termites appeared in any of the test-pieces.

Towards the end of the second year of the trials, there was a great reduction in the numbers of termites present in all the graveyards. In the case of Coptotermes this may have been due to the death of one or a few large colonies. In the case of Heterotermes no full explanation has been found. The termites continued to be distributed widely and fairly evenly throughout the graveyards, but in considerably reduced density. The food supply was not greatly diminished, because pieces of timber that were destroyed were not removed from the graveyards. It is possible that the timbers became less attractive or less nutritious as a result of fungal attacks or weathering, but even if this were true it would probably not provide a complete explanation. Under natural conditions Heterotermes is often found in great numbers in wood which is rotten throughout.

3. Resistance of the timbers to termites.—These notes refer to termite damage only. The figures for numbers of pieces destroyed by termites include pieces destroyed by termites and fungi jointly.

Acurel. ? Fairly resistant, but tests interrupted by fungal attack. Only slight attacks in first year; 2 of 3 remaining pieces badly damaged after 2 years.

Blackheart. Susceptible. Little attack in first year, but many pieces badly damaged after 1½ years and nearly 100% attacked after 2 years.

Bois lisette. ? Fairly resistant, but tests interrupted by fungal attack. Slight damage in first year and only a few pieces badly attacked after 1½ years.

Bois mulatre. Very resistant. Almost no damage during first 2 years, and only 5% badly attacked after 3 years.

Cajuca. Very susceptible. 71% attacked and 52% destroyed in 7-9 months.

Figuier. Very susceptible. 81% attacked and 48% destroyed in 7-9 months.

Black fiddlewood. Fairly resistant. 39% attacked and 7% destroyed after 2 years.

White fiddlewood. Fairly resistant. Few pieces attacked in first year, 46% attacked after 1½ years, but only 2% destroyed.

Galba. Fairly resistant. Slight damage to many pieces during first 2 years, severe damage to a few (5% destroyed in 1½ years).

Gommier viande biche. Very susceptible. 100% attacked and 71% destroyed in 1 year.

Guatecare. Very resistant. Little attack in first 2 years, except on sapwood. A few pieces badly damaged in third year, but perhaps mostly following attack on sapwood.

Red mangrove. Susceptible. 77% attacked in 6 months, 42% destroyed in 2 years, but 12 pieces standing after 3 years.

Laylay. Very susceptible. 95% attacked and 71% destroyed in 7-9 months.

Mahoe. Very susceptible. 67% attacked and 18% destroyed in 7-9 months.

Hog plum. Very susceptible. The most severely attacked of all the timbers. 99% attacked and 76% destroyed in 7-9 months.

Yellow mangue. Susceptible. 47% attacked in 6-9 months, 86% attacked after 2 years, but only 8% destroyed after 3 years.

Milkwood. Very susceptible. 83% attacked and 27% destroyed in 7-9 months.

White olivier. Fairly resistant. Few pieces badly damaged in first year and none destroyed after 3 years, but 72% attacked after 2 years.

Yellow olivier. Fairly resistant. 40% attacked in 1 year, but only 1 piece destroyed in 3 years and 21 of the original 23 pieces at Arena still standing after 3 years.

Sandbox. Susceptible. 48% attacked in 1 year, but only 17% destroyed after 3 years, and 8 of the 60 original pieces still standing. This very soft wood was not expected to last long in the ground; it proved highly attractive to termites in laboratory preference tests.

Sardine. Very susceptible. 50% attacked and 31% destroyed in 9 months.

Serrette. ? Resistant, but tests interrupted by fungus attack. No pieces badly damaged after 1½ years.

Tapana. Resistant. Only 4% attacked after 1 year, few pieces badly damaged after 2 years, and only 1 destroyed in 3 years.

Teak (10 years old). Susceptible. 13% attacked after 5 months and many badly damaged after 1½ years. Mature teak is known to be resistant to termites.

Toporite. Very susceptible. 69% attacked and 37% destroyed after 6 months.

Wild coffee. Susceptible. 23% attacked in 6-9 months; 59% attacked and 12% destroyed in 1½ years.

Wild chataigne. Very susceptible. 93% attacked and 52% destroyed in 7-9 months.

Balata. Very resistant. No pieces badly attacked in 2 years, 11% after 3 years.

Poui. Very resistant. No pieces badly attacked after 2 years, 12% after 3 years.

Pitch pine (high pitch content). Resistant, but due to protection by pitch. 83% attacked and 14% destroyed after 3 years but 59 of the original 81 pieces still standing after 3 years. When the pitch content is normal, this timber is subject to extensive damage by Heterotermes and Cryptotermes in Trinidad.

Douglas-fir. Very susceptible. 81% attached and 41% destroyed in 6-9 months, and 75% destroyed in 1½ years.

Redwood. Very resistant. No pieces badly attacked after 1 year and few badly attacked after 3 years.

Mora. Resistant, on 2-year test. No pieces badly attacked after 1 year, and 4% badly attacked after 1½ years.

The following table summarizes the resistance of the various timbers to termite attack:

Table 1.—Comparative resistance of timbers to termite attack

Very resistant	Resistant	Fairly resistant	Susceptible	Very susceptible
Balata	Mora	? Acurel	Blackheart	Cajuca
Bois mulatre	Pitch pine	? Bois lisette	Red mangrove	Douglas-fir
Guatecare	(high pitch	Black fiddlewood	Yellow mangrove	Figuier
Poui	content)	White fiddlewood	Sandbox	Gommier viande
Redwood	? Serrette	Galba	Teak (10 years	biche
	Tapana	White olivier	old)	Hog plum
		Yellow olivier	Wild coffee	Laylay
				Mahoe
				Milkwood
				Sardine
				Toporite
				Wild chataigne

4. Discussion of results.—The records show that wood susceptible to termite attack is not likely to escape damage by subterranean termites, especially Heterotermes, if placed in the ground in Trinidad, for more than a few months. Slightly susceptible timbers have little chance of remaining structurally sound for as much as 1 year. Only the more resistant woods are likely to survive for more than 2 years.

None of the timbers proved immune to termite attack under the severe test of partial burial in the ground. The most resistant wood, poui, remained entirely free from attack for 2 years (a few pieces containing small amounts of sapwood are not considered here), but during the third year 6 pieces (13% of those that had survived fungal attack) were damaged by termites, 1 of them seriously. Bois mulatre resisted all attacks for 1 year; 15% of the pieces free from sapwood were attacked in the second and 22% in the third year. One piece of balata was attacked in the first year, 22% in the second, and 48% in the third. None of these timbers suffered destruction by termites during the 3 years of the tests, but the number of pieces badly damaged by termites was 8 (4% of the original total, excluding sapwood) for the three species combined.

The records do not suggest that termite attack was favored by fungal damage, or that penetration of fungi was greatly accelerated by the inroads of termites. Indeed, the reduction in the numbers of Heterotermes and Coptotermes during the second and third years of the trials, as already mentioned, may even suggest that decayed wood is less attractive to these termites than sound timber.

In table 2, in each set of three figures the upper figure is the number of test-pieces standing at the time of each examination at all four graveyards combined. Of the two lower figures the first is the percentage of these pieces attacked by termites, including pieces recorded at that time as destroyed by them. The second lower figure is the percentage of the original total number of pieces destroyed by termites (or by termites and fungi combined) up to and including the time of each examination. The first examination was made after the timbers had been in the ground for about 6 months. Example: No. 2, Blackheart, Oct. 1939: On that date, 2½ years after the beginning of the trials, 43 pieces of Blackheart were standing in the graveyards. Of these 43, 93 per cent were then found to be attacked by termites. Of the original 69 pieces, 3 per cent were destroyed by termites (or termites and fungi combined) by October 1939.

Table 2.—Test-pieces standing at all four graveyards, and percentage attacked or destroyed by termites and by fungi (pieces inserted in ground in spring of 1937)

Species	Date of examination					
	November 1937	April 1938	November 1938	April 1939	October 1939	April 1940
Acurel	62 2 0	58 19 0	32 44 0	3 100 2		
Blackheart	69 9 0	69 22 0	68 60 1	56 84 1	43 93 3	28 93 4
Bois lisette	70 9 0	70 20 0	61 31 1	1 0 1		
Bois mulatre	60 0 0	59 0 0	56 4 0	50 18 0	47 19 0	40 28 0
Cajuca	77 92 68					
Figuier	67 86 48	4 50 48	2 50 48	2 100 48	2 100 48	2 100 49
Black fiddlewood	73 11 1	71 23 5	43 26 5	33 39 7	24 46 7	13 46 7
White fiddlewood	44 0 0	44 11 0	41 46 2	30 47 2	27 63 2	19 84 2
Galba	62 11 2	58 26 3	33 33 5	15 53 5	5 40 5	3 33 5
Gommier viande biche	69 87 43	38 100 71	17 94 80	8 100 84	3 100 86	1 100 86
Guatecare	43 7 0	43 12 0	43 33 2	42 38 2	42 48 7	33 70 7
Red mangrove	65 77 0	64 92 18	55 98 22	41 100 42	24 100 46	18 100 51
Laylay	59 95 71	1 100 71				

Table 2.—Continued

Species	Date of examination					
	November 1937	April 1938	November 1938	April 1939	October 1939	April 1940
Mahoe	66 67 18	20 60 23	2 50 23			
Hog plum	75 99 73	3 100 76				
Yellow mangue	73 47 1	72 57 1	72 86 3	64 95 7	59 100 8	54 96 8
Milkwood	63 83 27	3 100 29				
White olivier	67 0 0	67 21 0	65 55 0	53 75 0	41 73 0	27 74 0
Yellow olivier	52 23 0	50 40 2	46 48 2	38 66 2	35 86 19	35 60 19
Sandbox	60 23 0	60 48 7	49 76 13	35 94 13	29 93 17	15 93 17
Sardine	36 50 31	14 43 33				
Serrette	79 1 0	79 14 0	54 44 0	7 44 0	1 0 0	
Tapana	76 0 0	75 4 0	56 39 1	20 45 1	6 50 1	3 100 1
Teak (10 years old)				80 16 0	80 21 0	79 48 0
Toporite	59 69 37	1 0 37				
Wild coffee	66 23 0	65 57 6	37 59 12	12 17 12	11 27 12	7 29 12
Wild chataigne	56 93 52	2 100 54				
Balata	79 0 0	79 1 0	79 9 0	70 24 0	68 47 0	63 52 0
Poui	62 0 0	62 2 0	62 6 0	58 14 0	57 35 0	57 42 0
(high pitch Pitch pine content)	81 38 2	79 52 6	77 71 11	66 76 12	62 84 14	59 83 14
Douglas-fir	80 81 41	47 96 61	31 87 75	15 100 81	9 100 86	4 100 88
Redwood	59 3 0	58 2 0	54 11 0	52 17 0	41 32 0	32 44 0
Mora				49 27 0	49 8 0	49 27 0

Table 3.—Test-pieces attacked or destroyed at each of the four graveyards

Termites involved	Date of examination												Total pieces destroyed
	November 1937		April 1938		November 1938		April 1939		October 1939		April 1940		
	Attacked	Destroyed	Attacked	Destroyed	Attacked	Destroyed	Attacked	Destroyed	Attacked	Destroyed	Attacked	Destroyed	
Heterotermes tenuis	64 82 238 38 54	31 76 189 38 44	69 85 267 53 60	19 18 54 7 10	71 76 195 18 30	13 15 39 9 2	85 126 328 40 77	8 5 16 1 2	69 106 288 39 74	5 8 15 2 0	56 95 216 33 32	4 1 7 - 2	320
Coptotermes testaceus	32 - 85 - 53	34 - 112 - 78	- - - 37	- - - 10	- - - 2	- - - 2	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	124
Nasutitermes costalis	- 21 24 3 -	- 28 29 1 -	- 9 11 2 -	- 5 - -	- 5 40 35 -	- 1 3 2 -	- 10 33 23 -	- 1 7 6 -	- 10 38 28 -	- - 1 -	- 9 39 30 -	- - 1 -	46
Subulitermes sp.	3 1 8 - 4	- - - -	- - - 4	- - - -	- - - -	- - - -	- 1 2 - 1	- - - -	2 - 7 - 5	- - - -	- - - -	- - - -	-
Nasutitermes guayanae	- - 1 -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	-
Microcerotermes arboreus	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	6 - - -	- - - -	8 - - -	- - - -	6 - - -	- - - -	-
Neocapritermes angusticeps	2 - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	-
Armitermes holmgreni	3 - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	-
Termes hispaniolae	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	2 - - -	- - - -	- - - -	- - - -	-
Anoplotermes sp.	- - - -	- - - -	- - - -	- - - -	- - - 1	- - - -	3 - 2 -	- - - -	- - - -	- - - -	- - - -	- - - -	-

Explanation of Table 3

Attacked: Number of pieces attacked but not destroyed at each of the four graveyards at time of each examination, followed by total for all graveyards.

Destroyed: As for attacked. Includes pieces destroyed by termites and fungi jointly.

In some cases, especially at Arena in 1939-40, the test-pieces recorded as attacked by Heterotermes had been abandoned by the termites.

Order: Southern Watershed Reserve, Arena, Central Range Reserve, Royal Botanic Gardens.

Attack by fungi

1. Plan and scope of the tests against fungi.—The plan of the trials has also proved to be satisfactory with regard to fungal attack. No attempt was made to infect or inoculate the graveyards with wood-rotting fungi by means of cultures or rotten wood or any other method, so that all attacks are the result of natural infection. This has been satisfactory, as fungal attack has been very severe especially during the first year and on the softer timbers.

Many of the test-pieces were destroyed, i.e., broken at ground level, before the organisms concerned had formed their fructifications. Such pieces were put back in the ground and in many instances fructifications developed some months later. These were assumed to be the fructifications of the organism which had destroyed the piece. Some test-pieces never produced fructifications of any kind.

Cultural work with the fungi was thought to be beyond the scope of the present investigation and was not attempted. The list of fungi concerned is therefore of necessity incomplete, but gives some idea at any rate of the Higher Fungi concerned.

Conditions in the graveyards were especially favorable to fungi that attack wet wood, and constituted a very severe test for the timbers. It was most noticeable that the test-pieces usually broke at or near ground level, the point at which fence posts and other structures standing in wet soil are normally attacked. The typical "dry-rots" or floors, etc., such as Merulius lachrymans and Coniophora puteana, were not found. Many of the timbers which rapidly succumbed to fungal attack under the conditions of the graveyards should still prove of value if protected from the weather.

2. The fungi.—

Ascomycetes.—Ascomycetous fungi belonging to several genera, including Bolinia, Daldinia, Hypoxylum, and Xylaria, have occurred commonly (see table 5). Their fructifications are usually black, purple or reddish, resupinate and crustose. They are commonly associated with irregular black lines in the timber and a loss of

structural strength. They undoubtedly cause damage, and probably some of the test-pieces recorded as "destroyed by unknown fungi" were in reality destroyed by Ascomycetes.

It is unfortunate that specific identifications of some of these fungi could not be obtained.

Basidiomycetes.—Of necessity, many of the identifications have been made from American literature, and some of the names, especially those of Murrill, are not recognized outside the United States. Whenever possible, specimens have been sent to the Imperial Mycological Institute for confirmation.

List of genera and species of Basidiomycetes recorded

1. Rare and probably harmelss:

Boletus sp.
Cantherellus sp.
Hydnum sp.
Lentinus crinitus (Linn.) Fr.
Lentinus strigosus (Schw.) Fr.
Stereum spp. (not including S. australe)
Sphaerobolus stellatus (Tode) Pers.

2. Rare, but possibly doing damage:

Corticium spp.
Fomes spp.
Ganoderma praelongum Murrill
Pleurotus sp.
Polyporus spp.
Cycloporellus iodinus (Mont.) Murrill
Pycnoporus sanguineus (Linn.) Murrill
    Polystictus sanguineus Fr.

3. Common, but probably harmless:

Cyathus berkleyanus Tul.
Guepinia spathularia (Schw.) Fr.
    Calocera viscosa (Pers.) Fr.
Schizophyllus alneus (Linn.) Schroet.
    Schizophyllum commune Fr.

4. Common and doing damage:

Auricularia polytricha
    Auricularia auricula-Judae (Linn.) Schroet.
Auricularia spp.
Gloeophyllum striatum (Sw.) Murrill
    Lenzites striata Fr.

4. Common and doing damage (continued):

Hymenochaete sp.
Pogonomyces hydnoides (Sw.) Murrill
Trametes hydnoides (Sw.) Fr.
Poria spp.
Coriolopsis caperata (Berk.) Murrill
Polystictus caperatus (Berk.) Fr.
Coriolopsis occidentalis (Kl.) Murrill
Polystictus occidentalis (Kl.) Fr.
Coriolopsis fulvocinerea Murrill
Stereum australe Lloyd

Of these, Coriolopsis fulvocinerea, Cycloporellus iodinus, and Ganoderma praelongum are new records for Trinidad. Notes are given below on some of the commoner or more important species.

Cyathus berkleyanus.—One of the "bird's nest" fungi. It is very common in Trinidad, but probably only lives on rotten wood rendered useless by other organisms.

Guepinia spathularia.—Commonly found on top of the test-pieces, where it may have done a little damage, but more probably only attacks previously softened wood. It was never found at ground level and therefore contributed nothing towards the destruction of the test-pieces.

Schizophyllus alneus.—Occurred commonly on many different timbers. Although it has been described as a timber-destroying fungus, in our opinion it contributed little or nothing towards the destruction of the test-pieces.

Auricularia polytricha and other spp.—Has been found on several timbers, especially the 10-year-old teak. It is probably capable of destroying timber, but is of no great importance.

Gloeophyllum striatum.—Only found on red mangrove and blackheart, but was very common on the former. Although the fructifications are usually produced near the top of the test-piece, there can be no doubt that this fungus does considerable damage to these two timbers.

Hymenochaete sp.—The small brown fructifications of a species of this genus have been found just above ground level on several timbers, but especially on balata. As this timber is exceedingly hard and durable, the fact that this fungus has been constantly associated with its destruction is noteworthy.

Pogonomyces hydnoides.—Undoubtedly causes considerable damage, especially to acurel and wild coffee. The large, hairy, bracket-like fructifications are produced near the top of the test-piece.

Poria spp.—Species of this genus have occurred on and damaged several timbers. They are probably quite important. It has not been possible to make any specific identifications.

Polystictus spp.--Coriolopsis caperata, Coriolopsis occidentalis, Coriolopsis fulvocinerea, Cycloporellus iodinus, Pycnoporus sanguineus. These five species have been referred to collectively as "Polystictus species." One or more have occurred commonly in all four graveyards and have attacked many timbers, but especially acurel.

Stereum australe.--Has been very common on bois lisette, and has been responsible for the complete destruction of this timber in all four areas in the early stages of the experiment.

Many test-pieces have been destroyed by unidentified fungi. When a test-piece was found on examination to be rotten but without visible fructifications, the upper half was put back in the ground in the hope that fructifications would develop subsequently. Sometimes this hope was realized but in many instances none developed, and as no cultural work could be attempted, such test-pieces have simply been recorded as "destroyed by unidentified fungi."

3. Resistance of the timbers to fungi.--The 33 timbers under investigation were placed in 5 classes:

(a) Very resistant
(b) Resistant
(c) Fairly resistant
(d) Susceptible
(e) Very susceptible

Of the timbers classed as very resistant, most of the test-pieces remained unbroken after 3 years, while those classed as very susceptible were mostly destroyed in the first 6 months. The other three classes are intermediate. Accurate numerical results cannot be given as they are upset by termite attack and must depend to a large extent on observation and inference in an experiment of this kind. (See table 4.)

Table 4.--Resistance to fungal attack

Very resistant	Resistant	Fairly resistant	Susceptible	Very susceptible
Balata	Bois mulatre	Blackheart	Black fiddlewood	Acurel
Poui	Guatecare	White fiddlewood	Galba	Bois lisette
Pitch pine	Yellow mangue	Red mangrove	Gommier viande	Cajuca
	Redwood	White olivier	biche	Figuier
		Yellow olivier	Serrette	Laylay
		Sandbox	Tapana	Mahoe
		Teak (10 yrs. old)	Mora	Hog plum
		Douglas-fir		Milkwood
				Sardine
				Toporite
				Wild coffee
				Wild chataigne

4. Ecological observations.—It has sometimes been observed that one fungus has been particularly common in one locality or on one timber. (See tables 5 and 6.)

It is difficult to compare the damage done to any timber in the four graveyards, but on the whole table 6 seems to indicate that most of the fungi which have been at all abundant in the graveyards are common to all of them. Noteworthy exceptions include the presence of Corticium spp. in No. 4 only, the absence of Pogonomyces hydnoides from No. 4, and the absence of Poria spp. from No. 1. It is probable that most of the fungi concerned occur commonly on rotten wood all over Trinidad in the forests, and certainly the majority of them are among those commonly picked up while collecting in the forests.

It is also possible to pick out timbers which have been attacked by very many fungi, and fungi which show a marked preference for certain timbers. Examples of the first kind are acurel (attacked by 13 species), red mangrove (attacked by 12 species), and wild coffee (attacked by 10 species). On the other hand, Gloeophyllum striatum and Guepinia spathularia have occurred most commonly on red mangrove, Pogonomyces hydnoides has been confined to acurel and wild coffee, 60% of the Hymenochaete sp. found have been on balata, and Stereum australe was confined to bois lisette. This last association was most striking as the fructifications of Stereum australe were produced in great abundance.

Findlay[1/] states that the durability of the heartwood of most timbers is due mainly to the presence of certain extractives, soluble in water, alcohol, or benzol, which are formed as the sapwood is changing into heartwood, and are toxic to wood-destroying fungi. The marked preference of certain fungi for certain timbers already noted is probably due to the presence or absence of these extractives.

5. Discussion of results.—The results are summarized in table 4. As was expected none of the timbers proved to be immune to fungal attack, but the two celebrated local hardwoods, balata and poui, stood up best, although the imported pitch pine, which was apparently of very high quality, ran them close. Guatecare and redwood also stood up well. Young teak and mora, but especially the latter, were disappointing, while for a soft light wood the sandbox lasted very well.

The most destructive fungi are undoubtedly the group referred to as Polystictus species although certain others such as Gloeophyllum striatum, Hymenochaete sp., Pogonomyces hydnoides, Auricularia spp., and Stereum australe have attacked and damaged certain timbers. The chief interest of the latter lies in their close association with certain timbers as outlined in the previous section.

1/ Findlay, W. P. K. The Natural Resistance to Decay of Some Empire Timbers. Empire Forestry Journal 17 (2): 249-259. 1938.

Table 5.—Analysis of wood-rotting fungi occurring in the durability trials in Trinidad, B. W. I., up to March 1940[1/]

Species	Ascomycetes, various	Auricularia spp.	Boletus sp.	Cantherellus sp.	Corticium spp.	Cyathus berkleyanus	Fomes spp.	Ganoderma praelongum	Gloeophyllum striatum	Guepinia spathularia	Hydnum sp.	Hymenochaete sp.	Lentinus spp.	Pleurotus sp.	Pogonomyces hydnoides	Polyporus spp.	Poria spp.	Polystictus spp.	Coriolopsis caperata	Coriolopsis occidentalis	Coriolopsis fulvocinerea	Cyloporellus iodinus	Pycnoporus sanguineus	Schizophyllus alneus	Stereum australe	Stereum spp.	Sphaerobolus stellatus	Susceptibility to fungal attack
Acurel	37	3	-	-	-	-	2	-	-	10	1	-	3	-	15	1	5	31	-	2	2	-	-	-	-	1	Very susceptible
Blackheart	7	-	2	1	-	-	-	-	5	5	-	-	-	-	-	-	1	4	1	-	-	-	-	4	-	-	Fairly resistant
Bois lisette	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	1	58	-	Very susceptible
Bois mulatre	2	-	-	-	-	-	-	1	1	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	Resistant
Cajuca	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	Very susceptible
Figuier	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	8	-	-	-	-	-	-	-	-	Very susceptible
Black fiddlewood	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-	1	-	-	Susceptible
White fiddlewood	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	13	-	1	Fairly resistant
Galba	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	4	3	-	1	-	-	-	-	-	-	Susceptible
Gommier viande biche	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	Susceptible
Guatecare	4	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	1	-	-	-	-	-	-	-	Resistant
Red mangrove	3	-	-	-	-	-	-	-	27	30	-	-	1	4	-	3	-	3	-	2	1	-	1	3	-	-	Fairly resistant
Laylay	6	4	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	Very susceptible
Mahoe	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	-	-	-	-	Very susceptible
Hog plum	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	Very susceptible
Yellow mangue	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	Resistant
Milkwood	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Very susceptible
White olivier	-	-	-	-	2	-	-	-	-	-	-	3	-	-	-	-	1	-	-	-	-	3	-	-	-	-	Fairly resistant
Yellow olivier	-	-	-	-	3	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Fairly resistant
Sandbox	2	-	-	-	-	-	1	-	-	3	1	-	1	-	-	-	4	1	-	-	-	-	-	9	-	-	Fairly resistant
Sardine	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	Very susceptible
Serrette	-	4	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	Susceptible
Tapana	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	Susceptible
Teak (10 years old)	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	Fairly resistant
Toporite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	Very susceptible
Wild coffee	3	-	-	-	-	1	1	-	-	1	-	4	-	-	10	-	8	4	1	1	-	-	-	-	-	-	Very susceptible
Wild chataigne	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	Very susceptible
Balata	-	-	-	-	5	-	-	-	-	-	-	12	-	-	-	-	1	-	-	-	-	1	-	-	-	-	Very resistant
Poui	5	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	Very resistant
Pitch pine	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	3	1	-	1	-	-	-	-	-	-	Very resistant
Douglas-fir	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	Fairly resistant
Redwood	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	3	2	-	-	-	-	-	-	-	-	Resistant
Mora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Susceptible

1/ The figures represent the number of test-pieces in all four graveyards on which the organism in question was collected.

Table 6.—Occurrence of the fungi at the four graveyards

Fungi	Graveyard number			
	1	2	3	4
Ascomycetes, various	8	4	33	37
Auricularia spp.	8	15	3	6
Boletus sp.	-	-	1	1
Cantherellus sp.	-	-	1	-
Corticium spp.	-	-	-	13
Cyathus berkleyanus	-	1	3	2
Fomes spp.	-	-	4	-
Ganoderma praelongum	-	-	-	-
Gloeophyllum striatum	7	3	10	15
Guepinia spathularia	12	24	11	7
Hydnum sp.	-	-	-	3
Hymenochaete sp.	-	5	2	13
Lentinus spp.	3	-	-	1
Pleurotus sp.	1	1	2	3
Pogonomyces hydnoides	5	9	11	-
Polyporus spp.	2	2	-	1
Poria spp.	-	10	8	32
Polystictus spp.	17	5	29	14
Coriolopsis caperata	3	-	-	-
Coriolopsis occidentalis	1	2	4	1
Coriolopsis fulvocinerea	-	1	1	2
Cycloporellus iodinus	-	3	-	1
Pycnoporus sanguineus	1	-	-	-
Schizophyllus alneus	4	3	3	31
Stereum australe	20	19	4	15
Stereum spp.	-	-	-	1
Sphaerobolus stellatus	1	-	-	2

General conclusions

Under the conditions provided by the test, it was found that fungus attack was responsible for a greater degree of damage and destruction than termites, although, as has already been shown, very large populations of Heterotermes developed during the first 6 months throughout all the graveyards.

There was a fairly close correlation between the relative susceptibilities of the various timbers to termite and fungal attack. Six of the nine species with greatest resistance to termites were resistant to fungi also, but the other three, mora, serrette, and tapana, proved to be susceptible to fungal attack. Other exceptional cases were those of Douglas-fir, which was very susceptible to termites but fairly resistant to fungi; acurel and bois lisette, which were very susceptible to fungi but fairly resistant to termites; and yellow mangue, which was susceptible to termites but resistant to fungi.

It must be borne in mind that the results recorded in this paper show the durability of the various species of timber tested when in contact with

the ground where conditions were of extreme severity. It does not follow, therefore, that the species which show little resistance under these conditions are to be regarded as unsuitable for use under very much milder conditions, as when not in contact with the ground and protected from the weather.

The following summary shows the relative resistance of the timbers to both forms of attack:

Table 7.—Resistance of timbers to fungi and to termites

Species	Total No. pieces	To fungi	To termites
Acurel, Trichilia oblanceolata Rusby	62	Very susceptible	Fairly resistant
Blackheart, Clathrotropis brachypetala (Tul.) Kleinh.	69	Fairly resistant	Susceptible
Bois lisette, Mouriria marshallii Burtt Davy	70	Very susceptible	Fairly resistant
Bois mulatre, Pentaclethra macroloba (Willd.) Kuntze	60	Resistant	Very resistant
Cajuca, Myristica surinamensis Rol.	77	Very susceptible	Very susceptible
Figuier, Ficus sp.	67	Very susceptible	Very susceptible
Black fiddlewood, Vitex divaricata Sw.	73	Susceptible	Fairly resistant
White fiddlewood, Vitex capitata V.	44	Fairly resistant	Fairly resistant
Galba, Calophyllum lucidum Benth.	62	Susceptible	Fairly resistant
Gommier viande biche, Tapirira guianensis Aubl.	69	Susceptible	Very susceptible
Guatecare, Eschweilera subglandulosa Steud. Miers	43	Resistant	Very resistant
Red mangrove, Rhizophora mangle L.	65	Fairly resistant	Susceptible
Laylay, Cordia sulcata DC.	59	Very susceptible	Very susceptible
Mahoe, Sterculia caribaea R. Br.	66	Very susceptible	Very susceptible
Hog plum, Spondias monbin L.	75	Very susceptible	Very susceptible
Yellow mangue, Symphonia globulifera L. fil.	73	Resistant	Susceptible
Milkwood, Sapium aucuparium Jacq.	63	Very susceptible	Very susceptible
White olivier, Terminalia obovata (R. & P.) Steud.	67	Fairly resistant	Fairly resistant
Yellow olivier, Buchenavia capitata (Vahl.) Eichl.	52	Fairly resistant	Fairly resistant
Sandbox, Hura crepitans L.	60	Fairly resistant	Susceptible
Sardine, Laetia procera (Poepp. & Endl.) Eichl.	36	Very susceptible	Very susceptible
Serrette, Byrsonima spicata Rich.	79	Susceptible	Resistant
Tapana, Hieronyma caribaea Urb.	76	Susceptible	Resistant
Teak, Tectona grandis Linn. (10 yrs. old)	80	Fairly resistant	Susceptible
Toporite, Hernandia sonora L.	59	Very susceptible	Very susceptible
Wild coffee, Eugenia confusa DC.	66	Very susceptible	Susceptible
Wild chataigne, Pachira insignis Sw.	56	Very susceptible	Very susceptible
Balata, Manilkara bidentata (A.DC.) Chev.	79	Very resistant	Very resistant
Poui, Tabebuia serratifolia Nichols	62	Very resistant	Very resistant

Table 7.—Continued

Species	Total No. pieces	To fungi	To termites
Pitch pine, Pinus palustris Miller	81	Very resistant	Resistant
Douglas-fir, Pseudotsuga douglasii Carr.	81	Fairly resistant	Very susceptible
Redwood, Guarea trichiliodes L.	59	Resistant	Very resistant
Mora, Mora excelsa Benth.	49	Susceptible	Resistant

Resumen

Debido a la escasez de las dos maderas de construcción más durables de Trinidad (balata y poui) se llevaron a cabo pruebas de durabilidad con varias maderas nativas e importadas con el propósito de encontrar sustitutos satisfactorios. El objeto de las pruebas descritas con pedazos de madera sin tratamiento alguno, de 3 pies de largo y 2 pulgadas cuadradas, era para determinar las especies locales de hongos y termes que causan daño a la madera que está en contacto con la tierra, y también la resistencia natural relativa de las especies de maderas seleccionadas.

Un número considerable de muestras de madera de cada especie se enterraron parcialmente en la tierra a un pie de profundidad en cuatro localidades distintas en la isla y se examinaron los especímenes cada seis meses durante tres años. Las especies de termes y hongos que se encontraron atacando los especímenes de madera, y la susceptibilidad relativa o resistencia al ataque de aquellos, se relatan en el artículo.

Las conclusiones generales de los autores son las siguientes:

Bajo las condiciones proporcionadas por la prueba, se encontró que el ataque de los hongos ocasionaba más daño y destrucción que el de los termes, aunque como se ha probado, grandes colonias de Heterotermes se desarrollaron en todos los cementerios durante los primeros seis meses.

Hubo una correlación bastante estrecha entre la susceptibilidad relativa de las distintas maderas al ataque de los termes y los hongos. Seis de las nueve especies más resistentes a los termes fueron también resistentes a los hongos, pero las otras tres, mora, serrette, y tapana, demostraron ser susceptibles al ataque de los hongos. Otros casos excepcionales fueron los de Douglas-fir que fué susceptible a los termes pero bastante resistente a los hongos; acurel y bois lisette, susceptibles a los hongos y bastante resistente a los termes; y yellow mangue, susceptible también a éstos pero resistente a los hongos.

Debe tenerse en mente que los resultados expuestos en este artículo demuestran la durabilidad de las varias especies de madera al ser probadas en contacto con la tierra y donde las condiciones eran en extremo severas. Esto no significa, por lo tanto, que las especies que demuestran poca resistencia bajo estas condiciones se conceptúen inadecuadas para usarse bajo condiciones mucho más moderadas como cuando no están en contacto con la tierra y protegidas de la intemperie.

LOS PINARES DE LA REPUBLICA DOMINICANA

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Introducción

Los pinares de la República Dominicana ocupan una superficie de 7,500 kilómetros cuadrados, aproximadamente, en el interior montañoso del país.1/ La cifra indicada equivale a cuatro quintas partes del territorio de Puerto Rico. Esta selva de pinares constituye, pues, la mayor reserva existente de maderas útiles en las Antillas. Nada hay en ellas que pueda comparársele, en extensión ni en riqueza potencial. Su tamaño es cerca de cuarenta veces el área del Parque Nacional de Luquillo, en Puerto Rico, y tiene muchos lugares agrestes no hollados aún por la planta del hombre.

La región de la Cordillera Central Dominicana que guarda estos pinares está llena de leyendas y misterios que aun no se han podido descifrar. Gonzalo Fernández de Oviedo, en su "Historia General y Natural de las Indias" (1535), dice en su crónica:

"Muchos pinos naturales hay en esta Isla Española, grandes y pequeños, todos inútiles en el fruto, pues que no llevan piñas sino vanas e muy chiquitas. Esta es muy buena madera, aunque acá no usan della por estar lexos, y aún porque no es tan dulce ni tal como la de los pinos de Castilla, é tiene mucha thea é ñudos é mucha salvajez é gran olor de la resina é mas enojoso quel de los de España."

Es lástima que el más ilustre de los cronistas de la conquista tuviese un concepto tan pobre y errado de la madera de este pino, que, bien curada, es muy buena para construcciones, tanto como la de los pinos de Norte América.

En el interior de la Cordillera Central se encuentran las montañas más altas de las Antillas. Los dominicanos hablan, desde tiempo inmemorial, del Monte Tina como el más alto de su país. Esta creencia llegó a tener tal viso de seguridad, que el Monte Tina figura en muchos mapas y la famosa montaña se concedía estaba en alguna parte de la Cordillera Central, cerca de Constanza, con una altura de 3,140 metros sobre el nivel del mar. Nadie, sin embargo, la había visto sino "muy de lejos." Esta incertidumbre indujo al botánico E. L. Ekman a salir en su busca, y éste cuenta en su interesante folleto2/ como todos sus esfuerzos resultaron infructuosos. Luego, en setiembre de 1937, el autor recorrió una gran parte de este territorio, desde Constanza, pasando por Valle Nuevo y el Río de las Cuevas, a salir a San José de Ocoa, y no pudo dar con la montaña tan debatida.

Sea esto como fuere, en esta región, de acuerdo con los datos geográficos más recientes, se encuentran los picos más altos de las Antillas:

1/ Chardón, C. E. Reconocimiento de los Recursos Naturales de la República Dominicana. 1937. (MSS.)
2/ Ekman, E. L. En Busca del Monte Tina. Santo Domingo, R. D. 1930.

La Pelona (3,168 m.), Pico del Yaque (3,125 m.), Loma Rosilla (2,860 m.), y el Pico de Valle Nuevo (2,650 m.). Todo este arrugado territorio en la cornisa de las Antillas se encuentra poblado de pinos, casi hasta tocar sus más altas crestas.

Esta región incluye también el valle de Constanza, uno de los lugares más bellos de las Antillas, a 1,150 metros de elevación y a un día de camino en bestia, de Jarabacoa. Este valle está situado en el límite superior del piso subtropical, con clima muy fresco, rodeado de altas montañas cubiertas de pinos. En esta región se notan ya los cambios en la vegetación producidos por la altura. El mango y la palma real no florecen a esta altura; en cambio se producen muy bien las papas y el tabaco, y entre los frutales, descuella el aguacate por el tamaño y sabor de sus frutos. Un poco más arriba de Constanza, a los 1,200 metros, se encuentra el límite superior de los cultivos.

Origen de los Pinares

Una de las versiones, erróneas en nuestro concepto, sobre el origen de los pinares de la República Dominicana es la explicación dada por el ingeniero forestal W. D. Durland,3/ que dice:

"La existencia de bosques de pinos tan extensos en la República Dominicana se atribuye a las simples operaciones de los conuqueros con sus métodos agrícolas primitivos. El corte o desmonte contínuo y cremación de las selvas indígenas, que probablemente eran de las clases ya descritas, han destruido la fertilidad del suelo a tal extremo que no puede nutrir esas especies vegetales; como consecuencia el pino efectuó su invasión desde las regiones altas de su habitual morada, en ausencia de competidores y con sus cualidades inherentes para crecer en tales suelos, aclimatarse y reproducirse." (Versión castellana.)

La explicación de Durland es algo pintoresca y no desprovista de imaginación, pero no está sostenida por la lógica, ni menos por los hechos. De las pesquizas que hicimos en la República Dominicana se desprende que Durland no estuvo en el interior de los pinares, y más bien se concretó a visitar las orillas de los mismos a orillas de las carreteras. De acuerdo con nuestras observaciones, hechas sobre el terreno, la selva primitiva (selva pluvial y selva de montaña), al ser destruida por los conuqueros para dedicarla a la agricultura (y luego abandonada), no es reemplazada por formaciones de pinos, sino por formaciones de Cecropia peltata, Jambosa jambos, Piperaceas, y lo que comúnmente se llama "bejuquera."

De acuerdo con Ciferri,4/ la selva pluvial al tumbarse degenera durante los primeros años en una "bejuquera" (Convulaceae), y la selva de montaña degenera en un "calumetal." o asociación de helechos del género Gleichenia. Pero aun suponiendo que la hipótesis de Durland fuese cierta,

3/ Durland, W. D. Los Bosques de la República Dominicana. Geog. Rev. Vol. XII, Núm. 2. 1922. Reproducida por el Ministerio de Agricultura. Santo Domingo. 1925.
4/ Ciferri, R. Studio Geobotanico dell'Isola Hispaniola. Atti del Inst. Bot. Univ. Pavia, Serie IV, Vol. VIII, 336 págs. 1936.

la extensión de los pinares es tan grande que su explicación a base de conucos abandonados resulta pueril.

El origen de los pinares de la República Dominicana puede atribuirse a causas muy distintas a la anotada anteriormente. La familia de los pinos (Pinaceae) comprende unos 29 géneros y 250 especies, extensamente difundidas por la superficie del globo, especialmente en las regiones templadas del hemisferio boreal. De los 14 géneros conocidos en América, hay 13 en los Estados Unidos, 7 en Méjico, 5 en la América Central, y 2 en las Antillas. En la República Dominicana se encuentran dos géneros: Pinus, representado por el pino común, P. occidentalis, y el otro Juniperus, del Valle de Constanza (madera llamada "sabina"), cuya clasificación botánica está aun dudosa.

De acuerdo con Record y Mell,5/ el género Pinus constituye el grupo más importante de árboles de madera en Norte América. En Méjico se conocen 18 especies con una distribución vertical que fluctúa entre los 1,500 y 4,200 metros de elevación sobre el nivel del mar. No se conocen especies de Pinus en el continente de Sur América. Su centro de distribución en el Nuevo Mundo ha sido la región templada del hemisferio boreal, es decir, los Estados Unidos y Canadá. De este centro han habido, evidentemente, dos corrientes migratorias hacia el sur, a saber:

1. Una por Méjico, penetrando en la América Central por Guatemala y Honduras, pero sin llegar a Costa Rica.

2. Otra por las Antillas, que saltando del continente a Cuba y las Bahamas, pasó a Santo Domingo. El canal de la Mona ha servido de barrera infranqueable para estos pinos, pues no se les encuentra en Puerto Rico.

Como la evidencia geológica indica que Cuba y la Española estuvieron unidas en una época no remota, esto puede explicar como un salto del pino, del continente a Cuba justifica su presencia en las montañas de Haití y la República Dominicana. Las condiciones de clima y suelo de la Cordillera Central Dominicana han sido muy favorables al desarrollo de este pino tropical, y éste se ha adueñado sin gran dificultad de la parte alta de esta cordillera hasta constituir su característica florística más destacada. Caminando a caballo por el camino de herradura que va de Jarabacoa a Constanza anotamos: "Mas allá, hasta donde alcanza la vista, se ven montañas altas, cada vez más agrestes, cubiertas con una continua selva de pinos."

Si esta explicación del origen de los pinares en el maciso central de la república cabe dentro de los preceptos de la geología y la geobotánica, en cambio no se ha podido dar una explicación al hecho extraordinario que en la Cordillera Septentrional, distante cuarenta kilómetros al norte, no se encuentre un solo pino.

Límites de las Selvas de Pinos

Los límites de los pinares de la Cordillera Central los hemos determinado en la forma siguiente:

5/ Record, Samuel J., y Mell, Clayton D. Timbers of Tropical America. 610 pp., illus. New Haven y London. 1924.

Límite Oriental.—El límite oriental de los pinares fué determinado cuidadosamente por nosotros y localizado con exactitud en el mapa, usando la Carta Topográfica del Teniente Comandante R. M. Warfield, de la Marina de los Estados Unidos, reproducida por la Secretaría de Estado de Fomento y Comunicaciones. Para esto, se emplearon dos viajes a la región de Maimón y el Hatillo.

Por la carretera Duarte, en el lugar llamado Piedra Blanca (antes de llegar a Bonao), aparece a la derecha una extensa loma cubierta de pinos, llamada la Loma Peguera. De Piedra Blanca se toma un camino de bestias en dirección N.N.E. que vadea el río Maimón varias veces y después de pasar un aserradero, se llega al pueblecito de Maimón. Nosotros tomanos un camino mucho más largo, trepando hasta la misma Loma Peguera para apreciar mejor la extensión y distribución de los pinares. El camino de herradura de Piedra Blanca a Maimón tiene a su izquierda la Peguera y a su derecha una serie de colinas más bajas, en cuyas cimas se ven grupos aislados de pinos. Esto muestra que estamos cerca de los límites del pinar.

A poca distancia directamente al norte de Maimón se encuentra el río Yuna formando un recodo de 45 grados, tomando repentino rumbo hacia el norte. La vereda sigue por la orilla derecha del Yuna hasta llegar a media docena de ranchos que forman el caserío de el Hatillo. Este punto es la clave para encontrar el límite oriental de los pinares. El caserío está ubicado en un pequeño llano. Hacia el poniente las últimas casas tocan con dos pequeños montecillos de rica vegetación, que lo separa del río Yuna. Para encontrar el límite de la selva de pinos hay que tomar un camino de bestias hacia el saliente que sigue el curso de la quebrada Margarita. Al llegar a un lugar llamado Los Caobos, se observa una extensa colina al norte, de varios kilómetros de largo y que está toda cubierta de pinares. Esta colina larga se llama La Trinchera. Seguimos por mucho tiempo el curso de la quebrada Margarita y poco antes de llegar al caserío La Laguna, a unos 17 kilómetros aproximadamente de el Hatillo, en el sitio en que La Trinchera desciende hasta tocar con los linderos del pueblo, terminan los pinos, para no volver a aparecer más. Este lugar marca el límite oriental de los pinares en las Antillas.

Límite Sur.—En nuestro viaje a través de la Cordillera Central, desde Constanza a San José de Ocoa, pudimos también precisar con bastante exactitud la extrema demarcación sur de los pinares. (Véase el croquis adjunto que representa un corte de la Cordillera, con alturas aproximadas, desde Jarabacoa hasta San José de Ocoa.) Al sur de Constanza, después de subir el Montazo y Valle Nuevo, a dos días de camino en bestia, se encuentra el encajonado Río de las Cuevas, que separa abruptamente las últimas estribaciones de la Cordillera Central de la Sierra de Ocoa. Encontramos que todas las partes altas de la Sierra de Ocoa están cubiertas de grandes pinares, y así también las mesetas que se encuentran al sur de esta Sierra y que recuerdan las mesetas andinas de los Andes Venezolanos. Aquí se encuentra el Río Banilejos, pero según se desciende, un poco antes de llegar a los 1,000 metros, empiezan a aparecer la palma de caña (Sabal umbraculifera), la palma real dominicana (Roystonea hispaniolana), y la palma de guano (Coccothrinax argentea).6/ Poco después los pinos se encuentran en grupos

6/ De acuerdo con L. H. Bailey "Gentes Herbarum."

aislados. Antes de llegar al poblado del Pinar, la vegetación mixta se va adueñando del paisaje y los pinos se ven refugiados en las partes altas de las colinas. Desde el Pinar, divisamos una pequeña colina al sur con varios grupos de pinos, que marca el límite sur de esta especie en esta región del país.

Varios días después, el doctor H. A. Meyerhoff se internó en las montañas al norte de Bohuí, en la provincia de Azua, e hizo observaciones interesantes sobre la extensión de los pinares en esta parte de la República. Bohuí se encuentra al N.E.E. del valle de San Juan de la Maguana y es el lugar propicio para emprender exploraciones en la parte sur de la Cordillera Central.

Desde Bohuí hacia el norte, hasta el tercer paso del río Yaque del Sur, no hay pinos. Los grupos de pinos aparecen, esporádicamente, entre este río y el río Limón. El camino de herradura se eleva en este lugar hasta 300 metros, cuando aparecen los pinos mezclados con el resto de la vegetación. En las partes altas, a ambos lados del camino, los grupos de pinos aumentan y al llegar a una colina llamada Loma Tasajera, el pinar se encuentra en todo su apogeo. De esta loma, hacia el este y hacia el norte, las selvas de pinos continúan sin interrupción, con pequeñas interrupciones en los numerosos arroyuelos. Por este camino se hubiera salido al valle de Constanza, pero concluida su misión geológica (que era el objetivo de su viaje) el Dr. Meyerhoff regresó a la capital.

Todos los informes recogidos en el lugar concuerdan en que la selva de pinos se prolonga sólidamente hasta Constanza.

Límite Norte.—El límite norte de los pinares puede marcarse por medio de una línea irregular que partiendo de la Loma de la Cabrera, a algunos kilómetros al sur de Dajabón, en la frontera con Haití, se corre hacia el este pasando por Monción, San José de las Matas y Jánico, hasta parar en las colinas al norte de Jarabacoa y noroeste de La Vega. En San José de las Matas, los pinos llegan hasta una pequeña quebrada pegada a la población. En Jánico, los pinares cesan abruptamente, pero observamos que en la carretera que va de Jánico a Santiago, se encuentran por varios kilómetros pequeños grupos aislados hasta desaparecer por completo.

En el extremo oriental de los pinos, en la región ya descrita de la loma La Trinchera, al norte de el Hatillo, los pinos se detienen en el borde septentrional de la misma y desaparecen pues no se ve un solo ejemplar en las inmediaciones de Cotui.

Límite Occidental.—Hacia el oeste, el límite de la selva de pinos lo constituye la frontera haitiana, desde el sur de Dajabón, hasta la alta serie de montañas que hay al norte de Bánica.

Pinares de la Sierra de Bahoruco.—En uno de nuestros viajes a la hoya del Lago Enriquillo, se nos aseguró que en el interior de la Sierra de Bahoruco, en sus partes más altas, había extensos pinares que venían de la dirección de Haiti. Tomamos bestias y después de varias horas de camino pudimos localizarlos desde lejos. No se tiene gran idea sobre la extensión de los mismos, pero se sabe que los hay en gran abundancia y sin ser explotados por lo inaccesible de la región.

Estos pinares no figuran en el mapa forestal de Durland, pero sí en el de Ciferri. Es evidente que necesitan mayor estudio antes de poder apreciar sus condiciones.

Factores del Medio y el Desarrollo de los Pinares

1. La formación geológica.—La opinión general de los exploradores que han visitado los pinares de la Cordillera Central es que el Pinus occidentalis se encuentra asociado en alguna forma con formaciones volcánicas y tierras estériles y ácidas. Nuestras observaciones sobre este punto no corroboran esa opinión.

En la Loma Peguera, cerca de Maimón, los pinos se encuentran en un terreno de rocas serpentinas de origen volcánico, lo cual hacía suponer que los suelos lateríticos que caracterizan esta región constituían un factor edáfico importante para el desarrollo de esta especie. En el río Limón, cerca de Constanza, los suelos, aunque bastante altos en hierro, no están lateriliza-dos, por lo cual hay que descartar la teoría anterior.

En la región al norte de Bohuí, se nota la relación de los pinares con la roca volcánica. Desde Bohuí hacia el río Limón, a lo largo de los dos caminos que tomó el Dr. Meyerhoff, las rocas consisten en sedimentos altamente contorsionados, en los cuales las intrusiones igneas aumentan a medida que se avanza hacia el norte. En las laderas al norte de este río, aparecen las intrusiones basálticas hasta constituir el único tipo de roca en toda la región.

En contraste con esto, al sur del Río de las Cuevas, la formación volcánica que caracteriza la Cordillera Central cesa abruptamente, siendo sustituída por una formación de rocas calcáreas superpuestas sobre pizarras (shales). No pudimos notar que este cambio fundamental en la estructura rocosa del suelo afectase en nada el desarrollo y distribución de los pinares, los cuales se suceden hasta el pueblo de el Pinar hacia el sur.

De acuerdo con estas observaciones, no hemos podido establecer relación alguna entre la formación geológica y los pinares. Tampoco encontramos una relación en lo que se refiere al pH, puesto que al sur del río de las Cuevas las tierras son neutras o alcalinas, mientras que en el maciso de la Cordillera son ácidas.

2. El medio topográfico y edafológico.—Si no se ha podido establecer una influencia, por lo menos, directa de la geología con los pinares, en cambio, parece hay una relación marcada entre estos y los factores topográficos, pero este factor, a su vez, está unido a la constitución edafológica.

Se ha notado que los pinos no se encuentran en las tierras ricas de aluvión, sino que al contrario se encuentran limitados a las faldas y lomos de las montañas. Es difícil creer que esta especie no prospere en tierras buenas; lo que pasa es que en la competencia con la vegetación exuberante de las tierras aluviales, el pino, por su crecimiento lento, se encuentra en desventaja y es arrollado y vencido por la vegetación de la selva tropical. En cambio, en las cumbres y laderas de las montañas, donde la capa de tierra tiene poco espesor y la fertilidad de la tierra muy escasa, el pino sale

entonces casi siempre victorioso. Como se ve, es el factor edafológico el que impera, influenciado por la topografía.

La altura sobre el nivel del mar ejerce también su influencia en la supremacía de los pinos sobre el resto de la vegetación. El P. occidentalis se encuentra desde los 150 metros hasta los 3,000 metros sobre el nivel del mar. Pero su imperio no es absoluto hasta más arriba de los 2,000 metros. Subiendo a Valle Nuevo, por el Montazo, los pinares se encuentran salpicados de pequeñas selvas de montaña, a alturas entre 1,600 y 1,950 metros. Estas selvas de montaña se encuentran en sitios húmedos y abrigados, bordeadas casi siempre por el "palo de cotorra" (Brunellia comocladifolia). Con el altímetro en la mano pudimos ver que estas manchas de selvas de montañas desaparecen arriba de los 2,000 metros. A más altura, el pino es el dueño y señor de la flora.

El pinar en Valle Nuevo (2,250 m.) no muestra mezcla con ninguna otra especie arborea. Sólo hay ocasionalmente pequeños arbustillos de Baccharis myrsinites y otras compuestas y una deliciosa "zarzamora" (Rubus domingensis). El resto, bajo los pinos, es un continuo césped de la gramínea Danthonia domingensis.

En alturas próximas al nivel del mar, en cambio, la lucha del Pinus contra el resto de la vegetación es mucho más aguda. En medio del pinar se encuentran grupos, a veces considerables, de Byrsonima crassifolia, Chrysophyllum olivaeforme, y Eugenia que le disputan la posesión del terreno. A este altura el suelo se halla cubierto de gramíneas, principalmente del género Andropogon.

Para resumir: En las grandes alturas, el pino tiene la competencia de una flora escasa, compuesta mayormente de especies endémicas; mientras que en las regiones bajas, tiene que habérselas con las especies "veteranas" de la flora tropical, de gran vigor y crecimiento muy rápido.

3. El medio climático.

a. Régimen pluviométrico.—La República Dominicana, lo mismo que Puerto Rico, tiene una distribución muy irregular de lluvias. La región de mayor intensidad se encuentra a la entrada de la Bahía de Samaná, y la población de este nombre tuvo una precipitación de 121.4" (promedio de los años 1934-36). Las lluvias penetran con gran intensidad por la Bahía de Samaná y forman lo que se llama el "embudo de Gabb" hasta muy al interior, pero a medida que penetran van decreciendo en intensidad. San Francisco de Macorís, que se encuentra en pleno "embudo," tuvo un promedio de lluvias de 92.15" (años 1925-34). La Vega, que está bastante al interior, tuvo un promedio de 69.8" (años 1935-36). De ahí en adelante empieza la parte de la Cordillera Central poblada de pinos y la precipitación en algunos sitios ha sido la siguiente: Jarabacoa, 60.74", San José de las Matas, 44.64", y Constanza, 43.73". Esta disminución en lluvias es compensada, sin embargo, por la evaporación menor en los climas frescos de la Cordillera. De esta evidencia pudiera indicarse, tentativamente, que el límite óptimo para la selva de pinos es de cuarenta a sesenticinco pulgadas de agua.

b. Régimen térmico.—En lo que se refiere al factor térmico, el pino dominicano tiene una amplia latitud de tolerancia. Los climas de Maimón y el Hatillo, a poca elevación sobre el nivel del mar, le aseguran, por una parte, los intensos calores del trópico. Por otra, en Constanza, a 1,150 metros de elevación, la temperatura en enero se conserva en 7° y 8°C., bajando en algunas noches hasta cerca del punto de congelación. En Valle Nuevo, a 2,250 metros, el clima es muy frío, y de ahí en adelante, por consiguiente. Todo esto demuestra la tolerancia del Pinus occidentalis a las fluctuaciones térmicas, tolerancia no igualada, probablemente, por ninguna otra especie de la flora dominicana. (Véase en el croquis adjunto la distribución vertical de la vegetación en la Cordillera Central.)

De todos los factores arriba enumerados, el topográfico y el edafológico parecen ser los más importantes al desarrollo de la selva de pinos; el factor pluviométrico se ha fijado provisionalmente entre las cuarenta y sesenticinco pulgadas de precipitación; mientras que la constitución geológica y el régimen térmico, hasta ahora, no han mostrado influencia que pudiera apreciarse.

Valor Económico de los Pinares

Según se señaló al comienzo de este artículo, los pinares de la República Dominicana constituyen la mayor reserva de maderas útiles en existencia en las Antillas. Aun cuando no están explotados al máximum de su rendimiento económico, su valor potencial sobrepasa en mucho el valor de todos los demás bosques del país. En la actualidad hay muchos aserraderos que venden la madera aserrada de pino a $30.00 el millar de pies, puesto en Ciudad Trujillo. Los aserraderos compran el millar de pies, en el árbol, a $5.00, y se calcula que cada pino rinde, en promedio, 125 pies de madera. Entonces, el valor de cada pino en pie es de $0.60 y produce $3.75 de madera aserrada, puesta en Ciudad Trujillo. Este cálculo es muy conservador, para no pecar de optimista en el estimado.

Hasta ahora, nadie ha calculado el valor potencial de los pinares y aquí lo hacemos en una forma aproximada. El área aproximada de los pinares es la siguiente:

En la Cordillera Central	7,200 kms.^{2}
En la Sierra de Bahoruco	300 kms.^{2}
Total	7,500 kms.^{2}

Cada kilómetro cuadrado (100 hectáreas) equivale a unas 1,600 tareas, de manera que el área de los pinares es aproximadamente 12,000,000 de tareas. De los contajes que hemos practicado, obtuvimos un promedio de seis pinos por tarea, resultando entonces 72,000,000 de pinos. Estos, a un valor de $0.60 cada uno, en pie, tendrían un valor de $43,200,000 que representa, aproximadamente, el valor potencial de los pinares de la República Dominicana.

Bosquejo de una Política Forestal para los Pinares de la República Dominicana

La gran riqueza forestal que representan los pinares de la República Dominicana puede ser conservada y reglamentada con dos objetivos definidos,

de largo alcance, para la futura economía del país, a saber:

1. Por medio de una política de conservación que asegure la perpetuidad de estos bosques; y,
2. Por medio de una estricta reglamentación que asegure, a través de una explotación ordenada, el suministro de maderas de construcción para el mercado local, pero que permita la renovación del bosque.

Por conservación se entiende la protección de los bosques a los fines de asegurar la perpetuidad de los mismos; asegurar a las futuras generaciones el suministro de madera; proteger los nacimientos de los ríos para regularizar sus servicios de agua a la agricultura y para el desarrollo de fuerza hidroeléctrica; y conservar la fertilidad de los suelos, evitando los arrastres de las corrientes en las épocas de grandes lluvias. Esta conservación puede llevarse a cabo en una forma efectiva, nacionalizando el Estado aquella parte de los pinares cuya protección desea llevarse a cabo.

En esta línea de conducta el Gobierno ya ha llevado a cabo la creación de Reservas Forestales Nacionales, pero que sepamos, esta previsión no ha sido extendida a la región de los pinares. En estas Reservas Forestales, huelga decir, debe tenerse especial cuidado no incluir regiones de futuras posibilidades agrícolas, pues en el conflicto de la agricultura con la silvicultura, se ha probado que la necesidad agrícola, por ser más inmediata, impera siempre sobre la necesidad forestal, la cual tarda muchos años en ser servida.

De acuerdo con nuestra inspección ocular de la región de la Cordillera Central, todo el maciso de montañas a una elevación mayor de 1,200 metros, se presta admirablemente para esta clase de medida. Para citar un ejemplo concreto, se pueden declarar como núcleo de la Gran Reserva Forestal Nacional, los bosques de pinos comprendidos en un cuadrilátero de 35 kilómetros de largo por 20 kilómetros de ancho, cuyo lado norte coincida con el río Limón, al sur de Constanza, y cuyo límite sur sea el "cajón" del río de las Cuevas. Este territorio comprende un maciso de pinares de gran valor, prácticamente intocados por la mano del hombre y a una elevación mayor de 1,200 metros. (Véase el croquis adjunto en el cual aparece demarcado esta propuesta Reserva Forestal.) La superficie de este cuadrilátero es de aproximadamente 1,000,000 de tareas.

Tomando este núcleo de bosques como punto de partida, el Estado podría después extender el área de esta Reserva, hasta cubrir la Sierra de Ocoa, al sur del río de las Cuevas, extenderse luego hacia el N.E. de Constanza para proteger los nacimientos de los ríos Yaque del Norte y Yaque del Sur, los más caudalosos de la República y cubrir los altos picos de La Pelona, Loma Rosilla, y el Pico del Yaque.

El objetivo final de este programa de conservación debe ser la ampliación de la Reserva Forestal Nacional hasta cubrir todos los pinares a una elevación mayor de 1,200 metros sobre el nivel del mar.

La expropiación por parte del Estado de estas tierras es factible, por estar prácticamente inhabitadas. Son muy remotas y pueden conseguirse a precios muy bajos. Esta medida, en nada afectaría la agricultura, ni afectaría los intereses de los pinares particulares que se están explotando

actualmente, pues éstos están a una elevación menor y cerca de las vías de comunicación. En cambio, la medida sería de una alta previsión y sentaría las bases de una política forestal de largo alcance.

Por reglamentación se entiende la explotación ordenada y científica de los bosques; es decir, el permitir el corte de árboles cuyo diámetro en el tronco sea superior a un límite especificado por ley. De esta manera, sólo son cortados los árboles de tronco bien desarrollado, quedando los de menor edad en reserva, esperando su turno. En esta forma, se consiguen simultáneamente dos objetivos:

1. Se impide la explotación viciosa y anti-económica de aquellos árboles que aun no han desarrollado a su máximo de rendimiento; y
2. Se facilita la renovación del bosque cada treinta o cuarenta años, multiplicándose la riqueza forestal.

Estas medidas de reglamentación pueden ser dictadas para los pinares en explotación y en donde, según pudimos constatar el decir explotación implica la destrucción del bosque.

Si a estas medidas se une la creación de una modesta pero bien equipada estación experimental forestal, con personal adecuado, establecida en el valle de Constanza para la observación cuidadosa del crecimiento de los pinos, con las medidas anuales de su tronco, la clasificación más cuidadosa de las regiones y los suelos forestales, el estudio de la "sabina" (Juniperus), las variaciones en el clima y su efecto en el desarrollo de estas especies, el llevar a cabo pequeñas pruebas de reforestación, etc., la obra de conservación forestal de la República Dominicana estaría sentada sobre bases permanentes y podría servir de modelo y prodigar experiencias muy útiles al resto de las Antillas.

Summary

The pine forests of the Dominican Republic cover an approximate area of 7,500 square kilometers in the mountainous interior of the country, and constitute the largest existing reserve of useful lumber in the Antilles. Within this area are found the highest peaks in the Antilles, one of these, La Pelona, reaching 3,168 m. above sea level.

The temperate region of the northern hemisphere, namely, the United States and Canada, was the center of distribution of the genus Pinus in the New World. Apparently, there were two migrations towards the south from this center, one passing through Mexico into Central America, and the other jumping from the mainland to Cuba and the Bahamas, which extended into Santo Domingo. Finding satisfactory conditions in the latter, the pine took possession of a large part of the high mountain country.

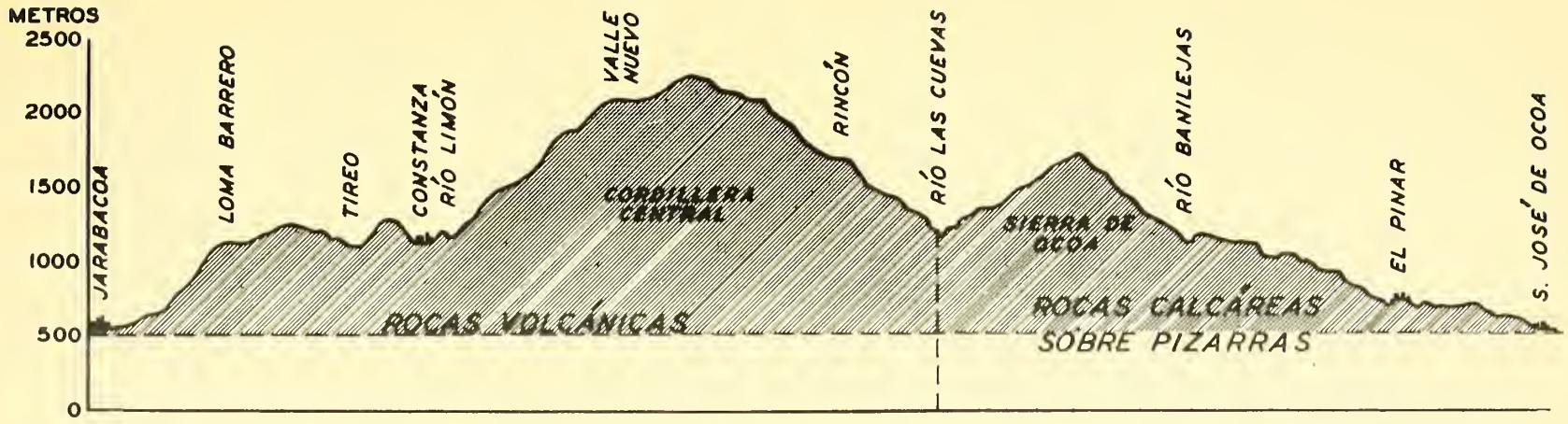
The limits of the pine forests of the central mountains can be drawn as an irregular line on the north, starting at the Loma de la Cabrera on the Haitian frontier some miles south of Dajabón and running eastward by Monción, San José de las Matas and Jánico to a point northwest of and near La Vega.

In the east, the last solid block of pines is that in the triangle formed by the Río Yuna, the Duarte highway and the town of Maimón, where the pine drops down to an elevation of 150 meters above sea level. In the south, the pines disappear close to the Río Banilejos and their boundary continues west to the Haitian frontier north of Bánica. On the west, the pine forests continue across the Haitian frontier. Pine forests were seen in the Sierra Bahoruco, the southern range of the Republic, but little is known of their extension.

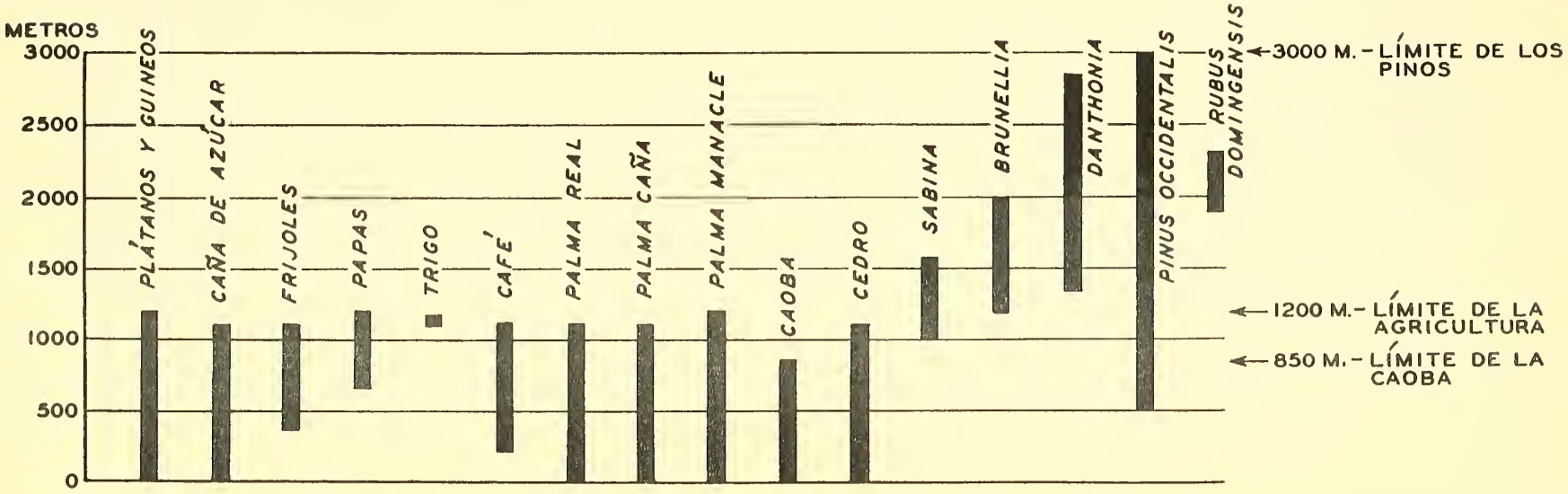
Of all the silvical factors, the topography and edaphics seem to be the most important for the development of the pine. At high elevations, the pine is competing with a restricted flora largely composed of endemic species, whereas, at lower elevations, it must struggle with the veteran species of the tropical flora which are very vigorous and grow rapidly. The precipitation limits for the species have been fixed provisionally between 40 and 75 inches per year, while the geological formations and the temperature range have not shown as yet any appreciable influence.

Based on a stumpage price of $5.00 per M bd. ft., and estimates of 6 trees per tarea (1,600 tareas = 1 square kilometer) and an average of 125 board feet per tree, the 7,200 K^2 of the central mountains plus 300 K^2 in the Sierra Bahoruco would represent a value in pine timber of approximately $43,000,000.

This immense forest resource could be conserved and regulated with two definite far-reaching objectives for the future economy of the country, namely, (1) a policy of conservation which would ensure the perpetuation of these forests and (2) a strict regulation which would insure, by means of proper exploitation, a supply of construction lumber for the local market as well as the renewal of the forests. If in addition to these measures, a certain amount of forest research could be carried on, forestry in the Dominican Republic would be firmly established on a permanent basis and could serve as a model and provide valuable experiences to the rest of the Antilles.



CORDILLERA CENTRAL - SECCIÓN TRANSVERSAL DIAGRAMÁTICA



DISTRIBUCIÓN VERTICAL DE LA VEGETACIÓN CORDILLERA CENTRAL

THE DISPERSION OF THE COTTONY CUSHION SCALE IN PUERTO RICO IN EIGHT YEARS

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The first record of the presence of Icerya purchasi Maskell in Puerto Rico was a collection made on a rose bush in Santurce in October 1931. Additional observations of its presence on Casuarina and citrus trees in Santurce, in San Juan, and across the bay at Palo Seco in the spring of 1932 are given at considerable length in "A Year's Experience with the Cottony Cushion Scale in Puerto Rico" (Jour. Dept. Agr. P. R. 17 (3): 199-221. 1933). Originally thought of primarily as a pest of citrus, it is now of greatest importance when attacking the Australian pine, Casuarina equisetifolia Forst. Dispersion is largely by wind, but may also result from man's activities. The first observed instance of the latter was by a suburban resident on the Trujillo Alto road, who "reported some scale on a rose bush which had been presented to him by a friend in Santurce. Scales were also found on the casuarinas beside the Las Monjas racetrack between Río Piedras and Santurce. All of these new records, however, were in the immediate vicinity of San Juan, and except in the one case where the scale had obviously been carried on the host, were to the west and southwest. No infestations were found to the east or far to the south, indicating that normal dispersion was resulting from the prevailing winds (from the east and northeast), and that this was by far the most important single factor in dispersion.

"...Dr. W. A. Hoffman reported another infestation on casuarina and citrus west of Dorado, ten or twelve miles in an airline from San Juan and seven or eight miles west of Isabela Grove. At first this seemed to be an isolated outbreak, but later and more careful observations in this region disclosed an infestation in a few citrus trees just outside of Dorado. That only two infestations were discovered in this region is largely due to the scarcity of appropriate hosts, most of this region being in cane, pasture or coconuts. Their presence, however, and the complete absence of infestation east of San Juan, despite an abundance of suitable hosts, confirms the original observations on the importance of the prevailing wind as an agent in dispersion.

"Farther west of Dorado than Dorado is west from San Juan, a small infestation was later reported on a windbreak of casuarinas in the hills back of Barceloneta, on the Florida road." When inspected in person, however, this was found to be a native scale, Icerya montserratensis R. & H., and not the Australian immigrant.

"During the night of September 26-27, 1932, the hurricane of San Ciprián swept the northern coast of Puerto Rico and entirely changed the status of the cottony cushion scale...Except in special instances where especially well protected by high buildings, all the large scales and practically all the small scales were carried away and destroyed...So far as can be determined, the hurricane had no effect in the dispersion of the scale."

What happened to Icerya purchasi in the following years has been recorded each year in the annual report of the entomologist of the Agricultural Experiment Station at Río Piedras, as is shown in the following quotations from these reports.

1933-34 - "The Cottony Cushion Scale, Icerya purchasi Maskell, has extended its range very little during the past year, the only new infestations being in individual trees at Vega Baja and at Río Piedras. No heavy infestations of the scale have been reported during the year, despite the dry spring."

1934-35 - "The almost unbroken drought during April 1935 was not sufficiently extended to have a very pronounced effect on the cottony cushion scale, and this pest has been of but minor importance during the past year. Nevertheless, a supply of Rodolia beetles has been maintained at the laboratory at Río Piedras, and on request, releases have been made on new infestations at Vega Baja in September, December and March."

1935-36 - "New infestations of the scale have developed this year at Manatí (July), at Humacao (October)—indicated as '35' in a black circle on the map—and at Arecibo (December). When a sufficient supply of beetles had been obtained to make a release at Arecibo, it was discovered that the beetles had already reached this infestation by their own efforts, presumably flying from Vega Baja or Manatí."

1936-37 - "A new infestation of cottony cushion scale was discovered on the Trujillo Alto road during the year, presumably having been carried on nursery stock or plant cutting to this location which is east of the main infestation. Natural dispersion by the wind has carried the scale this year from just beyond Arecibo to a Casuarina grove a mile or more west of Camuy."

1937-38 - "During the past year, the scale continued its natural spread, due to wind, in the extreme western end of the island: two new infestations being found at Isabela. Due to the action of man, also, new infestations developed on Casuarinas brought from the Forest Service nurseries at Río Piedras and planted at the Guajataca CCC camp near Ponce village, Isabela, and on Mona Island. Ladybeetles were released at all of these new infestations, the vial of beetles for Mona Island being taken there by the Forest Service airplane."

It will be noted that the more distant new infestations have marked a regular advance westward from the main focus of infection in the San Juan-Bayamón-Dorado region: Vega Baja in 1934, Manatí in July 1935, Arecibo in December 1935, Camuy in 1936, and Isabela in 1937. These may be regarded as anticipated new infestations, presumably all due to the action of prevailing winds. As the scale has now reached the western end of the island, however, no further dispersion due to this cause can be expected.

The dispersion against the direction of prevailing winds has been slow, not reaching Río Piedras until 1934, nor Sabana Llana until 1939. The new outbreak in the Trujillo Alto road recorded in 1936 is presumably only a recurrence of that reported in 1932, and that at Humacao in 1934

was obviously due to grapefruit nursery stock brought from the infested Bayamón region.

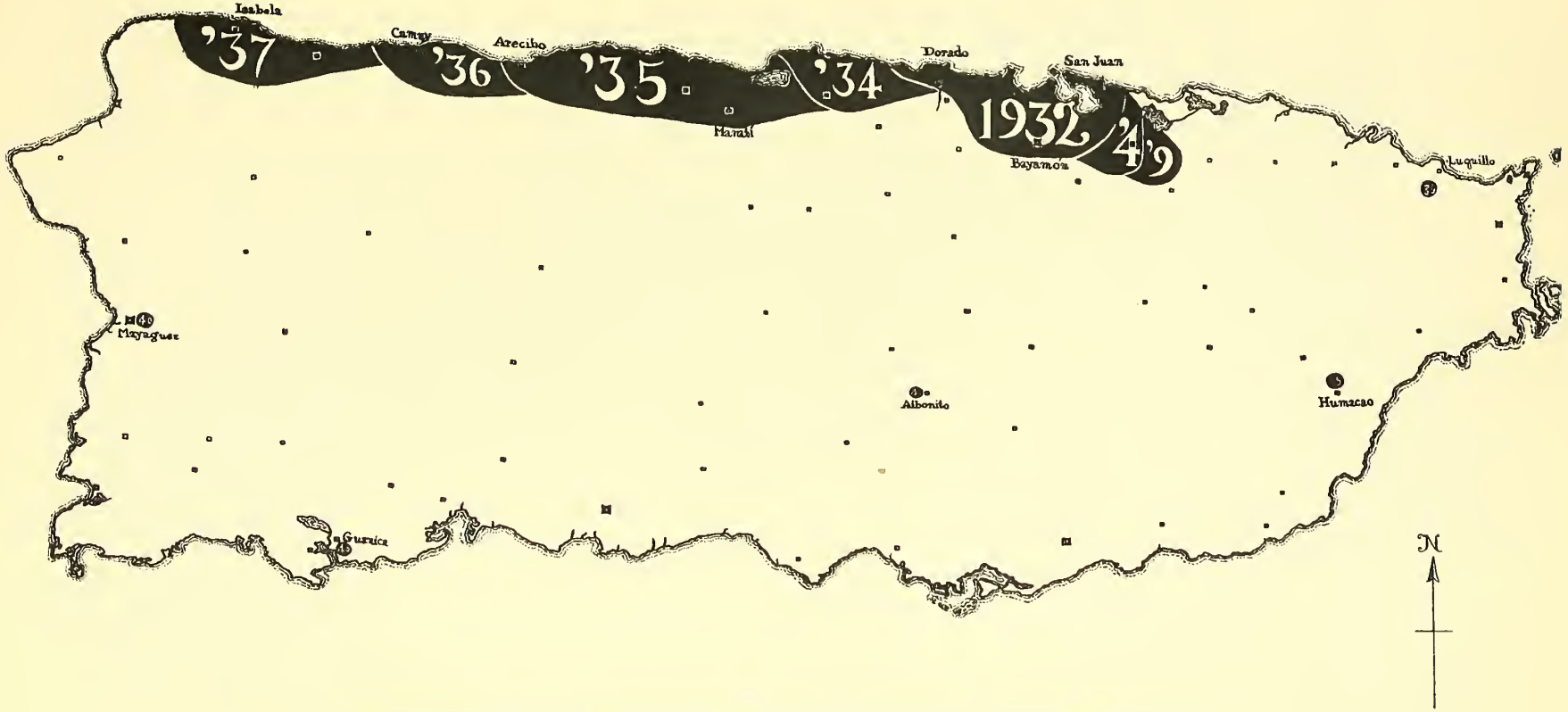
When the scale reached Río Piedras, however, even though only isolated trees were infested at first, such as the Pithecellobium dulcis tree in the patio of the old building at the Experiment Station, and the Casuarina windbreak at the University, yet this latter infestation close to the nurseries of the Forest Station resulted in several new outbreaks when Casuarina seedlings from this nursery were replanted elsewhere. The first noted was at Camp Guajataca at Ponce village, near Isabela, the second on the Casuarinas on Mona Island, and a third is at San Pedro de Macoris in the Dominican Republic. The last reported is at Camp La Perla near Luquillo (indicated as "39" in a black circle in the map). While the first two (and very doubtfully, the third) of these might possibly be due to dispersion, the last in the shadow of El Yunque is so far removed from any other known infestation that it seems impossible that it could have become established in any other way than by the aid of man.

Most recently, rose bushes near Aibonito have been found scantily infested, another instance of establishment by the activity of man, but in an environment so humid that no increase in abundance, and consequently no dispersion occurs. Occurrence on grapefruit and Casuarina at Mayaguez and also on the Consumo road towards Maricao has been reported by Mr. J. A. Ramos, accompanied also by Rodolia ladybeetles which had reached these new infestations through their own efforts. The final record is in the Casuarinas at Guanica, noted by Mr. L. F. Martorell, in a xerophytic locality admirably suited to the propagation of the scale. The infestation was on old trees, and not apparently due to infested nursery stock from Río Piedras. It remains to be seen how long will be required for infestation to spread east along the South Coast, against the direction of prevailing winds, if not hastened by the unpremeditated activites of man.

Resumen

La queresa de polizón blanco o queresa acanalada, Icerya purchasi, apareció por primera vez en Puerto Rico en octubre del 1931, atacando arbustos de rosas en Santurce. Más tarde se encontró en árboles citrosos y en Casuarinas, convirtiéndose en una seria amenaza para estos últimos.

Como puede verse en el mapa adjunto, la infección en los años sucesivos ha avanzado hacia el oeste del foco original de infección cerca de San Juan. Como los vientos alisios soplan hacia el oeste, se presume que esta dispersión se debió a la acción del viento. Los huracanes no afectan aparentemente la dispersión del insecto y por el contrario ayudan a destruirlo. Desgraciadamente, su distribución ha avanzado en varias direcciones por medio de la distribución de material infestado de los viveros de Río Piedras.



PROGRESSIVE DISPERSION OF THE COTTONY CUSHION SCALE
IN PUERTO RICO DURING 8 YEARS.

SOIL EROSION ON THE ISLAND OF CHACACHACARE, TRINIDAD, B.W.I.

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Trinidad and Tobago

Rather an interesting example of soil erosion recently came to light when the writer visited Chacachacare to draw up a working plan for the cutting of firewood.

Chacachacare is a small island lying off the western end of the north-western peninsula of Trinidad. Since 1926 the island has been reserved for a leper settlement so that except for the lighthouse staff the sole inhabitants are the patients (about 400) and their attendants, nurses, and doctors. The island is mountainous, rising to nearly 800 feet above sea level; slopes are somewhat steep and for the most part descend abruptly into the sea. The soil resembles that of the northern range areas of Trinidad. The rainfall is low, averaging about 48 inches annually. The effect of this low rainfall on the vegetation is aggravated by the steep topography and exposure to sea winds, leading to a deciduous type of forest with a low canopy. The principal constituents of the vegetation are as follows:

Dominants:	Savonette	Lonchocarpus punctatus	Very abundant
	Saltfishwood	Machaerium robinifolium	Very abundant
	Balsam	Copaifera officinalis	Frequent
	Poui	Tabebuia rufescens	Frequent
	Olivewood	Capparis spp.	Occasional
	Goodbread	Pisonia cuspidata	Occasional
	Laylay	Cordia spp.	Rare
	Naked Indian	Bursera simaruba	Rare
	L'epinet	Fagara martinicensis	Rare
	Cypre	Cordia alliodora	Rare
	Hog plum	Spondias monbin	Rare
Shrubs:	Bread & cheese	Pithecellobium unguis-cati	
	Bois lezard	? Tecoma stans	
	Grape	Coccoloba fallax	
	Wild tamarind	?	
	Buis	?	
	-	Rudgea spp. ?	
	Wild cerise	?	
	Biscuitwood	?	
	Manchineel	Hippomane mancinella	
	Christmas bush	Cassia bacillaris	
	Juniper	Genipa americana	
	Black sage	Cordia cyclindorstachya	
	Cacti	Cereus spp.	

Cacti are not found higher than about 300 feet above sea level, and laylay, l'epinet, cypre, and a few of the shrubs are not found below this. Everything except hog plum and cacti appears usable for firewood. The height of the forest canopy varies considerably with exposure. On the southern half

of the island it is at 20 feet or less, whereas on the sheltered southwest slope of the northern half trees up to 50 feet high are found.

The position as regards cutting of firewood was found to be fairly satisfactory. The settlement has an annual consumption of about 500 cords of firewood, which is procured by bringing it in a motorboat from felling areas round the shores of the island. Strips of forest are clear-felled, running upwards from the landing place—any convenient little beach or cove—and the wood is rolled down and stacked into boats. Fortunately, forest fires appear to be unknown on the island, and regrowth of the forest takes place satisfactorily as coppice, after the abandonment of the coupe. Presumably owing to the very dry conditions there is no invasion by second-growth weeds (Cecropia, Ochroma, Vismia spp., etc.), such as occurs when rain forest is similarly felled. No signs of erosion were found in the natural forest or on the firewood coupes.

Very different conditions were found, however, in two valleys immediately at the back of the leper settlement. Here, the vegetation had become progressively degraded by overcutting of wood, partly through removal by patients of wood for their own purposes from the nearest accessible piece of woodland, and partly through general cutting of firewood on occasions when the motorboat was out of order and wood could not be brought in from 'round the coast. This led to a poor growth consisting of clumps of bushes about 8 feet high with no closed canopy. Normally under such conditions the soil would be protected by development of the dense herbaceous ground layer which is found to come in at once after felling of the firewood coupes. However, at this particular point such a development is prevented by the very considerable numbers of fowls belonging to the patients which range at large. The fowl population has been steadily on the increase of recent years and is now estimated at 1,500. The birds are concentrated in the small area of the valleys and their lower slopes and, being seldom fed, must scratch for their living. Every little green plant which appears, therefore, is either devoured or scratched up, with the result that the soil is utterly bare and erosion has become rife. Serious sheet erosion is revealed by the bare roots of the bushes and gullying is beginning. During the last three years, formerly well-behaved ravines in the valley bottoms have become wild torrents.

Erosion through overgrazing by cattle and other livestock is a commonplace in many parts of the world, but it would be interesting to hear of another example of overgrazing by chickens.

Resumen

Recientemente se observó un caso singular de erosión en la pequeña y escabrosa isla de Chacachacare, donde hay una colonia de leprosos con una población de 400 personas. La isla está cubierta mayormente por un bosque decíduo de dosel bajo. El corte de leña en la isla es seguido por un buen crecimiento de retoños, excepto en dos valles muy cerca de la colonia. Allí, el corte en exceso no ha permitido el establecimiento de un dosel cerrado y cerca de 1,500 gallinas han evitado el crecimiento herbáceo resultando en grave erosión superficial y el principio de cárcavas.

INFORME SOBRE PLANTACIONES FORESTALES EN CUBA

(Suministrado al Ministro de Agricultura el 5 de sbre. de 1940)

Ing. Alberto J. Fors
Encargado de Viveros Forestales
Habana, Cuba

Como el Ministerio de Agricultura ha limitado sus actividades a la divulgación y a la distribución de semillas y posturas, las plantaciones existentes están hechas exclusivamente por individuos y entidades privadas.

A pesar de que uno de los fines principales de nuestra política forestal es la repoblación, ésta ha tenido efectos en pequeña escala y en algunos casos, sin otras miras que las de percibir el premio establecido por el Decreto-Ley No. 753 de 24 de mayo de 1923, modificado actualmente por el No. 681, de 21 de marzo de 1936. No existen en el Territorio Nacional plantaciones forestales de escala comercial ni lotes experimentales de menos extensión bajo dirección oficial inmediata.

Además, como el criterio privado no siempre se amolda a nuestras recomendaciones, las plantaciones existentes adolecen en muchos casos de serios defectos de localización, que perjudican al desarrollo general de los árboles. Esto obedece, en parte, a que las demandas del marcado han hecho arraigar en el público el deseo de plantar cedros, resultando plantaciones de cedros en suelos inadecuados, al menos por el presente, al desarrollo de esta especie.

Existen plantaciones de cedros de poca extensión en suelos silico-arcillosos de poca profundidad, más adecuados a otras especies, como el pino y el encino. Por otra parte, el público, que generalmente no está inclinado a hacer inversiones a largo plazo o a sembrar para sus descendientes, adopta el cedro, de crecimiento rápido, y duda de la conveniencia de plantar especies cuya madera han de disfrutar sus sucesores—de modo que la casi totalidad de las plantaciones existentes es de cedros.

En la mayoría de los casos el cedro ha sido plantado en suelos favorables por su composición mineralógica al desarrollo de esta planta, pero actualmente inadecuados por la falta de una cubierta protectora y la necesaria elaboración de humus. En estos casos era preferible posponer la siembra del cedro, estableciendo primero una vegetación protectora (leguminosa con preferencia) que devolviera al suelo, en un período de 3 a 5 años, las condiciones fisico-químicas y biológicas que convienen a esta planta. De otro modo hubiera sido conveniente plantar el cedro desde luego en sociedad con la especie protectora, para fomentar, desde los comienzos de la plantación, las condiciones favorables necesarias.

Las plantaciones examinadas están generalmente correctas en cuanto a su densidad, o sea el número de árboles por unidad superficial. En algunos casos no solamente se han plantado cedros demasiado espaciados, sino que se han asociado cultivos anuales, resultando plantaciones arruinadas por el tráfico de bueyes y aperos y la frecuente alteración de las capas horizontales del suelo.

Muchos agricultores han obtenido cedros de este Ministerio para plantarlos en filas simples a lo largo de las cercas. Este Departamento ha procurado siempre condenar esta práctica puesto que el cedro, de todas las especies forestales, es el que menos se presta para ser plantado en esta forma. La siembra de árboles en hileras simples escasamente puede considerarse como un proyecto de repoblación forestal.

Casi todas las plantaciones examinadas son exclusivamente de cedros, a pesar de que en nuestra propaganda hemos insistido en la conveniencia de plantar el cedro en sociedad con otras especies. El monte puro, en nuestro clima, es indeseable y su existencia en ciertas localidades se debe a las limitaciones establecidas por ciertos factores del mismo medio o a caracteres intrínsecos de determinadas especies gregarias y amantes del sol, como el pino y la teca.

En algunos casos hemos examinado plantaciones de cedros con majaguas lo que a nuestro juicio es una buena combinación, pues la majagua por su forma constituye una excelente protección a la capa superficial del suelo la que enriquece constantemente con la caída de sus hojas.

Se ha empleado también el método de plantar cedros inmediatamente después de establecido un platanal. El empleo del plátano como planta protectora es aceptable, pero cuando se plantan cedros exclusivamente en el platanal, cuyo techo no es muy alto, los cedros ramifican prematuramente y resultan cortos de fuste.

En muy pocos casos se han aprovechado las grandes ventajas de plantar cedros bajo techo natural (under shelterwood) y suelo rico en materia orgánica. Aun en estos casos se ha incurrido en el error de aprovechar un techo demadiado denso, bajo monte alto cuya competencia ha resultado demasiado para el cedro.

En términos generales, se han plantado muchos cedros en el Territorio Nacional, pero en forma esporádica y en pequeños grupos. Esto obedece en parte al estímulo oficial, pues muchos agricultores han obtenido del Gobierno y plantado un número determinado de cedros con el solo fin de obtener el premio establecido.

La generalidad de las plantaciones del cedro son puras. Como hemos indicado anteriormente, esto es indeseable por la existencia en Cuba de un insecto (Hypsipyla grandella) cuya larva taladra y destruye las plantas jóvenes. Es evidente que la plaga encontrara menos facilidades para extenderse en plantaciones forestales en que el cedro se encuentre mezclado esporádicamente con otras variedades de árboles. Hemos encontrado algunas de las plantaciones puras completamente arruinadas por el taladrador y hemos informado al Sr. Ministro de la conveniencia de realizar un estudio detenido del insecto y la posibilidad de encontrar fuera de Cuba el parásito con que combatirlo.

En relación con el asunto de la repoblación forestal, objeto de este informe, tengo el honor de reiterar a usted la sugerencia aceptada ya por el Sr. Ministro, de establecer la Estación Experimental Forestal, desde la cual estaremos en mejores condiciones que las actuales para cooperar con establecimientos análogos de otras naciones.

Además del cedro, se han plantado tecas, con resultados hasta ahora satisfactorios. La plantación de tecas más extensa, hasta el presente (unos 20,000 árboles), establecida en abril de 1938, en suelo arcillo-silíceo de poca profundidad, está desarrollando admirablemente con una altura media de 4 metros.

Summary

Since the Ministry of Agriculture has limited its forestry activities to the divulgation of information and distribution of seeds and seedlings, existing plantations in Cuba belong exclusively to individuals and private enterprises.

Owing to the ready market for its timber and its rapid growth, which promises an early return, almost all of the plantations have been established with Spanish cedar alone. In spite of recommendations to the contrary, the species has been planted too often on unfavorable soils, in pure stands or in single lines. Spacing followed is usually satisfactory. The shoot borer, Hypsipyla grandella, has attacked heavily the pure plantations of cedar, some of which are completely ruined.

Cedar in mixture with majagua appears to be a good combination. The use of plantains as an overstory for cedar is acceptable but because of their low height results in short trunks producing little timber. In a very few cases, the advantageous system of planting cedar under a shelterwood was employed, but often the overstory was too dense.

The largest teak plantation (20,000 trees), planted in 1938, is developing very well, with an average height of 4 meters.

The idea of the establishment of a Forest Experiment Station is reiterated as beneficial to Cuba's forestry and allowing for a better opportunity to cooperate with similar establishments in other nations.

New Turkish Delegate to The International Forestry Centre

The Turkish Government has appointed the Chief of the Forestry Service, Director General Mr. Fahri Bük, as Delegate to the Committee of the International Forestry Centre, a branch of the International Institute of Agriculture.

BIOLOGICAL NOTES ON THE SEA-GRAPE SAWFLY, SCHIZOCERA KRUGII CRESSON, IN PUERTO RICO

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The ravages caused by this insect in Puerto Rico on the trees of the genus Coccolobis are so noticeable, and the insect itself is so conspicuous and common, that it is of general importance for foresters and men interested in agriculture to know the behavior of this interesting sawfly.

The sea-grape sawfly Schizocera krugii Cresson = Sterictiphora zaddachi Dewitz belongs to the family Tenthredinidae of the super-family Tenthredinoidea, order Hymenoptera. It is the only member of this group reported in Puerto Rico. The insect was first described by E. T. Cresson, and the description was published in the "Transactions of the American Entomological Society," Vol. 8, page 54, during the year 1880. Sometime later, H. Dewitz, a German scientist, published the description of the same insect under the name of Sterictiphora zaddachi, in the "Berliner Entomologische Zeitschrift," Vol. 25, Pt. 2, pp. 197-208, 1881, in an article entitled "Hymenopteren von Porto Rico."

Adult.—The female (fig. 1) is 8 mm. long, with bright crimson thorax and abdomen; head and mouth parts shiny black; antennae dull, black; legs reddish with dark brown marks; wings transparent with black veins. The male (fig. 2) is smaller than the female, about 6 mm. long, the dorsal part of the prothorax and about half of the mesothorax crimson, the dorsal part of the metathorax and dorsal part of the abdomen shiny black. Ventrally thorax and abdomen bright crimson. Head and mouth parts shiny, black; legs rufous. The most interesting part of the male is the antennae. The insect appears to have four antennae due to the forking on the third antennal segment. The antennae thus forked is plumose. The wings are similar to the ones of the female but much smaller.

Behavior.—It has been observed that the females are more numerous than the males. During oviposition the females do not move from the egg-mass, even if disturbed. Oviposition takes many hours and even after the last egg of a cluster is laid the females stay over the egg-mass as if they were brooding the eggs. Once in a while a male is observed between 3 or 4 females ovipositing on the same leaf. The males are gregarious and one can see them in groups of 10 to 20 close together on the undersides of a leaf. Both males and females are very deliberate in their movements and can be easily collected by hand. Copulation and oviposition take place on the parts of the trees least affected by direct wind currents. At the seashore, the trees nearer to the coast are less infested than those inland or the ones which are back of other trees. The wind disturbs or blows away the small insects.

Schizocera ranges from the seashore to the high mountains. Severe infestations had been observed on Coccolobis pirifolia Desf. at the mountains of the Carite Unit, 2,700 feet in altitude. As the favorite host tree of the

species is the sea-grape, Coccolobis uvifera, common on the lowlands, the insect is most frequently observed at or near the coast.

Eggs.—(See fig. 3.) These are laid on the undersides of leaves in clusters varying in number from 15 to 40 eggs. The eggs in the cluster are regularly spaced and sometimes as many as 6 or 7 clusters are found on a single leaf. The eggs are about 2 mm. high and of a bright red color when freshly laid, later on turning pink at the same time increasing in size. The increase in size of the eggs as they get older is a general characteristic of sawfly eggs. This is probably due to the absorption of moisture before hatching.

Larvae.—(See fig. 3.) When freshly hatched the larvae are dirty green, small grubs. They are gregarious and feed on the edges of the leaves. They are attached to the edges of the leaf by means of their three pairs of thoracic legs, the rest of the body or abdomen being curled up a little to the side. This position of feeding is characteristic of sawfly larvae.

In the later instars, the larva measures about 25 mm. long, the body is pinkish, with a light green line not well defined running dorsally from the first segment to nearly the last one. Dorsally, the last abdominal segment is black. The whole body is covered by round, small, black spots regularly arranged. The head is reddish, shiny, with one shiny black line running longitudinally on its center. The region around the ocelli is also black. The legs are strong, fleshy, pinkish and covered with numerous black spots. The uropods and postpedes are pink and small. The larva as described above is the stage commonly observed in the field. The last larval instar is very short, pupation taking place shortly after the last moulting. In it, the head and dorsum are shiny black; the first thoracic segment, the precoxae and the last abdominal segment carmine; the sides of the body wine-colored. This stage is rarely seen in the field.

Pupae.—(See fig. 4.) The larva webs a tough, parchment-like brown pupal case, composed of a secretion mixed with leaf particles. The pupal case is nearly oval, with one end truncate, measuring 10 mm. long by 6 mm. broad. Pupation may occur on twigs, branches or on the trunk. Sometimes hundreds of pupal cases are seen in large masses attached to the trunk of sea-grape trees. Usually, the larva spins its pupal case in concealed places or on parts of the trunk or branches most protected from wind or rain. The pupal period averages 20 days.

Host trees.—The insect has been recorded from Coccolobis uvifera Linn. from many localities on the island. Van Zwaluwenburg also reports it on Chrysobalanus icaco L.

More recently the pest has been recorded on "moralón" (Coccolobis grandifolia Jacq.) at the Guajataca Unit; on "uvilla" (C. laurifolia Jacq.) at the Guajataca Unit and the Guánica Insular Forest; on C. venosa Linn. at Maunabo, P. R.; and on C. pirifolia Desf. at the Carite Unit.

Injury.—The larva is a voracious feeder and in a few days small trees are completely defoliated. As soon as new leaves are developed on defoliated trees these are attacked also. Heavy outbreaks are noticed most often during

the winter and spring months of the year, but the insect occurs the year round. Sometimes infestations on sea-grape extend for miles along the beach.

Control.—So far, no natural enemies are recorded from this pest. The larva can be controlled by applications of poison sprays in the form of 3 pounds of powdered lead arsenate to 100 gallons of water. Soap may be used as an adhesive.

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Resumen

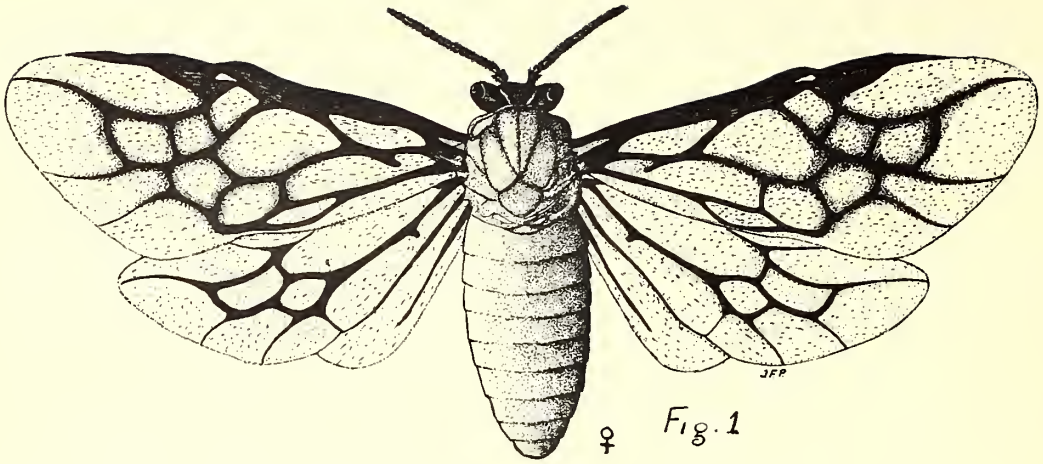
El tentredo de la uva de playa, Schizocera krugii Cresson = Sterictiphora zaddachi Dewitz, es le único representante del grupo de los tentredínidos (Orden Hymenópteros) en Puerto Rico.

La hembra (fig. 1) es mayor que el macho y su cuerpo es de color carmesí. El macho (fig. 2) es carmesí y negro y su antena es muy peculiar. Esta se bifurca en el tercer artejo, dando la impresión de poseer cuatro antenas. En ambos sexos, las alas son transparentes con venas negras bien definidas.

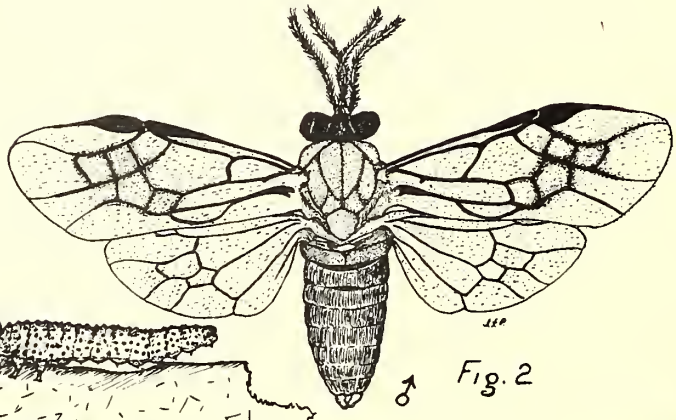
Los huevos (fig. 3) son pequeños, rojos. Estos son depositados por la hembra en grupos de 15 a 40, en las hojas de las plantas hospederas. Las larvas son gregarias y se alimentan en el borde de las hojas. La larva teje un capullo (fig. 4) dentro del cual pasa su estado de crisálida.

El tentredo ataca en Puerto Rico a los siguientes árboles: Coccolobis uvifera L., C. grandifolia Jacq., C. laurifolia Jacq., C. venosa Linn., y C. pirifolia Desf. Van Zwaluwenberg informó el insecto en Chrysobalanus icaco L.

Para combatir la larva puede usarse aspersiones de arseniato de plomo en polvo en proporción de 3 libras de arseniato por 100 galones de agua.



♀ Fig. 1



♂ Fig. 2

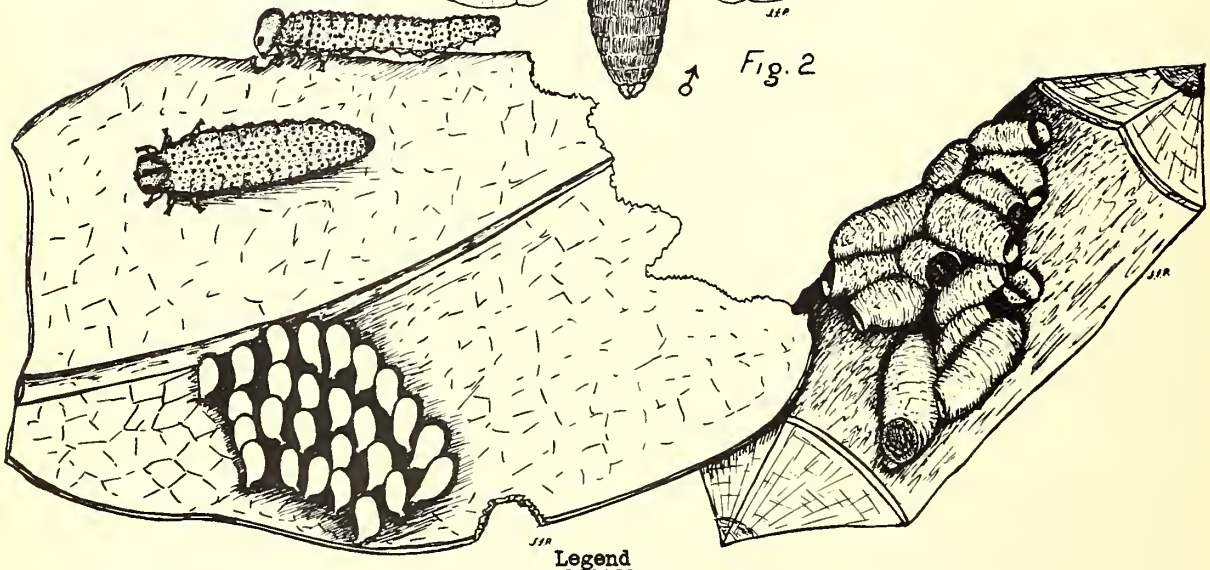


Fig. 3 Fig. 4

Legend

Schizocera krugii Cresson (Tenthredinidae)

Fig. 1 - Adult female (actual size 8 mm. long).
Fig. 2 - Adult male (actual size 6 mm. long).
Fig. 3 - Larvae 25 mm. long and eggs 2 mm. high.
Fig. 4 - Pupal cases on branch (actual size 10 mm. x 6 mm.).

SUPPLY OF TANNING MATERIALS IN JAMAICA

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Conservator of Forests, Jamaica

(Extract from the Journal of the Jamaica
Agricultural Society for June-July 1939)

Imports of leather.—The following leather goods were imported into Jamaica in 1936 and 1937:

	Value £	
	1936	1937
Boots, shoes, etc., of leather	115,672	163,902
Saddlery and harness	3,983	4,239
Dressed and undressed leather	4,115	3,030
Other leather manufactures	6,638	5,188
	£130,408	£176,359

At the same time tanning materials to the value of £1,254 were imported in 1936 and £3,143 in 1937.

Exports of hides.—Exports for the same years were as follows:

	1936		1937	
	Number	Value £	Number	Value £
Hides of cattle	21,547	11,322	24,807	17,627
Goatskins	231,551	20,811	183,042	22,109
Total		£32,133		£39,736

Divi-divi to the value of £812 was exported in 1936, and £1,083 in 1937.

Local tanneries.—At the request of the Forest Branch, the Secretary, Jamaica Agricultural Society, called for reports from Instructors on tanneries in their districts. Returns were received from the following parishes, the number in brackets representing the number of tanneries: St. Andrew (7), St. Thomas (nil), Portland (1), Western St. Ann (5), Eastern St. Ann (10), Hanover (2), St. Catherine (2), Clarendon (nil). This list is probably far from complete. Many of the country tanneries use primitive methods and produce poor leathers although at least one tanner is producing really first-class leather.

Materials used.—The tanbarks in most general use are:

Mangrove (Rhizophora mangle)
Broadleaf (Terminalia latifolia)
Mahogany (Swietenia mahagoni)
Divi-divi pods (Coriaria caesalpinia)

In addition the use of the following barks has been noted:

Tamarind (Pithecellobium arboreum)
Shadback (Pithecellobium alexandri)
Locust (Hymenaea courbaril)
Almond (Terminalia catappa)

Mangrove, though it has a high tannin content, ranging from 22%-33%, has a tendency to produce a harsh, red brittle leather and for this reason it is undesirable to use it alone.

Broadleaf bark has a very low tannin content and its use should be discouraged. The barking of economic timber trees, often of small size, is a very unsatisfactory feature of this trade. These remarks apply with even greater force to mahogany, the bark of which is used for coloring. The number of immature trees of these species which may be found on both private and Crown lands with their bark stripped off and either dead or dying is very distressing.

Divi-divi pods are only used in mixture with other tans.

Apart from locally produced tanning materials, a certain amount of quebracho and oak-bark extract is imported, together with chemical and synthetic tans.

Conclusions

1. Considerable quantities of tanned leathers are imported and untanned leathers exported.
2. Leathers tanned with local materials are often unsatisfactory.
3. Many economic trees are barked and killed for tans.
4. Tanning materials are imported.
5. There is, therefore, scope for production of better tanning materials within the Island.

Recommendations

1. Analyses of tanbarks.—The Imperial Institute has agreed to undertake the analyses of tanbarks submitted. They require for each sample 7 pounds of thoroughly air-dried bark, selected at random from normal commercial supplies; such data are necessary to show the low tannin content of local materials. It is suggested that the following species be analyzed: Mangrove, broadleaf, mahogany, Acacia dealbata (from the Blue Mountains).

2. Legislation.—Efforts should be made to enforce the sale of the Bark of Trees Law of 1929, and its provisions should be strengthened.

3. Growing of wattle.—There appears to be ample scope for the growing of trees producing tans of good quality and high yield; the green and black wattles of South Africa (Acacia molissima and A. decurrens) probably produce the best and most valuable vegetable tans on the market today and the demand exceeds supplies. Wattle-growing in South Africa and Australia forms an important and valuable industry.

Seed of these species has recently been imported and trials are being made in the Blue Mountains. It appears unlikely that the trees might thrive at any altitude under 4,000 feet and experimental planting will be therefore confined to these regions. Growth of both species in a plot at approximately 4,800 feet is most satisfactory and has reached up to 15 feet in as many months.


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THE CARIBBEAN FORESTER

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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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The journal is presented quarterly, in January, April, July, and October. Material for publication should be submitted at least two months before publication date and be addressed to the Director, Tropical Forest Experiment Station, Rio Piedras, Puerto Rico.

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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CONTENTS

THE FORMATION OF TEAK PLANTATIONS IN TRINIDAD

WITH THE ASSISTANCE OF PEASANT CONTRACTORS

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General.—Teak, Tectona grandis Linn., was first introduced into Trinidad about 60 years ago, when a few trees were planted in the Royal Botanic Gardens in Port of Spain. The first plantations were formed in 1913, and small plantations were made in most of the succeeding years until 1928, when a definite planting program was commenced, covering an area of about 70 acres of teak annually. This program has been gradually expanded until today the annual plantings cover some 400 acres at six separate plantation centers. The expansion of the program is considered justified by the satisfactory growth of the older plantations and by the remarkable absence of any serious fungal and insect pests.

Choice of site.—Teak is very tolerant of wide variations in the annual rainfall and climatically nearly the whole of Trinidad is suitable on this account. The rainfall at the six plantation centers varies from about 50 inches to 120 inches per annum, and there is usually a marked dry season from the end of January to the beginning of May. During the dry season the teak are, of course, leafless.

In its soil requirements, teak will again tolerate wide extremes, and there are successful plantations on soils varying from 95% pure sand to stiff red-weathering clays, with a pH value as low as 4.5. The plantations with the highest rate of increment are situated on highly fertile calcareous clays, but the area of such soils available for planting is very small. The limiting factor with all soil types is drainage. Good drainage is absolutely essential for teak, and flat, swampy land, flat-topped ridges with a hard, compact, impervious clay soil, and shallow sand beds 1 to 2 feet thick overlying impervious clay are quite unsuited to this species. All attempts to establish plantations in such situations have failed.

Land which is undulating is best suited to teak, since this kind of topography usually affords excellent drainage, but even very gentle slopes can be planted successfully if the soil is free draining. Natural drainage may often be advantageously supplemented by shallow artificial drains about 18 inches deep.

Silvicultural system.—Since teak is an exotic and a strong light-demander, the only suitable silvicultural system is clear-felling, followed by artificial regeneration under the Uniform System.

Regeneration technique.—The area selected for regeneration is cleared by timber licensees and charcoal burners in the year prior to regeneration. After all marketable trees have been sold, the coupe is divided up into 1-acre plots and each plot is allocated to a peasant contractor. These contractors cut down and lop up any remaining vegetation, and during September to October plant their first crop. For their first crop they are allowed to plant maize,

adlay, beans, and tomatoes, but no other species. Before their first crop is planted the contractors sign a contract with the Forest Department and their duties and privileges are carefully explained to them. Under the terms of the contract, they are allowed the use of the land rent-free for a period of 15 months to plant certain specified crops, in return for which they undertake to keep the land free from weeds during their occupancy.

The first agricultural crop is harvested during February to March. Afterwards the contractors cutlass their plots, and those on the outside of the coupe make fire traces 25 feet wide between the coupe and the adjoining forest or private property. Fire is set towards the end of April and if a satisfactory burn is not obtained the contractors pile the remaining wood in heaps (boucans) and burn them. A good clean burn is most desirable, as it facilitates the rapid planting of the teak and is essential to the proper growth of the main second agricultural crop, hill-rice.

At the first break of the rains, usually in May, any drains which may be necessary to improve the natural drainage of the ground are constructed. Care has to be taken to see that the drains are properly aligned so as to have the maximum effect. A herringbone pattern arrangement is frequently the most effective. At the same time the natural watercourses are cleared of all obstructions so that nothing shall impede the rapid removal of surplus water. After a few heavy showers the soil is usually in a satisfactory condition for planting to begin. The planting gang is organized in two sections. The first consists of a line of men provided with a 6-foot rod and a coffee-digger, which is simply a steel blade about 10 inches long and 4 inches wide mounted on the end of a rough handle. A hole of sufficient size to take the teak plant is dug with the coffee-digger. The rod is, of course, used to ensure accurate spacing of 6 feet by 6 feet.

The second section, which follows the first across the coupe, consists of men and women with cutlasses, a bag of stump plants, and a bundle of thin pickets about 2 feet long. This section does the actual planting. The plants are placed vertically in the holes and the earth carefully replaced and rammed with the cutlass handle. This is necessary to ensure that there are no air-spaces left at the roots where stagnant water can collect and rot the plant. One of the small pickets, which are cut beforehand from the undergrowth of any forest nearby, is stuck firmly into the ground by each teak plant. In moist sandy soils the simpler method of notching can be resorted to, but this method is unsuitable for heavy clay soils.

Planting should if possible be finished by the end of June, and the stump plants begin to shoot about 1 week after being planted, provided there has been sufficient rain.

The contractors now make a deposit of $2.00 per acre occupied to the Forest Department, as a surety that they will complete their contracts satisfactorily. After this they are free to plant their second crop. The main item in this crop is hill-rice, which is sown thickly in shallow holes, but they are also allowed to plant beans, tomatoes, and a small amount of maize. No plant or seed may be placed closer to the teak than 1 foot, while maize must be 3 feet from the teak and with a space of 12 feet between individual maize plants. Before they can sow their crop they usually find it necessary

to weed the land, and it is here that the pickets marking the teak prove their usefulness. Without the pickets it is common for a careless contractor to damage or uproot a large number of teak plants with his hoe during the weeding. When the position of each plant is clearly marked by a picket there is far less likelihood of such damage.

The contractors frequently try to grow a few plants of cassava, pigeon peas, ochroes, tannias, etc., but as these plants rapidly outgrow the teak and provide excessive shade and competition, their cultivation is forbidden and offending contractors are made to remove them. The teak are bound to suffer to some extent from the competition of the agricultural crop, but it has been found that the least damage is caused by the hill-rice, since this does not reach a height greater than 3 feet. During August all teak plants which have died are replaced with new stump plants to bring the stocking up to 100%. In normal circumstances not less than 90% of the original plants will be found to have established themselves.

The contractors look after the teak and their own crops until their harvest. Since the contractors are only too human, a good deal of time has to be spent serving notices on them calling for the weeding of their plots. When such notices are ignored, the necessary weeding is done departmentally and the contractor given the choice of paying the cost or having his contract canceled and his crop forfeited.

The second harvest is reaped during November. At this time considerable damage can be caused to the teak if the rice is threshed in the coupe, the teak plants being broken and covered up by the piles of straw collected at the threshing site. Rice-threshing in the teak is therefore forbidden and the contractors cut off the ears of rice and remove them in bags for threshing at home. The remaining rice and maize straw is cut near ground level and spread between the teak, where it acts as a mulch. As soon as a contractor has cutlassed his plot properly his deposit of $2.00 is refunded. Should a contractor neglect this final cutlassing the work is done departmentally in December and he forfeits his deposit.

By the end of December the teak usually have an average height of 4 to 6 feet, exceptionally vigorous individuals attaining up to 12 feet or more.

The contractors are not allowed a third crop, since this would impose a severe strain on the fertility of the soil and the cultural operations would impede the establishment of an understory of woody species.

Tending and thinning.—During the second and following years tending operations aim at the elimination of grass, the control of vines, and the establishment of a dense understory of native woody species, which helps to kill out the grass and prevent soil erosion. Great importance is attached to this understory, which results from coppice regrowth of the original forest and from seeds distributed by birds, owing to its function of protecting the soil during the dry season when the teak are leafless. On several occasions young teak plantations have been heavily invaded by a leguminous shrub, Flemingia strobilifera, and there has been a marked subsequent improvement in the teak. Attempts at introducing Flemingia artificially into plantations by broadcasting the seeds have, unfortunately, nearly always proved a failure, although the plant spreads naturally with great rapidity.

Thinning is begun in the 5th year, when approximately 50% of the crop is removed. Subsequent thinnings are carried out on a 5-year cycle. The grade of thinning is at present governed by the degree to which the coupe approximates the quality classes of the Nilambur teak plantations of India.

Nursery technique.—Although teak plantations can be formed by sowing seed direct into the coupe, much better results are obtained by the use of nursery plants. The initial growth of stump plants is so rapid that they have a much better chance of survival among the contractors' crops than the small seedlings resulting from seed sown direct. In Trinidad seed is only sown direct on the rare occasions when insufficient nursery plants are available, and ordinary transplants with bare roots or balls of earth are never used.

The nurseries are established a year in advance in the coupe to be planted. A site is chosen on a moderate, well-drained slope, and if the soil in the coupe varies in quality, the nursery is located on the best soil type. The clearing of the site is done in the dry season, charcoal burners being employed as much as possible to reduce expense, but all charcoal pits are made outside the nursery site. When the lop and top are thoroughly dry, fire is set. A good fierce fire is of great assistance in clearing the site thoroughly. A wide border around the nursery is cleared also to eliminate drip, root competition, and shade.

The beds, which are about 4 feet wide, are aligned along the contours to reduce soil loss, and they are separated one from another by shallow drains about 12 to 15 inches wide and 6 inches deep. The soil removed from the drains is spread on the beds, which are not as a rule forked over unless the soil is very hard and compacted. Seeds are sown in rows 9 inches apart, the distance between the seeds in the rows being 6 inches, and they are pressed into the soil and covered with half an inch of earth, to prevent their being washed out by heavy rainstorms. For every acre to be planted in the following year, 4,840 seeds are sown in the nursery, on the assumption that 25% of the seeds will produce plants of suitable size. In good years a higher percentage will be obtained, but bad years must be guarded against, and it has been found that the above allowance is the most reliable.

The formation of the nursery and the sowing of the seeds are normally completed by the end of July. This allows a 6-month growing season for the nursery plants before the advent of the dry season, sufficient to produce good-sized plants. Germination as a rule begins within a week or 10 days from the date of sowing and may be continued over a period of several months.

It is absolutely essential to keep the nursery beds free from weeds at all times, but particularly so when the seeds have just germinated, and regular light weedings are cheaper and more effective than heavy weedings when the nursery beds have been overrun with grass, vines, and herbs.

The young seedlings are fairly hardy, but are liable to sun-scorching, which may be fatal during unseasonable periods of drought. The larvae of one or more species of Melolonthidae are occasionally responsible for a small amount of damage, the taproot of the seedling being eaten.

Plants are removed from the nursery by being pulled up, or if the roots are too large, by being dug out. A laborer can pull out from 1,500 to 2,000 plants in an 8-hour day, depending on the type of soil and the size of the plants. After uprooting, the plants are trimmed to form root and shoot cuttings (otherwise stump plants) by the removal of all but 1 to 2 inches of stem and 6 to 8 inches of root. Unless there is a shortage of nursery plants, only the biggest plants are kept and used, any plant with a stem diameter of less than 1/2 inch being discarded. This culling is most important, since it has been repeatedly found that the largest stump plants produce the largest trees in the first growing season, are less liable to suppression and damage by the contractors' crops, and have the biggest survival percentage. Small stump plants, the thickness of a pencil, have a poor chance of producing a big, healthy tree.

Markets and marketable products.—The merits of Burma teak are too well known to need any reiteration here, and for a good many years the principal product of the Trinidad teak plantations will be roundwood poles rather than sawn lumber. A small amount of lumber of very satisfactory quality has, however, been cut from thinnings in 15- and 20-year-old plantations, and successfully used for furniture, in the railway wagon shops, and, more spectacularly, for about 3,000 superficial feet of wood-block flooring in Government House in Port of Spain.

The main market exists at present for round poles, used for fence posts, pillar trees and frames for native houses, jerk-line poles and telephone poles in the oil fields, and since September 1939 for barbed-wire barricades for the defense of the colony. The possibilities of supplying teak pit props for the mines in Great Britain are under investigation. During 1940 all the poles, amounting to some 30,000, cut in the thinning of 10-year and older plantations, have been disposed of at a satisfactory profit. The smaller poles have a fairly high proportion of sapwood and consequently are not very durable, but the heartwood is resistant to decay and termite attack. The sapwood when seasoned can be readily impregnated with creosote, an absorption of about 10 to 12 pounds per cubic foot being obtained by use of the open-tank hot-and-cold process. Poles treated in such a manner should be extremely durable.

Costs.—Owing to the fact that the removal of the existing forest is undertaken by timber licensees and charcoal burners, and that the care of the teak during the first growing season is the responsibility of the peasant contractors, the costs of formation of teak plantations are fairly low.

With an 8-hour working day and a daily wage of 60 cents for male laborers and 42 cents for female laborers, the first-year cost of formation is approximately $13.00 per acre, comprising the following items:

Preliminary work, i.e., cleaning up the coupe before planting	$0.80	
Planting teak at 6 ft. x 6 ft.	4.20	
Draining (if necessary)	.50	
Supplying, i.e., replacing casualties	1.00	
Picketing	1.00	
Nursery costs	5.50	$13.00

Subsequent tending until the end of the fifth year costs another $11.00, bringing the gross total cost for the 5-year period to approximately $24.00 per

acre. Against this must be set the receipts from the sale of timber and charcoal, which may amount to $10.00 or $12.00 per acre where fairly untouched forest is being cleared. From the time of the second thinning the revenue from sales of poles at present more than covers the cost of all tending and thinning operations, and further it reduces the capital cost of the plantations.

Diseases and pests.—Teak has so far proved remarkably free from serious diseases and pests, but the possibility of an outbreak of disease has been constantly borne in mind and the plantation centers are widely scattered throughout the island. Furthermore, at certain plantation centers cutting sections have been formed so that teak coupes of nearly similar age are separated by areas of natural forest or older plantations.

As previously stated, in the nursery damage is occasionally caused by larvae of cockchafers, but the extent is negligible and no control measures have had to be adopted. Parasol ants are also occasionally responsible for a small amount of leaf stripping, but the nests are easily destroyed with carbon bisulphide.

In established plantations trees are sometimes seen to be dead or dying, and it is believed that rapid changes in the level of the water table may be the cause. Sickly trees are attacked by a wide variety of bark beetles, but their occurrence is almost certainly of secondary importance; a heart-rotting fungus, Plemotus commiscibilis, has been recorded from a few trees which had obviously been previously damaged by fire or other causes. The bee-hole borer which is such a pest in Burma is happily absent from Trinidad.

Statistical.—A considerable number of sample plots have been formed in teak plantations from 5 to 25 years old. These plots have revealed that the bulk of the teak is nearly Quality I by the standards of the Nilambur Teak Plantations in India, while those plantations situated on the poorer, degraded soils are between Classes II and III. The following table based on some of the sample plots gives an indication of the yield which can be expected from teak in Trinidad.

Yield per acre of teak plantation

Standing crop after thinning					Thinnings	Total yield
Age in years	Number of trees	Mean girth at 4' 3"	Mean height of dominant trees	Solid volume of stemwood	Solid volume of stemwood	Solid volume of stemwood
		Inches	Feet	Cu. ft.	Cu. ft.	Cu. ft.
5	634	12.5	45	400	107	507
10	286	21.0	63	924	252	1,283
15	224	25.0	67	1,118	287	1,764
20	169	29.0	71	1,295	309	2,250

It is expected that the rotation will vary between 60 and 80 years according to the quality of the soil.

Summary

Teak was introduced into Trinidad about 60 years ago and planting has been expanded gradually since 1913 up to the present amount of 400 acres annually. The increase is justified by satisfactory growth of older plantations and the remarkable absence of any serious fungal and insect pests.

The species is very tolerant of wide variations in annual precipitation as well as in soils, although good drainage is absolutely essential. As it is a strong light-demander, the only suitable silvicultural system is clear-felling, followed by artificial regeneration.

The areas selected are cleared by timber licensees and charcoal burners in the year prior to regeneration. Later, peasant contractors are allotted 1 acre each and sign a contract with the Forestry Department for free use of the land for 15 months in return for keeping the area free from weeds. They plant and harvest one crop before and another crop after the planting of nursery stump plants of teak by the Forestry Department.

Teak planted in June averages 4 to 6 feet in height at the end of December. Subsequent tending operations aim at the elimination of grass, the control of vines, and the establishment of a dense understory of native woody species. Thinnings are begun in the 5th year and carried out subsequently on a 5-year cycle. Interesting details of the requirements placed on the contractors, methods of their control, silvicultural techniques, growth, yields, and costs are given in the article.

Resumen

La teca fué introducida en Trinidad hace como 60 años y su siembra se ha ido aumentando gradualmente hasta la cantidad actual de 400 acres anuales. El aumento está justificado debido al buen crecimiento de plantaciones viejas y la ausencia notable de ataques por insectos y enfermedades.

Esta especie tolera una variación amplia tanto en la precipitación anual como en los suelos aunque un buen drenaje es absolutamente esencial. Como necesita mucha luz solar, el único sistema forestal aplicable es la tumba total seguida con repoblación artificial.

En el año antes de la siembra aserradores autorizados y carboneros limpian las áreas seleccionadas. Más tarde se les asigna un acre de terreno a cada campesino, el cual firma un contrato con el Departamento Forestal por el uso gratis de la tierra por 15 meses, a cambio de mantener tal área libre de malas yerbas. Siembran y recolectan una cosecha anterior y otra después de la siembra departamental de tocones de teca procedentes de almácigas.

La teca sembrada en junio alcanza un promedio de 4 a 6 pies de altura a fin de año. Los desyerbos subsiguientes se orientan hacia la eliminación de la yerba y de los bejucos y la formación de una cubierta baja de especies nativas leñosas con el fin de proteger el suelo. En el quinto año empiezan los entresaques los cuales se repiten cada cinco años. En el artículo se ofrecen detalles interesantes sobre los requisitos exijidos a los campesinos contratistas, medios de hacerlos cumplir, técnicas forestales, y datos sobre crecimiento, producción y costos.

CONDITIONS ÉCO-SOCIOLOGIQUES ET ÉVOLUTION DES FORÊTS DES ANTILLES FRANÇAISES

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L'aménagement rationnel de la forêt doit être basé sur une connaissance préalable approfondie des conditions écologiques et sociologiques ainsi que des peuplements primitifs et des formations végétales d'équilibre denommées "climax" vers lesquelles tendrait une évolution progressive de la végétation spontanée. Or, ces conditions édapho-climatiques sont très diversifiées suivant la position topographique et l'origine géologique des îles qui constituent les Antilles françaises.

Conditions topographiques et écologiques

Ces îles s'étendent en latitude Nord depuis la Martinique à 14°26, située entre Ste-Lucie et la Dominique (B.W.I.), jusqu'à l'île de St-Martin (Dépendance de la Guadeloupe) située sous 18°5, non loin de Porto-Rico. Elles comprennent du Sud vers le Nord de l'archipel des Petites Antilles, la Martinique, les Saintes, la Guadeloupe, comprenant elle-même deux îles: la Basse-Terre et la Grande-Terre; la Marie-Galante, la Petite-Terre, la Désirade, qui sont des Dépendances proches de la Guadeloupe et enfin: St-Martin et St-Barthélémy qui sont des Dépendances lointaines de la Guadeloupe à laquelle ces îles sont rattachées administrativement.

L'altitude varie depuis le niveau de la mer jusqu'a 1.484 m. à la Soufriere qui est le point culminant des Antilles françaises situé en Guadeloupe et 1.350 m. au sommet de la Montagne Pelée, à la Martinique si tristement célebre par l'éruption de 1902. La température oscille depuis 34° dans les zônes seches et littorales situées Sous-le-Vent, jusqu'à 3 a 4° en altitude et 18° sur la côte située au Vent. Cette distinction de côtes au Vent et Sous-le-Vent est justifiée par l'emplacement des îles dans l'arc et leur position par rapport au vent dominant, tantôt le vent alizé qui souffle du Nord ou du Nord-Est vers le Sud et le Sud-Ouest, humide et frais, tantôt le vent desséchant du Sud.

Le **sol** comme le climat, est des plus variés, non seulement avec les diverses îles de ces Petites Antilles, mais encore à l'intérieur d'une même île. Il est d'origine volcanique avec tuf, basalte ou labradorite en Guadeloupe proprement-dite et aux Saintes, avec andésites, dacites et dépôts meubles à la Martinique et a partir desquels la latérite s'est formée par un processus particulier d'altération de ces roches meres donnant les terres à ocre rouge ou jaune suivant l'oxydation. À la Grande-Terre, ce sont principalement des terrains sédimentaires constitués par des calcaires miocenes fournissant la pierre à chaux dite "roche à ravet," alors que les dépôts de calcaires du Vauclin et de l'Anse Macouba, à la Martinique, sont de l'oligocene moyen et supérieur; des récifs littoraux ou même situés dans la mer et dénommés "cayes" sont formés par des corallinées récentes d'origine pleistocène. Enfin, une troisieme catégorie de sol est celle des terrains alluvionnaires et rivulains,

abondants en raison de grand nombre de fleuves côtiers, rivières et ravines, surtout à caractère torrentiel, qui coulent dans ces îles, entrainant des détritus abandants.

Ainsi donc, les facteurs du climat, comme ceux du sol offrent dans les Antilles françaises une gamme de variations des plus amples et à ces conditions, s'est encore superposée l'action de l'homme qui s'y manifeste depuis des siecles.

Climax forestiers et évolution régressive.—Dans les divers secteurs, l'équilibre biologique vers lequel tend la végétation est la forêt. Mais cette forêt, en raison même des facteurs divers qui ont régi sa constitution puis son évolution, présente des aspects différents. La forêt native du Sud de la Martinique, du Nord de la Guadeloupe et des Dépendances de cette île, n'était pas la même que celle du Centre, plus humide et comportant des sommets élevés.

L'étude des formations végétales de ces zônes permet de reconnaître des lambeaux primaires et, à partir de'eux, des stades d'évolution régressive et même des paratypes de substitution avec des peuplements purs de la forêt secondaire et des taillis, broussailles et halliers.

En Guadeloupe, des restes de forêt native subsistent, dans un état primitif parfaitement conservé en particulier a Fumée, Terre-Plate, Haut-Corbier et Montiberge, alors qui'à la Martinique, ou la culture a été poussée plus loin, amenant une dégradation plus profonde, il n'y à plus de relicts, à l'état pur, de la forêt primaire.

Néanmoins, l'étude comparée de ces îlots subsistants dans les divers secteurs et la constitution des forêts les moins abusées, nous a permis de reconnaître divers climax.1/

Une esquisse rapide de leurs caractères fait saisir leur complexité, dont la connaissance nécessite une étude détaillée et approfondie.

1o. La forêt xérophytique.—C'est une forêt littorale, ne dépassant pas 200 metres d'altitude et établie sur en milieu sec, ou la pluviométrie ne dépasse pas 1 m.50 de hauteur d'eau. Les arbres possèdent dans ce secteur des cellules sécrétrices ou essentielles et leur bois est souvent coloré; les troncs sont durs et les branches perdent leurs feuilles à la saison seche. Suivant les conditions édaphiques, on distingue trois facies différents:

Le facies sableux à Ceiba caribaea - Tabebuia pallida qui posède des arbres élevés (jusqu'à 25 m. de haut) et présentant des contreforts angulés, des futs droits et énormes. C'est la forêt de Folle-Anse à Marie-Galante, celle des Anses d'Arlets (Grande-Anse) à la Martinique.

Le facies calcaire à Krugiodendron ferreum - Forestiera rhamnifolia var. martinicensis, du Vauclin, Marin et Ste-Anne ou les dépôts sédimentaires se mélangent avec les tufs volcaniques lenticulaires. C'est une forêt d'arbustes

1/ H. Stehlé: Essai d'Écologie et de Géographie botanique, Flore de la Guadeloupe, t.1, Basse-Terre (Guadeloupe), 1935.-Esquisse des Associations végétales de la Martinique, in Bul. Agr. Martinique-Fort-de-France, 1938.

a feuilles petites, luisantes et coriaces dont l'aspect rappelle le paysage méditerranéen de la garrigue rhamnoide.

Le facies volcanique à Fagara microcarpa - Myrcia paniculata var. Imrayana, constitué surtout par des mérisiers du pays et reconnaissable sur les mornes labradoritiques et basaltiques du Honelmont et de Deshaies, à la Guadeloupe, aux Saintes et dans les hauteurs des Trois-Ilets, du Diamant et du Vauclin, à la Martinique où dominent des sols andésitiques.

2o. La forêt mésophytique.—Elle est à caractère intermédiaire, recevant de 1 m 50 à 3 m. d'eau annuellement, établie sur sol volcanique à une altitude comprise entre 150 m. et 400 m. C'est là que les productions agricoles se sont installées. Ses différences avec la forêt précédente résident dans son aspect pas verdoyant, ses arbres élevés plus nombreux, à la fois des sempervirentes, à feuilles persistantes et des diciduae, à feuilles caduques; elle est polystrate. Elle se différencie de la forêt humide par son paysage bryophytique pauvre, l'absence d'épiphytes corticoles et d'épiphylles, l'importance de ses gros arbres.

C'est l'association à Andira inermis - Lonchocarpus latifolius. Les légumineuses arborescentes y sont nombreuses. Les peuplements a Swietenia mahogani Jacq. et ceux à Swietenia macrophylla King, réussissent fort bien dans cette ambiance.

Elle a subit une dégredation qui a conduit à la formation des taillis à Piper dilatatum, à Vernonia icosantha DC., à Cordia martinicensis Roem. et Schult., et de brousses à Solanum triste Jacq.

3o. La forêt hygrophytique.—C'est la forêt la plus abondante, dense et humide, qui, à l'origine devait former la manteau continu dans les zônes de 3 m. à 6 m. de chute d'eau. Elle n'exite que dans le Centre et le Nord de la Guadeloupe proprement dite et de la Martinique. Elle est du type pseudo-équatorial, dense, humide, polystrate et sempervirente et se localise entre 400 et 1,000 m. d'altitude. Elle est l'homologue de la "rain-forest" de Porto Rico décrite par H. A. Gleason et M. T. Cook,[2] de la "foresta udica," d'Haiti et St-Domingue de Ciferri,[3] et c'est, à notre sens, le correspondant caraibe de "l'hylea," que Polakowsky[4] a décrit pour l'Amérique centrale et l'Amérique du Sud. Son ensemble constitue un Udophytia. Nous l'avons décrite dans l'Esquisse des Associations Végétales de la Martinique avec quelques détails (p. 23 à 36), sous le nom d'association à Sloanea massoni - Oxythece hahniana.

Les peuplements les plus primitifs sont nettement mélangés, mais non entremêlés, répartis par parcelles qui ne sont cependant pas bien délimitées ni uniformes. C'est de la très belle futaie rappelant le haut-perchis de forêt traitée dans ses endroits purs; à densité de 50 à 80 arbres à l'hectare seulement, mais hauts fastigiés, dépassant 30 m. au-dessus d'un empêtment étalé avec des contreforts très amples. L'hétérogénéité est la regle cependant, tantôt des espèces dominantes apparaissent par exemple les chataigniers du genre

2/ H. A. Gleason and M. T. Cook. Plant ecology of Porto Rico, in Sc. Surv. Acad. Sc. New York, 1927.
3/ R. Ciferri. Studio geobotánico dell'Isola Hispaniola (Antille), R. Universita di Pavia, 1936.
4/ H. Polakowsky. Petersmann's Mitteil. XXIII, p. 220, 294, 346. Gotha, 1930.

Sloanea dans les bois de la Varvotte à la Martinique, et des Bains James à la Guadeloupe, des marbrés: Richeria grandis Vahl, en forêt de Fumée, le bois rouge: Amanoa caribaea Kr. et Urb. dans la Vallée de la Rivière St-Louis en Guadeloupe, ailleurs c'est le laurier-rose; Podocarpus coriaceus L. Cl. Rich, le Koumaré: Eugenia octopleura Kr. et Urb. ou le balata: Oxythece hahniana Pierre.

Ce noyau de sylve primaire est entouré, suivant les facultés d'accès, par la forêt primaire de cycadée ou un mélange de ces essences natives existe en proportions variées avec des espèces de seconde croissance.

C'est là que l'on peut situer l'action de l'homme en vue d'une reconstitution possible du peuplement primitif par la méthode des points d'appui basé sur la dissémination en tache d'huile d'essences progressives.

Dans cette forêt dégradée, les espèces de lumière de la sylve primaire y sont représentées telles que les acajous blancs: Simaruba amara Aubl.; les résolus ou bois rivières: Chymarris cymosa Jacq., les pois doux chypre: Phoebe elongata (Vahl) Nees, les pois doux poilus: Inga vera Willd., les mapous-barils: Sterculia caribaea R. Br. et Benn., les boispin ou magnolia: Talauma plumieri (Sw.) DC., les guépois: Myrcia leptoclada DC., les bois de soie ou bois la glue: Sapium caribaeum Urb., le bois côte noir: Tapura guyanensis Aubl., etc.

La présence de ces arbres dans les parties inférieures dégradées de forêts en évolution, doit être interprètée comme les signes d'une amélioration certaine. Ce sont des essences de haute progressivité sous le couvert desquelles le sous-bois, auparavant xéro-héliophile là où l'on peut les introduire, tend à devenir méso-sciaphile. Elles seront utilisées avec profit dans l'entreprise de régénération de la forêt caraibe.

4o. La sylve montagnarde.—C'est une forêt d'altitude, sur sol acide, rabougrie sous l'action des vents et orages violents et dont l'intérêt botanique est grand mais l'importance forestière des plus réduites. On se bornera ici a citer les formations végétales qu'on peut y reconnaître facilement. Ce sont: le clusietum: à Clusia venosa Jacq. à la Guadeloupe, à C. pluckenettii Urb. à la Martinique et dénommées aralies ou mangles montagnes; le Lobelietum, à Lobelia guadeloupensis Urb. (Soufrière à la Guadeloupe) et à Lobelia conglobata Lam., aux Pitons du Carbet, à la Martinique; le Pitcairnietum à Pitcairnia bracteata et à Guzmania plumieri de la Montagne Pelée et de la Soufrière; enfin, la forêt de palmiste à Euterpe globosa Gaertn. qui est la "palm-forest" de Porto Rico, ou la "foresta amanacle" ou "manaclar" d'Haiti.

L'évolution régressive de ces divers types éco-sociologiques de forêt s'est manifestée sous l'action des conditions naturelles de dégradation du sol, des cyclones et ouragans, comme ceux du 7 août 1899 et du 12 septembre 1928 à la Guadeloupe, ou des éruptions volcaniques comme celles de la Montagne Pelée en 1792, 1852, 1902, et 1929 à la Martinique et dont la plus grave a été celle de mai 1902 qui a détruit St-Pierre et les forêts de la Calebasse, auparavant très riches.

Mais le facteur le plus important de dégradation de la forêt des Antilles françaises, comme les autres Petites Antilles a été l'homme. Il a

attaqué la forêt par la hâche ou le sabre d'abattis ou par le feu pour la culture ou pour ses besoins les plus variés.

Des associations nouvelles sont apparues qui constituent les paratypes de substitution, variant les milieux et les causes néfastes qui ont provoqué la ruine du manteau végétal.

Les principales causes de la forêt xérophile, pour laisser place aux paratypes de substitution, ont été l'exploitation abusive des bois, les feux préculturaux et les incendies pastoraux. Les résultats en ont été l'érosion des pentes et la disparition par entrainement de la couche arable, l'irrégularité d'écoulement des eaux à la surface du sol et la tendance vers le tarissement des rivières. Cette régression dans le Sud de la Martinique et la Grande Terre ou le Secteur Sous-le-Vent à la Guadeloupe fait apparaître des taillis à Chrysobalanus icaco (icaques), à Lantana involucrata L., à Haematoxylon campechianum L. (campêchiers), à Croton, d'origine diverse, édaphique, climatique ou même édapho-climatique et enfin des brousses à Acacia, des associations ouvertes, hyperxerophiles à lactacées, des savanes herbacées et des pelouses rases.

Les dérivés de la forêt mésophytique sont des taillis plus amples que les précédents et d'un aspect plus vert, à feuilles persistantes en général, à Piper, Vernonia cordia et Miconia. L'espèce dominante atteint parfois, comme certains taillis à Miconia laevigata DC., un pourcentage de 70%.

La régression de la forêt dense et humide à lieu surtout à la suite des coupes abusives en vue de la culture. De nombreuses formations dégradées, en évolution régressive et des associations ou peuplements de substitution s'observent suivant les conditions de sol et de climat des divers secteurs et suivant la périodicité des retours de l'homme et l'intensité de son action sur la forêt.

Lorsqu'une trouée importante est pratiquée en forêt, soit accidentellement, soit par l'homme, le terrain conservant les qualités du milieu forestier, il apparaît une formation secondaire ou formation de seconde croissance. Ce sont des peuplements presque purs dans les clairières d'arbres à bois blanc, tendre, cassant et spongieux, à fût droit et homogène, constitué par des cellules lâches et à feuilles larges. Les espèces dominantes sont: les Cecropia peltata L. et Ochroma pyramidale (Cav.) Urb., pour les arbres: l'Hemitelia grandifolia (Willd.) Fée et Cyathea arborea (L.) J. E. Sm. pour les fougères arborescentes. Sur terrains latéritiques, on observe les taillis à Miconia guianensis - Miconia trichotoma, à Nectandra-Ocotea et à Byrsonima spicata (Cav.) DC. La régression ultime de la forêt dense conduit aux savanes hydrophiles à Clidemia umbrosa Cogn., Hyptis atrorubens Poit., Sauvagesia erecta L. ou Phenax vulgaris Wedd.

La sylve montagnarde, sous l'action du ruissellement des orages et des éboulis, régresse et le peuplement à Oreopanax dussii Kr. et Urb. ou la brousse à Dicranopteris bifida (Willd.) Maxon, sont les faciès de dégradation le plus souvent observables.

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Une étude préliminaire des formations natives et de leur dégradation, minutieusement réalisée dans chaque île antillaise, en recherchant les causes édapho-climatiques et humaines mises en jeu, doit être à la base de toute action utile en forêt.

Elle permet de déduire des méthodes d'exploitation rationnelle en essayant de retrouver une ambiance perdue et en remontant, étape par étape, à l'aide d'essences progressives, aux stades antérieurs à la dégradation et à reconstituer des climax, des peuplements voisins en sylve native ou des forêt homogènes d'exploitation précieuse.

Summary

Proper forest management must be based on a thorough knowledge of ecological and sociological conditions such as those of virgin stands and climax types. The edapho-climatic conditions vary greatly in the French Antilles in accordance with the wide range of variations in topography, soils, etc. In addition, man has exerted a profound influence on the vegetation during the past few centuries.

Based on several years of study, the author presents the various climax types with notes on their character, composition, and subdivisions. These are: The xerophytic forest, the mesophytic forest, the hygrophytic or rain forest, and the mountain woodland.

The regressive evolution of these various types due to the action of soil deterioration, hurricanes, cyclones, and the activities of man are discussed and notes given on the composition of the more common substitute formations.

Resumen

El manejo adequado de los bosques debe basarse en un conocimiento concienzudo de las condiciones ecológicas y sociológicas tales como aquellas de las selvas vírgenes y los tipos o formaciones clímax. Las condiciones edafoclimáticas varían grandemente en las antillas francesas de acuerdo con las amplias variaciones en topografía, suelo, etc. Además, el hombre ha ejercido una profunda influencia sobre la vegetación durante los últimos siglos.

Basado en varios años de estudio, el autor presenta aquí los varios tipos clímax con anotaciones sobre su carácter, composición y subdivisiones. Estos son: la selva xerófila, la selva mesofítica, la selva pluvial y la selva de las altas sierras.

Se discute la evolución retrógrada de estas diversas formaciones debido a la acción del desgaste del suelo, de los huracanes y a la actividad del hombre y se presentan notas sobre la composición de las formaciones substitutas más comunes.

SOME OBSERVATIONS ON FOREST ENTOMOLOGY IN PUERTO RICO

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During the spring of 1940, a survey of forest insect activities in parts of Puerto Rico, the Virgin Islands, and the Dominican Republic was made by the writer. Various general impressions were received on this survey which may be of interest to other forest entomologists. Unavoidable circumstances prevented spending a longer time on the survey, and so these observations are very sketchy. They would have been even more so had it not been for the cooperation of, and the information gained from, Director Bevan and Mr. L. R. Holdridge of the Tropical Forest Experiment Station, and Dr. G. N. Wolcott and Mr. L. F. Martorell of the Insular Agricultural Experiment Station. Both stations are at Rio Piedras, P. R.

The insect activities discussed fall into rather natural categories. They were the activities affecting:

1. Seed production and germination
2. Seedlings in nurseries.
3. Forest management.
4. Forest products.

Activities affecting seed production and germination.—The seeds or the seed pods of many tropical plants are valuable for the therapeutic properties of chemicals contained in them. Research work in this field is constantly enlarging the knowledge concerning these properties, and there is an ever greater demand for the seeds of various tree species. Yet because of poor seed supply it is generally difficult, and often impossible, to meet the demand. Adequate supplies of seeds for nurseries are likewise often difficult to obtain. The inability to meet these needs is frequently caused by insects which destroy either the developing flowers, or the seeds before they can be used. For example, it was observed that the developing flowers of several species of Erythrina are destroyed by a lepidopter. It has been difficult to meet the demand for these seeds because of poor crops which presumably are due to the activities of this insect. Aceitillo, Zanthoxylon flavum Vahl., a valuable cabinet wood, is reported to have its seeds so heavily infested by a weevil that it is impossible to obtain an adequate supply for nursery needs. Important studies could be made on the biology and control of these and other insects affecting seed supplies of commercial importance.

Activities affecting seedlings in nurseries.—Damage to nursery stock by root-feeding insects as well as by scale insects and defoliators was common in the nurseries observed. It was noted also that infested nursery stock was occasionally distributed for planting. Some methods of control are well-known and have been used, but there is room for much closer application of control methods and inspection of nursery stock. Bacterial and other tropical nursery diseases have been recorded, but the role of mites and insects in the transmission of such diseases has not been studied. The field of nursery pests in the tropics seems to be very poorly known.

Activities of insects affecting forest management.—Considering the great diversity in the tree species in the regions visited, it does not appear likely that the damage done by any one species of insect will ever as seriously affect forest management as has the nun moth, the European spruce sawfly, the Black Hills beetle, or any of the numerous other forest pests of the temperate climates of Europe and North America. There the vast stands of timber that are almost entirely composed of a single tree species furnish nearly ideal conditions for the building up and spread of outbreaks.

The nearest approach to outbreak conditions observed in Puerto Rico was that of the cedro shoot borer, Hypsipyla grandella (Zell.), which was doing relatively serious damage in cedro, Cedrela mexicana Roem., plantations. The injury is caused by the larvae, which mine out the centers of new shoots. These finally wilt and die. The constant attacks on small trees occasionally kill them, but the least they do is to cause a stunting of growth and excess branching. It is believed that the highly unnatural conditions caused by pure plantings, plantings on sites unsuitable in regard to soil and drainage, and plantings with little or no shading have contributed appreciably to the increase in activities of this caterpillar. A careful study of the biology of this insect and of ways to control it by silvicultural and biological methods is greatly needed, for at present the damage wrought by this borer has brought the planting of this very valuable tree practically to a standstill. Not only has the moth seriously affected the cedro plantations, but now that it is becoming more abundant the moth is attacking mahogany (mahogany belongs to the same family as cedro), which was frequently set out in plantations with cedro. Such a practice is no longer continued, but the damage done by the borer in mahogany seems to be increasing.

In the regions visited the Scolytidae, which play such an important role in the coniferous stands of temperate regions, are of relatively little economic importance. No conifers are native to Puerto Rico or the Virgin Islands, and Pinus occidentalis Swartz, which is native to the Dominican Republic, was not, at least in the area where they were observed, seriously attacked by Scolytidae.

In making cuttings and thinnings care in some cases will have to be exercised to prevent the building up in the slash of an insect population which will later emerge and attack standing green trees. An example of this is described by Martorell[1/] where Apate monachus (F.) (=A. francisca) built up in slash and later emerged to attack a mahogany stand. Observations indicate, however, that insects do not always breed up in slash, and when this is the case and where there is no fire hazard, it is much better to leave the slashings in situ. Studies may show that slashings cut at certain times of the year do not favor insect attacks. If such proves to be the outcome, the time of cutting or of thinning should be modified to permit the leaving of debris.

Scale insects are everywhere present in the forests and seem to play an important but usually inconspicuous role. Data should be obtained not only concerning the effect they have on tree increment, but also concerning their

1/ Some notes on forest entomology. Caribbean Forester 1 (1): 25-26. October 1939.

preferred hosts, in order to prevent favored-host plantings in locations that would tend to spread the scales to less favored hosts.

Homoptera, which are everywhere abundant in the forests, are important vectors of virus diseases, yet the importance of the vector role these insects play in tropical forests is not known. The cedro leaf-hopper, Dikraneura cedrela Oman, for example, causes a yellowing of the leaves at the point of feeding. The injury is often so abundant and continuous that it causes the trees to drop their leaves, sometimes several times a year, thereby seriously affecting the annual increment. Is this damage caused primarily by a virus or is it due merely to the mechanical injury caused in feeding?

In temperate regions forest management is affected chiefly by the following groups of insects, which are listed here in order of their importance: Coleoptera, Lepidoptera, Hymenoptera, and Homoptera; but in the tropical areas visited the impression received is that the order of importance would be Lepidoptera, Homoptera, Coleoptera, Isoptera, and Hymenoptera. Yet from a forestry standpoint the biology of not a single important species of even the first two orders has been adequately studied.

Insects affecting forest products.—Into this group would fall insects attacking sawlogs not yet hauled from the woods; logs, beams, and lumber for construction; and finished products. Several species of ambrosia beetles and roundheaded borers were commonly observed attacking logs not yet hauled from the woods. The activities of either of these groups, however, are limited chiefly to the sapwood and do not at present seem to be of great importance, although in particular instances it is to be expected that they will cause serious damage to sawlogs. Termites do the greatest amount of damage to forest products, especially those imported from the States. The rapidity with which they establish infestation and the damage done by either the comején, Nasutitermes costalis Holmgren, or the polilla, Cryptotermes brevis (Walker), to most of the furniture and lumber imported from the States is unbelievable. These two insects probably do more damage than all the other insects attacking this type of wood combined. A great amount of work has been done on termites of the tropics, but it would seem that much more work could still be done in developing methods for the control of, and for the prevention of, attacks by these insects. Studies should also be carried out in furthering the utilization of tropical woods that are not, or are only very slightly, subject to termite attacks. The work of Wolcott[2/] is an interesting step in this direction.

In conclusion, it seems safe to say that the field of tropical forest entomology has not really been scratched, that the activities of forest insects have caused and will continue to cause forestry problems that can be satisfactorily solved only when methods for the control of these activities are known, that with an increasing demand for the products of tropical trees for pharmaceutic use there will be numerous insect problems developing, and that forest insects play a very important but inconspicuous role in the economy of Puerto Rico.

2/ A list of woods arranged according to their resistance to the attacks of the "polilla," ... Cryptotermes brevis Walker. Caribbean Forester 1 (4): 1-8. July 1940.

Summary

During the spring of 1940, a survey of forest insect activities in Puerto Rico, the Virgin Islands, and the Dominican Republic was made by the writer. The article discusses the insect activities affecting seed production and germination, seedlings in nurseries, forest management, and forest products.

Adequate supplies of seeds for nurseries or other uses are often difficult to obtain because of insect attacks which destroy either the developing flowers or the seeds. Damage to nursery stock by root feeders, scale insects, and defoliators was noted. Apparently, single species of insects will not affect forest management as seriously in the region visited as occurs in temperate climes. However, the cedro shoot borer does sufficient damage to affect forest plantations seriously.

Scale insects and other Homoptera, the latter as vectors of virus diseases, are also important pests. It appears that the Lepidoptera, Homoptera, Coleoptera, Isoptera, and Hymenoptera constitute the most important groups. Several species of ambrosia beetles and roundheaded borers attack sawlogs, rough lumber, and finished products. The activities of both of these groups are limited mainly to the sapwood. Termites do the greatest amount of damage to forest products, especially those imported from the States.

Activities of forest insects are causing and will continue to cause forestry problems that can be solved only when methods for the control of these activities are known.

Resumen

El escritor llevó a cabo estudios en la primavera del 1940 sobre las actividades de los insectos en los bosques de Puerto Rico, en las Islas Vírgenes y en la República Dominicana. Se expone en el artículo las actividades de los insectos que afectan la producción de semillas y su germinación, las plántulas en los viveros, la administración de los bosques, y los productos del mismo.

Un abastecimiento adecuado de semillas para viveros u otros usos es a menudo difícil de obtener debido a los ataques de insectos que destruyen las flores en desarrollo o las semillas. Se observaron daños en las existencias de los viveros, causados por formas que se alimentan de las raíces, queresas y defoliadores. Aparentemente especies individuales de insectos no afectan tan seriamente el manejo de los bosques en la región visitada como ocurre en los climas templados. Sin embargo el taladrador del cedro causa suficiente daño como para afectar seriamente las plantaciones de la selva.

Los homópteros, trasmisores de las enfermedades virulíferas, y las queresas son también plagas importantes. Parece que los lepidópteros, homópteros, coleópteros, isópteros y hymenópteros abarcan los grupos más importantes. Algunas especies de escólitos y plátipos atacan los troncos aserrados, la madera sin pulir y los productos terminados. Las actividades de ambos se limitan principalmente a la albura. Las termitas causan el mayor daño a los productos de los bosques, especialmente a aquellos importados de los Estados Unidos.

Las actividades de los insectos de bosques son y continuarán siendo la causa de problemas forestales que no se resolverán hasta que no sean conocidos los métodos para dominar estas actividades.

THE REGENERATION OF MIXED RAIN FOREST IN TRINIDAD

R. L. Brooks, Conservator of Forests
Trinidad and Tobago

INTRODUCTION

Tropical silviculturists are doubtless all conversant with the extremely successful technique employed in the natural regeneration of the Malayan forests, accounts of which have appeared in the Malayan Forester.[1] But Malaya appears to be, in the words of Dr. L. Chalk,[2] "a silviculturist's paradise": many of the marketable species "are more or less 'weed species,' that regenerate with great freedom and grow very rapidly": ". . . the trees appear to thrive and regenerate freely however they are treated . . ." These conditions are not present in the Trinidad mixed forests. Here, the weed species are not marketable, whilst the marketable species are for the most part of slow growth: seed bearers are few and far between—a condition aggravated by past overcutting—whilst their seeds are, with few exceptions, unwinged, heavy, restricted in dispersal and very liable to damage by insects or consumption by animals. Complete reliance on natural regeneration is, in consequence, impossible.

Between the years 1927 and 1940, a technique has been slowly evolved in one of the depleted Forest Reserves of Trinidad, known as Arena Reserve; this technique as it stands at present involves a combination of natural with artificial regeneration under a shelterwood. A brief account of its evolution and present practice may be of interest, and possibly of help, to tropical foresters elsewhere who are faced with similar conditions.

DESCRIPTION OF ARENA RESERVE

The following brief description of the Reserve will, it is hoped, enable the reader to visualize the general conditions:

Area.—3,797 acres.

Topography and elevation.—Undulating throughout: 100 feet - 200 feet above sea level; good drainage, except on the flats and on areas with an underlying pan, where swampy conditions prevail.

Geology and soil.—The underlying geological formation over the bulk of the area is Caroni sand of lower Pliocene age: in the northwestern area there is detritus from the Northern Range, characterized by a badly drained plateau bearing a quartz sand overlying a hardpan. The Caroni sand formation yields a pure fine whitish sand of very poor quality, which deteriorates very rapidly on exposure. In places there are small exposures of the slightly reddish Talparo clay, also a very poor, highly acidic soil. Soil deterioration studies have been carried out and recorded.[3]

1/ The Malayan Forester, Vol. 1, 1931 & 1932, pp. 86, 186, and 254.
2/ A Forestry Tour in 1937, by L. Chalk, M.A., D.Phil. Imperial Forestry Institute Paper No. 16.
3/ Soil Investigations in the Arena Forest Reserve, Trinidad, by D. W. Duthie, F. Hardy and G. Rodríguez. Summarized by R. L. Brooks, I.F.I. Paper No. 6.

Climate.—The averages of monthly means of shade temperature are as follows: In the natural forest 66° F. minimum, 83° F. maximum, in the open, 61° F. minimum, 103° F. maximum. The average rainfall is 97 inches.

Composition and condition of the natural forest crop.—The forest is tropical lowland evergreen rain forest subdivided into three types:

Carapa-Eschweilera-Maximiliana type.—This covers the greater part of the area. The commonest marketable species are Carapa guianensis, Eschweilera subglandulosa, Calophyllum lucidum, Tabebuia serratifolia, Manilkara bidentata, Vitex divaricata, Aniba spp., Ocotea spp., Terminalia obovata, Byrsonima spicata, Didymopanax morototoni (for match making only), and Hieronyma caribaea. The commonest understory species is Pentaclethra macroloba.

Carapa-Palmae type.—The swampy flats contain this type. There are several species of palm, including Manicaria saccifera and Jessenia oligocarpa. The commonest trees are Carapa guianensis and Symphonia globulifera.

Calophyllum-Palmae Ecotone type.—This is an ecotone between the Carapa-Eschweilera-Maximiliana type and the Calophyllum-Palmae type of a nearby forest and is found on the plateau where quartz sand overlies an impermeable pan. Palms are abundant, mainly Maximiliana caribaea, Manicaria setifera, Jessenia oligocarpa, and Euterpe oleracea.

The whole forest has been heavily overcut in the past and there is now little valuable timber left. Considerable quantities of Tabebuia serratifolia have been taken from this area. This wood is extremely hard, heavy and durable and is most suitable for railway sleepers, bridges, etc., for which it was in great demand.

Seed and seed dispersal.—Only Tabebuia serratifolia and Terminalia obovata have winged seed; parent trees of the former are extremely restricted in number. Seed of Hieronyma are eaten by birds and dispersed fairly widely, possibly those of Ocotea spp. also. Species such as Manilkara, Calophyllum, Carapa, Byrsonima, etc., have heavy unwinged seeds, very restricted in dispersal. All these species are hard to medium hardwoods and their rate of growth is very much slower than that of the softer-wooded "forest weeds." Of the latter, species such as Alchornea biglandulosa, Vismia cayennensis, etc., rapidly invade any area when the canopy is opened; their timber is not marketable.

SILVICULTURAL TREATMENT

From the foregoing description of the crop of a Forest Reserve constituted as such for production purposes, it is clear that the improvement of the growing stock, so seriously depleted by past overcutting, was essential, and in 1927 work was started under a Working Plan with a view to the regeneration of the whole area over a period of 60 years. The Working Plan was deliberately made extremely elastic, so far as the silvicultural prescriptions were concerned, in order that a silvicultural technique based on actual experience might be evolved.

1927-1931 clear-felling system.—Clear-felling followed by artificial regeneration with two or three species was adopted from 1927 to 1931, except for two small areas artificially regenerated under a shelterwood in 1930 and 1931. Certain modifications of treatment were introduced, as the following brief description will show:

1927. Clear-felling was followed by burning; ground provisions, such as cassava, were planted as ground shade; tending took the form of clean-weeding.

1928. Burning was abandoned as conducive to grass invasion, but otherwise the treatment was the same.

1929-1931. The practice of clean-weeding was discontinued, and instead the growth of invading woody accessory species was encouraged as a soil protecting and improving measure.

Generally speaking, the results of clear-felling were the same throughout: it was followed by a heavy invasion of grass, together with the appearance of considerable areas on which all the vegetation was markedly chlorotic. Extensive filling up of blanks was necessary in the second and third year after planting, together with constant expensive tending; growth of the crop was extremely slow and canopy was not formed for several years. The formation of a crop was a prolonged struggle and costs were naturally extremely high. It is noteworthy, however, that the practice (begun in 1929) of the encouragement of a woody understory—formed mainly by the invasion of Vismia spp. and Melastomaceae spp.—effected a marked improvement: it was observed that chlorotic areas returned to normal as soon as the woody understory was established and growth of the crop improved immediately.

Obviously the outstanding fault of the work of these earlier years lay in the failure to approach regeneration problems from an ecological standpoint. An attempt was made to force an artificial crop of two or three species on a clear-felled area, which formerly carried a highly mixed and complex crop, without any adequate knowledge of how such a drastic interference with natural conditions would affect the local climate and soil. It is a matter for some surprise, therefore, that on the whole quite good crops have resulted, though at an uneconomic price.

The extreme difficulty experienced in establishing the new crop pointed to a pronounced deterioration in local climatic and soil conditions consequent upon clear-felling, and the necessity for a different technique. In order to ascertain just what climatic and soil changes were induced by clear-felling in this area, a soil deterioration experiment was commenced in 1933 in collaboration with the Soil Department of the Imperial College of Tropical Agriculture. The results of this experiment have been published (see footnote 3, p. 164), but the following brief notes will give an indication of how serious these changes are:

Climatic.—Clear-felling caused the evaporating ability of the air to increase by about 4½ times, the degree of insolation to increase by about 10 times and the range of shade temperature to become almost twice as great. Natural forest temperatures varied from 67 - 88° F., and clear-felled areas from 58 - 96° F.

Soil.—Soil deterioration was very rapid by the time clear-felling was completed, i. e., within about 8 weeks after the land had become exposed: there was a rapid reduction in organic matter and nitrogen, and a decrease of the C/N ratio. Burning consumed shed leaves and thus prevented the incorporation of carbon and nitrogen into the soil: alkaline salts were liberated, raising the pH value, but rapid wet-season leaching soon caused their removal, with a concomitant fall in the pH value.

1932 onwards. Shelterwood system.—From 1932 onwards clear-felling was abandoned and replaced by a shelterwood technique. For the first two years regeneration measures took the form of mainly artificial regeneration, supplemented by natural regeneration. Experience showed, however, that far more natural regeneration resulted than had been anticipated, largely owing to the kindly action of parrots and pigeons in distributing seeds of Hieronyma caribaea; as a result, operations took the form of merely supplementing natural regeneration with the minimum amount of artificial regeneration necessary: the latter was particularly required on the sites of charcoal pits.

Under the shelterwood technique the invasion of grass and the appearance of chlorotic areas entirely ceased—indeed it was remarkable how light a shelterwood prevented grass invasion; successful crops were established in the year of regeneration, whilst costs were enormously reduced and became economic.

Considerable difficulty was experienced at first in the formation of a satisfactory shelterwood. In the first place, whilst it was desirable to employ charcoal burners to do the actual felling for the sake of economy, the charcoal burners proved to be careless, often willfully so, felling marked trees in such a way as to knock down other trees intended to form part of the shelterwood, thus creating large gaps in the canopy. Secondly, the relative merits of a high or low shade had not been worked out: low shade appeared to be more easily controllable, but the felling of large trees did excessive damage.

Experience has now shown that high shade, such as that afforded by the dominants of the natural forest crop, whilst protecting the soil adequately, offers practically no interference with the young crop being brought on beneath it. Low shade, on the other hand, although it may protect the soil adequately, actively interferes with, and retards the development of, the young crop. The ideal form of shelterwood, therefore, would consist solely of dominants evenly spaced so that their crowns formed a regular, light, even canopy throughout.

Unfortunately, mainly owing to past interference with the natural forest crop by the overcutting of the marketable dominants, it is impossible in practice to obtain such a shelterwood: the remaining dominants are so irregularly spaced, and where overcutting has been severe, so few in number, that if all the trees except the dominants were removed, the resulting shelterwood would contain excessively large gaps.

The next best shade is, of course, that afforded by the subdominants which must be left, where required, to fill the gaps between the crowns of the dominants. If the dominants and subdominants together do not give sufficient shade, then trees of the lower stories must be left, but such trees should have light, and not dense, crowns.

It must not be inferred from the foregoing that all the dominants must necessarily be left, but dominants should be marked for removal only if, after the removal of all the trees of the lower stories, they would still form too dense a shade.

The actual felling of the dominants and subdominants with large crowns will inevitably cause damage in the lower stories, and may de-crown or knock down trees intended to be left as part of the shelterwood. It is clearly necessary, therefore, to mark and fell any dominants or subdominants, which have to be removed, before any other markings are made in their vicinity, if large gaps in the canopy are to be avoided.

Lianes tying together the crowns of adjacent trees are a further cause of damage to trees intended to be left, and advance action must be taken on them.

In the light of the foregoing, the present rules laid down for the formation of a shelterwood are as follows:

1. Cut all vines and lianes 2 years in advance.
2. Complete the formation of the shelterwood 1 year before regeneration.
3. Mark for felling only such dominants and subdominants as will cause too dense a shade even after the removal of the lower stories. These trees must be felled before any other trees are marked for felling in their vicinity so that the damage done by their fall is known, to guide further cutting. Dominants of marketable species should, so far as is possible, be left unmarked.
4. Mark for felling all the trees forming the lower stories, unless there are no dominants or subdominants above them. In the latter case leave trees with light, not dense, crowns.
5. If after the marking and felling of the subdominants and lower stories it is found desirable to remove any additional dominants, such trees must be poisoned, not felled, or they will damage the adjoining canopy.
6. All palms must be felled.

The condition of the forest before and after the formation of the shelterwood is illustrated diagrammatically in figures 1 and 2.

The achievement of the final shelterwood should not be attempted in a single marking: it is impossible to rectify errors of overmarking, but errors of undermarking are easily made good.

Figure 1.—Profile diagram of typical forest of the crappo-guatecare-cocorite type at Arena Reserve, drawn from measurements of an actual strip of forest, 200 feet by 25 feet, in a coupe before treatment for the formation of a shelterwood. Owing to past exploitation the larger dominants are more scattered than in virgin forest; general structure remains, however, unchanged. The letters are abbreviations for the local names of the trees, of which the following is a list:

Abbreviations	Local name	Scientific name	Number in strip
	Dominants		
Cr.	Crappo	Carapa guianensis Aubl.	2
Gu.	Guatecare	Eschweilera subglandulosa (Steud.) Miers.	4
A.S.	Arena Sardine	?	2
	Subdominants		
B. ch.	Bois charbon	Diospyros ierensis Britton	6
B. m.	Bois mulatre	Pentaclethra macroloba (Willd.) Kuntze	4
In.	Incense	Protium guianense (Aubl.) March.	2
Y. ol.	Yellow olivier	Buchenavia capitata (Vahl) Eichl.	1
Ma.	Mahoe	Sterculia caribaea R. Br.	2
P. d.	Pois doux	Inga sp.	1
	Lower Story		
W.	Wakamy	Warscewiczia coccinea (Vahl) Kl.	8
R. m.	Red mangue	Tovomita eggersii Vesque.	10
B. C.	Bois chandelle	?	4
B. l.	Bois l'agli	Ryania speciosa Vahl	5
W. c.	Wild cocoa	?	2
P.	Poui	Tabebuia serratifolia (Vahl) Nichols	1
Mi.	Miconia	Miconia sp.	1
W. co.	Wild coffee	Rubiaceae sp. ?	1
L. s.	Laurier stinker	Ocotea arenaensis R. L. Brooks	1
La.	Laylay	Cordia sp.	1
S.	Soiebo	Rheedia sp.	1
Cb.	Carimbo	Guarea glabra Vahl	1
Cp.	Cooperhoop	Brownea latifolia Jacq.	1
M.	Manac	Euterpe oleracea Mart.	2
N.	Niaure	Calliandra guildingii Benth.	2
Bl.	Blackheart	Clathrotropis brachypetala (Tul.) Kleinh.	1
Ca.	Cajuca	Myristica surinamensis Rol.	1
Mk.	Milkwood	Sapium aucuparium Jacq.	1
Coc.	Cocorite	Maximiliana caribaea Gr. & Wendl.	1

Figure 2.—The same strip after formation of the shelterwood. Note how certain of the dominants and subdominants have been left to give high shade, and everything else has been cleared away except for 4 small saplings of valuable species which will form part of the regenerated crop. Somewhat of a gap has been created at the left of the strip: the bois charbon tree, which should have been left, was probably knocked down by the fall of a neighboring tree.

Fig. 1.—Profile diagram of typical forest of the crappo-guatecare-cocorite type at Arena Reserve. See notes on page 169.

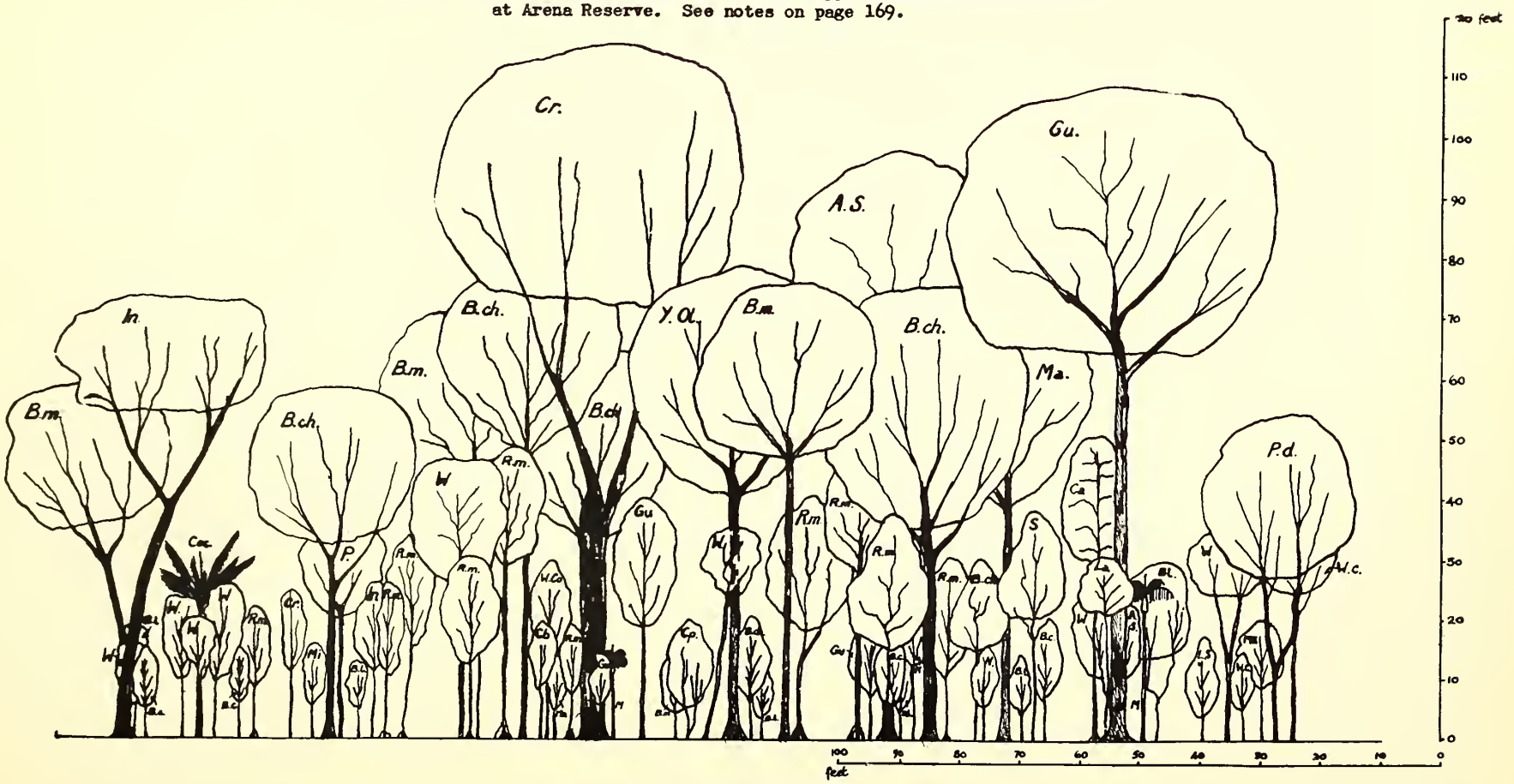
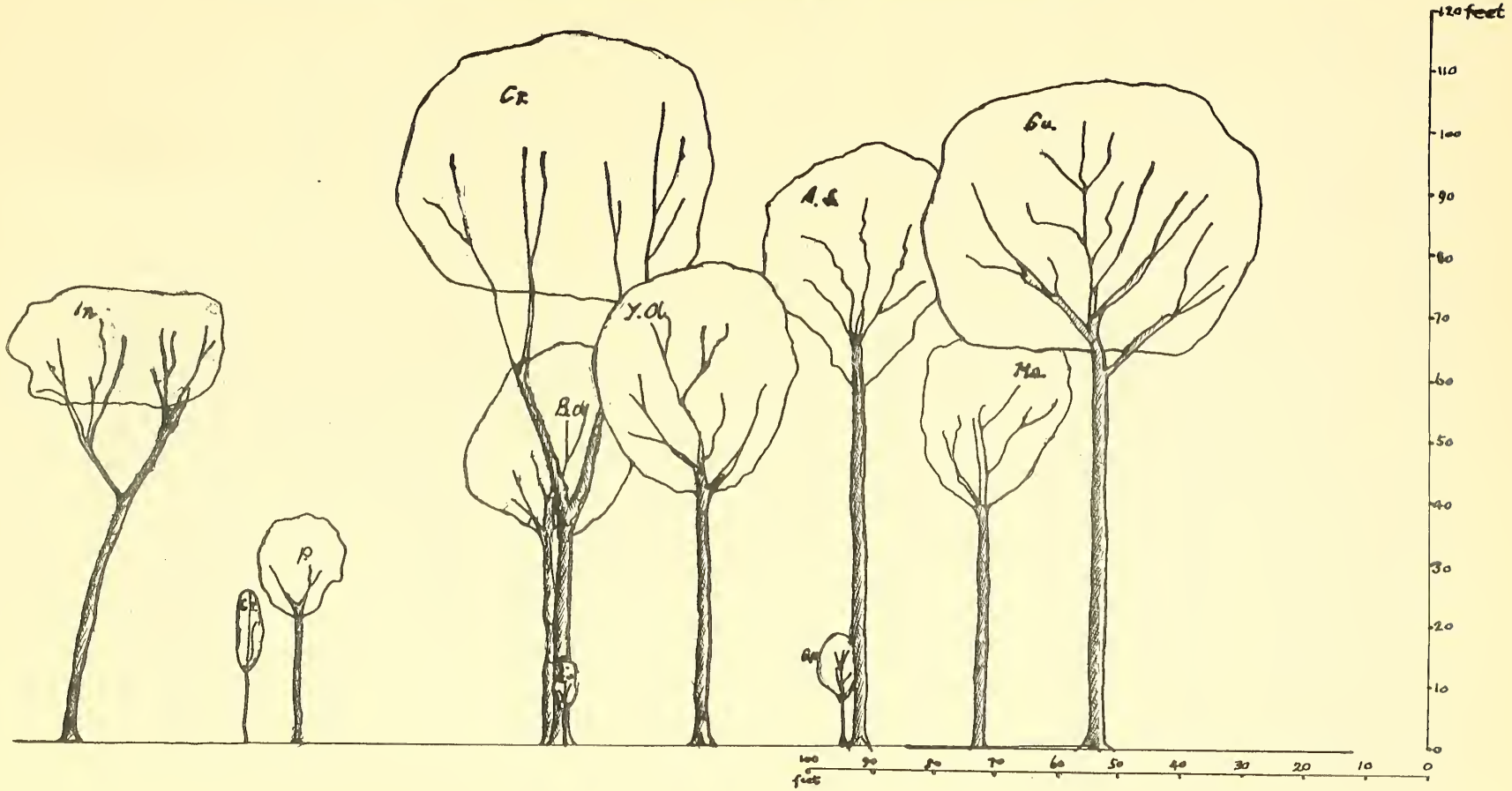


Fig. 2.—The same strip after formation of the shelterwood. See notes on page 169.



It has been found that under such a shelterwood a considerable amount of natural regeneration, mainly of the following species, springs up: Tabebuia serratifolia, Terminalia obovata, Byrsonima spicata, Ocotea spp., Hieronyma caribaea, and Didymopanax morototoni, together with a few Carapa guianensis and Eschweilera subglandulosa. All these are marketable species. Gaps in the natural regeneration are filled by artificial regeneration mainly of Calophyllum lucidum. Thus a mixed crop of useful species is formed under a protecting shelterwood and conditions approximate as closely as possible to those of the natural forest.

Subsequent tending.—After regeneration has been completed, the aim is to allow the resulting crop, together with valueless woody accessory species, to grow up under the shelterwood and form a pole crop as rapidly as possible.

If the shelterwood has been formed in accordance with the rules set forth above, it will contain no trees that will interfere with the development of the young crop. What must invariably happen, however, is that the fast-growing, valueless woody accessory species, such as Pentaclethra macroloba and Alchornea biglandulosa, rapidly outstrip most of the valuable natural and artificial regeneration, whereupon they will form harmful low shade unless kept properly controlled. If this is allowed to happen the young crop will suffer as much retardation as though the original shelterwood had been formed of low instead of high shade.

Tending operations must, therefore, be sufficiently frequent to ensure that the woody accessory species are kept checked to the proper degree so that they may play their part in the protection of the soil without damaging the valuable species in the crop.

When the young crop has formed a satisfactory pole thicket capable of protecting the soil and shows some demand for increased light, the method of poisoning can be used to remove the shelterwood progressively over 2 or more years, or in 1 year, as conditions dictate.

Costs.—No account of this nature could be complete without some reference to costs. There is some difficulty in giving reliable figures, however, as the best and cheapest shelterwood plantations are those made from 1938 to 1940: improvements in technique have resulted in progressively lowered costs. The following costs may, however, be taken as a guide:

Year of regeneration	Per acre No cost—revenue from charcoal burners equals or exceeds expenditure.
2d year: tending	$5.40
3d year: tending	4.40
4th year: tending	3.00
5th year: tending	2.00
	$14.80

Summary

Contrasting with the Malayan forests, where many factors favor natural regeneration, in the mixed forests of Trinidad the fast-growing species are not marketable and the commercial species are largely of slow growth. With few exceptions seeds are unwinged, heavy, restricted in dispersal, and very liable to damage by insects or consumption by animals. A technique evolved in the Arena Reserve involves a combination of natural with artificial generation under a shelterwood. A brief description of the area is given.

In 1927 work was started under a working plan with a view to the regeneration of the whole area over a period of 60 years. This plan was made extremely elastic in order that a silvicultural technique based on actual experience might be evolved. From 1927 to 1931, a system of clear-felling followed by artificial regeneration was adopted, with some modifications. An experiment in collaboration with the Imperial College of Tropical Agriculture showed that clear-felling resulted in very rapid deterioration of the soil.

The shelterwood technique replaced the clear-felling. Considerable difficulty was experienced at first in the formation of a satisfactory shelterwood. If the shelterwood has been formed in accordance with the rules given in the article, it will contain no trees that will interfere with the development of the young crops. Improvements in the shelterwood technique resulted in progressively lowered costs.

Resumen

En los bosques mixtos de Trinidad, distinto a las selvas malayas, las especies que crecen espontaneamente no tienen valor comercial, mientras que aquéllas útiles son mayormente de crecimiento lento. Con pocas excepciones, las semillas forestales son pesadas, sin alas, de dispersión limitada y muy susceptibles a ser dañadas por insectos o consumidas por animales. La técnica desarrollada en la "Arena Reserve" consiste en una combinación de regeneración artificial y natural bajo techo de abrigo. Se da una breve descripción del área.

Se iniciaron trabajos en el 1927 bajo un plan de manejo con miras a la regeneración de toda el área en un período de 60 años. Tal plan se hizo extremadamente elástico de manera que se pudiera desarrollar una técnica silvícola basada en la experiencia obtenida. De 1927 a 1931 se siguió el sistema de corta total seguida de regeneración artificial con algunas modificaciones. Un experimento en colaboración con el Colegio Imperial de Agricultura Tropical demostró que la corta total ocasionó un rápido desgaste del suelo.

El sistema de corta de abrigo reemplazó a la corta total. A principio se tuvo gran dificultad en la formación de un techo de abrigo satisfactorio. Si éste se ha formado de acuerdo con las reglas presentadas en el artículo, no habrán árboles que obstaculicen el desarrollo de la regeneración. Por medio de mejoras a este sistema, se consiguió una reducción progresiva de los costos.

LA CONSERVACIÓN DE LOS RECURSOS NATURALES: EL PROBLEMA, SUS DIVERSAS FASES Y LA IMPORTANCIA RELATIVA DE ÉSTAS

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CONSERVACIÓN DE LOS RECURSOS NATURALES

Lo Que es Conservación

Uso sabio e intencionado: uso prudente de los recursos no renovables y perpetuación de los renovables. El témino "conservación" tiene dos significados diferentes que dependen del punto de vista desde donde se les enfoca. Para el público en general, para el artista y para el simple amante de la naturaleza, conservación significa la preservación de algo en su estado actual o natural. Para el economista y el estadista modernos y refiriéndose principalmente a los recursos naturales, conservación quiere decir "uso sabio o prudente." Ambas acepciones son genuinas si se las aplica en su lugar apropiado y en realidad, la segunda puede comprender a la primera. A menos que se especifique lo contrario, la palabra Conservación (escrita con mayúscula) debe entenderse en este último sentido en el transcurso de esta exposición.

Este uso sabio o prudente implica un cuidadoso desarrollo, un manejo eficiente y sostenido para obtener una producción continua hasta donde sea posible, una planificación efectiva, y una administración estrechamente coordinada de tales recursos.

En último término la Conservación significa, pues, el control de la tierra y de todo lo que está en ella o sobre ella, teniendo como última finalidad el bienestar permanente de la humanidad. Los éxitos de la Conservación deben ser medidos no sólo por sus beneficios inmediatos, sino también por los servicios diferidos que indudablemente prestará a las generaciones venideras.

Necesidad de la Conservación

Nuestros primeros colonizadores y las generaciones subsiguientes no apreciaron la importancia de conservar los recursos naturales en previsión de un día de mayor necesidad. En aquellos días, las tierras, los montes, las aguas, los animales silvestres y los minerales parecían existir en cantidades tan enormes que su posible agotamiento fué rara vez considerado y aún entonces tal idea fué enseguida desechada como una falsa suposición.

Sin embargo, hoy día la situación ha cambiado por completo. Una población creciente y progresivamente exigente está sintiendo agudamente los efectos desastrosos de la explotación desmedida a que han sido sometidos los recursos naturales y ha comenzado a preocuparse por el mañana. Como ha sucedido en todos los países, el pueblo venezolano ha abandonado su posición de indiferencia sólo cuando se ha visto al borde de la ruina. En efecto, la situación actual es alarmante. Matorrales raquíticos existen hoy donde moraban bosques vigorosos ayer; cursos mezquinos de agua sucia ocupan el cauce, hoy empequeñecido, por el cual corrían ríos caudalosos en un pasado no muy lejano, siendo

impresionante la carencia de agua en la mayoría de las comunidades urbanas; el suelo—capa fértil—merced a la acción desgarradora del erosionamiento, ha ido poco a poco perdiéndose en las profundidades del agua y en las sinuosidades de los rincones urbanos, haciéndose cada vez más difícil la labor sanitaria y restringiéndose progresivamente el campo de acción de la agricultura; peladeros escarpados y calcinantes han reemplazado a colinas ondulosas y pletóricas de frescura; la caza y la pesca fluvial se hacen cada día más difíciles. Estamos echando los cimientos de una nueva Palestina...

La conservación de nuestros recursos naturales es, pues, apremiante y constituye la solución fundamental de casi todos los problemas de nuestra vida nacional. En último término, el desarrollo, la continuidad y el bienestar común de la nación dependen directa o indirectamente de como sean manejados tales recursos. La Conservación es esencial para una vida feliz y abundante. El futuro de la nación no estaría asegurado sin ella. De una manera general, la Conservación implica el mantenimiento de la armonía natural dentro de los confines del territorio nacional y debería constituir la tarea fundamental de toda política gubernamental perspicaz y bien orientada.

Con toda franqueza podemos afirmar que la presente exposición constituye el primer llamamiento razonado por la Conservación sobre una base estable y duradera que se haya hecho en Venezuela. A nosotros nos ha tocado, pues, iniciar el movimiento en favor de la Conservación.

El Dominio de la Conservación

Las principales actividades de la Conservación hoy generalmente reconocidas son:

A. Conservación de los Minerales
B. Conservación de las Bellezas Escénicas Naturales
C. Conservación de la Vida Animal Silvestre
D. Conservación de la Tierra y el Suelo
E. Conservación de las Aguas
F. Conservación de los Montes

A continuación pasamos a definir y a demarcar los límites de cada una de estas actividades y a exponer sumariamente su importancia relativa.

A. Conservación de los minerales.—Las riquezas minerales son transitorias. La Conservación de los Recursos Minerales presenta un carácter distintivo y único que se debe a la naturaleza esencialmente inerte de tales recursos. En efecto, ellos, a diferencia de los demás, son limitados y no pueden ser renovados. En otras palabras, las existencias de minerales no pueden ser aumentadas y tienden hacia la desaparición mediante el uso. Los recursos minerales se asemejan pues a un capital que se guarda en casa y que se va utilizando a medida que se va necesitando. En caso tal, un uso prudente significaría evitar el despilfarro, no usando sino lo estrictamente necesario. Evidentemente llegará un día en que dicho capital dejará de existir.

En cambio, los demás recursos naturales son renovables, pudiendo durar eternamente. Tales recursos pueden compararse a un capital que se deposita en un banco y que podría ser conservado intacto si sólo se utilizara el interés.

Lógicamente, estos recursos permanentes y renovables constituyen nuestra mayor riqueza.

Los recursos minerales están, pues, llamados a desempeñar un papel transitorio en la economía de cualquier país. Sin embargo, en la mayoría de los casos las existencias de minerales son suficientes para abastecer a la industria por varias centurias. El petróleo constituye la excepción ya que sus existencias visibles y probables pueden agotarse en veinte o treinta anos.

Por lo que respecta a Venezuela, ningún otro recurso natural ha contribuído tanto a su desarrollo económico como los minerales, el petróleo en particular. De hecho, Venezuela le debe a este producto gran parte de lo que es hoy día—bueno y malo. La abundancia deslumbradora del oro negro ha ocasionado el descuido de los demás recursos naturales. Nuestro país "ha edificado su casa sobre petróleo" y por lo tanto, está expuesto a la suerte de tan incierto flúido.

Todo venezolano debería tener el convencimiento absoluto de que llegará un día en que el petróleo desaparecerá por completo o será reemplazado por un substituto mejor. ¿Qué será de nosotros entonces? Ello depende de como nos manejemos hoy. Debemos comenzar a "reedificar sobre roca" promoviendo el desarrollo de los recursos naturales renovables. Para conseguir tal fin todavía contamos con la fuerza financiera que aporte la explotación de hidrocarburos. Esto es lo que en mi concepto quiso dar a entender quien dijo que "debemos sembrar nuestro petróleo."

B. Conservación de las bellezas escénicas naturales.—Pinturas, esculturas y otros trabajos de arte son conservados por nosotros con el mayor celo. Mientras tanto, obras extraordinarias que representan el trabajo milenario de la gran artista, la naturaleza, son miradas por nosotros mismos con la mayor indiferencia. Dentro de este encabezamiento podemos incluir, de una manera general, los paisajes de incomparable belleza, las formaciones geológicas extraordinarias, las regiones y los objetos naturales de interés estético o valor histórico o científico, y los lugares donde existen condiciones primitivas. Estos aspectos diversos caen dentro del dominio de uno de los tres grupos administrativos siguientes: Parques Nacionales, Reservas de Regiones Vírgenes, y Monumentos Naturales.

Según lo aprobado por la "Convención para la Protección de la Flora, de la Fauna y de las Bellezas Escénicas Naturales de los Países de América" y celebrada en Washington en mayo de 1940,

Se entenderá por Parques Nacionales: "Las regiones establecidas para la protección y conservación de las bellezas escénicas naturales y de la flora y de la fauna de importancia nacional, de las que el público pueda disfrutar mejor el ser puestas bajo la vigilancia oficial."

Se entenderá por Reservas de Regiones Vírgenes: "Una región administrada por los poderes públicos, donde existen condiciones primitivas naturales de flora, fauna, vivienda y comunicaciones, con ausencia de caminos para el tráfico de motores y vedada a toda explotación comercial."

Se entenderá por Monumentos Naturales: "Las regiones, los objetos o las especies vivas de animales o plantas de interés estético o valor histórico

o científico a los cuales se les dá protección absoluta. Los monumentos naturales se crean (decretan) con el fin de conservar un objeto específico o una especie determinada de flora o fauna—declarando una región, un objeto o una especie aislada monumento natural inviolable excepto para realizar investigaciones científicas debidamente autorizadas o inspecciones gubernamentales." Monumentos naturales podrían ser: el Samán de Güere, la Cueva del Guácharo y los Saltos del Caroní.

Muchos de los que vivimos en la presente era industrial a menudo hacemos alarde de nuestro dominio o control sobre la naturaleza. Planta o animal, estrella o átomo, viento o río—no existe ninguna fuerza sobre la tierra o en el cielo que no tratemos de aparejar enseguida para que nos proporcione una "vida mejor." Pero, ¿en qué consiste esta vida mejor? ¿Sería justo derrochar todo este acopio de poder en la mera consecución de nuestra subsistencia, en destruirnos unos a los otros, o en el pingüe logro de placeres frívolos y efímeros? ¿O es que somos tan pobres en recursos o de espíritu que no tratemos de emplear algo de ese poder en mantener el planeta que habitamos agradable a la vista y hacer de él un sitio bueno para vivir?

La belleza es la gran inspiradora de la decencia y un tributo a ella. La fealdad engendra miseria. La protección y el desarrollo de las bellezas escénicas naturales sería indudablemente una inversión social y económicamente provechosa—una expresión de respeto a nosotros mismos—un método de aumentar el prestigio del país como un lugar digno de visitar, y agradable para vivir y hacer negocios.

C. Conservación de la vida animal silvestre.—La Conservación de la vida animal silvestre no puede ser lograda por el mero control de las armas de fuego. Aun cuando la vida animal silvestre se haya convertido de un artículo de primera necesidad que era pocas centurias há, en instrumento de un deporte, principalmente, su importancia continúa siendo reconocida. Tan cierto es ello que la protección de tal recurso ha sido objeto de acuerdos internacionales.

La caza.—La historia muestra que universalmente la primera medida protectora en favor de los animales silvestres ha consistido casi invariablemente en la restricción de la cacería, bien sea por el control en el uso de las armas de fuego o mediante la fijación de períodos de actividad cinegética legal. Sin embargo, estas medidas aisladas de carácter restrictivo no han dado los resultados apetecidos y ha sido necesario apelar a medidas constructivas científicamente coordinadas con las primeras.

La secuencia cronológica de aparición de estas diversas medidas o formas de conservación parece ser más o menos la siguiente:

1. Restricción de la Cacería
2. Control de los Animales Rapaces
3. Reservación de Areas-Refugios
4. Procreación Artificial
5. Control del Medio Ambiente (alimentos, cubierta o abrigo, enfermedades, factores accidentales)

Venezuela apenas ha comenzado la primera etapa. Aun la cruda legislación adoptada para restringir la cacería no puede hacerse complir en la gran mayoría de los casos.

Las represas (lagos artificiales) y los depósitos de almacenamiento constituyen medios muy efectivos en la regulación de las crecientes cuando son suplementados por una cubierta forestal permanente.

No obstante, el control efectivo de las crecientes sólo puede ser logrado mediante el desarrollo de un plan coordinado que comprenda el manejo racional de las tierras, la conservación del suelo, la reforestación, e "ingeniería río arriba" en las cabeceras de las corrientes de agua, junto con trabajos de "ingeniería río abajo" en los grandes ríos.

Influencia sobre la erosión.—La erosión del suelo es probablemente el efecto más serio que acompaña a la remoción o supresión de la cubierta vegetal. El suelo es transportado de un sitio a otro por uno de los dos agentes erosivos principales siguientes: el viento o las aguas.

(a) El viento.—Suelos desprovistos de vegetación son fácilmente arrastrados por el viento, el grado de inestabilidad de aquellos dependiendo principalmente de la velocidad de este último. Arenas movedizas (dunas) sujetas a la erosión del viento deberían estar cubiertas de vegetación de tal manera que ésta las mantenga unidas y fijas, evitando así su expansión y disminuyendo la frecuencia e intensidad de las tormentas de polvo.

(b) Las aguas.—La erosión debida al agua es muy generalizada e intensamente destructiva: al lugar erosionado, el cual queda desnudo hasta la roca viva o de tal manera arañado que es prácticamente imposible su aprovechamiento agrícola; a los cursos y recipientes de agua, pues los materiales arrastrados se depositan sobre los cauces de aquellos y en el fundo de estos últimos y de esta manera queda destruída la navegación, disminuída la capacidad receptora de los depósitos, y se provoca el rebozamiento o desbordamiento de los ríos con la consiguiente inundación de las planicies circundantes.

Los montes, pues refrenando la velocidad del viento y regulando el deslizamiento de las aguas sobre la superficie terrestre, ejercen una gran influencia sobre la estabilidad del terreno—constituyen el enemigo acérrimo del erosionamiento.

Influencia sobre las corrientes aéreas.—Los montes pueden anular o por lo menos atenuar la fuerza de las corrientes aéreas, protegiendo de esta manera las tierras que yacen al lado opuesto de la dirección del viento contra: (a) vientos fríos y secos, y (b) vientos de gran velocidad.

La necesidad de protección contra el viento es máxima en las planicies desprovistas de vegetación alta. En tales lugares y especialmente donde la precipitación es deficiente y donde predominan vientos secos, una contínua protección contra el viento es a menudo imprescindible si se contempla el establecimiento de comunidades permanentes o una actividad agrícola intensa. Vientos desenfrenados originan enormes nubes de polvo, desproveyendo al suelo de su mayor riqueza. Plantaciones de árboles pueden ser utilizadas con éxito para proteger campos, huertos, viveros, edificios y el gadano, y para la fijación de dunas.

La conservación de los recursos animales silvestres implica la aplicación equilibrada de todas las cinco medidas arriba enumeradas cuyo conjunto elaborado, razonado y ordenado constituye una ciencia relativamente nueva que se denomina "Manejo de la Vida Animal Silvestre."

La pesca.—Análogas consideraciones podrían hacerse respecto a la Pesca Fluvial. La Pesca Marítima no es de nuestra incumbencia. Viene al caso añadir que una pesca fraudulenta con explosivos o por envenenamiento acabaría en muy poco tiempo con una riqueza que ha tardado tantos años en producirse. Como sucede con casi todos los recursos naturales, el proceso destructivo es muy rápido; en cambio, el proceso constructivo es desconsoladoramente lento.

En general, la Caza y la Pesca Fluvial no sólo constituyen uno de los deportes más sanos y excitantes sino que podrían ser una fuente de riqueza nacional. El comercio de pieles, cornamentas, carnes, plumas, etc., tiene posibilidades extraordinarias.

En pocas palabras, la extensiva renovación de la vida animal silvestre en Venezuela restauraría un recurso nacional de incalculable valor cuyo aprovechamiento integral aumentaría considerablemente la salud, la felicidad y la prosperidad del país.

D. Conservación de la tierra y el suelo.—La erosión es la moderna espada de Dámocles. Ella es una amenaza constante tanto para nuestra propia seguridad como para la seguridad de las generaciones futuras. La extensión de nuestras tierras fértiles era tan grande en épocas pasadas que hasta hace relativamente muy poco tiempo nadie se había ocupado de la conservación de nuestro suelo. La situación actual es totalmente diferente. En efecto, la remoción de la cubierta vegetal protectora ha expuesto las tierras a la acción de muchos agentes destructivos, particularmente la erosión. Como consecuencia, existen hoy en nuestro país miles de hectáreas arruinadas y cada año que pasa miles de toneladas de materiales constitutivos son arrancados al suelo por las garras despiadadas de los agentes erosivos—las aguas y el viento. Los peladeros que caracterizan las Laderas de San Pablo en el Estado Mérida, y las áreas semidesiertas adyacentes a muchas de las Quebradas larenses, ofrecen ilustraciones palpables de tan generalizado proceso destructivo.

Los efectos de la erosión son múltiples y eminentemente perjudiciales. Entre ellos se destacan: el deslizamiento del suelo en las laderas de las montañas y colinas (derrumbes) que, entre otras cosas, ocasiona grandes daños a las vías de comunicación; el enturbiamiento de las corrientes de agua; la formación de deltas y barras en los ríos, con el consiguiente entorpecimiento de la navegación; el levantamiento del fondo del cauce de los ríos que determina una reducción en su capacidad receptora, lo que a su vez es responsable por muchas crecientes; la sedimentación de los depósitos de agua; y la degradación del agua potable.

La construcción de los diversos tipos de terrazas, diques o represas, pavimentaciones y otras obras de ingeniería, aporta otros tantos medios que pueden ser utilizados en el control del erosionamiento. Sin embargo, solo el establecimiento y mantenimiento de una cubierta vegetal suministra una defensa o control adecuados y permanentes. Esta misma cubierta vegetal facilita el único método eficiente para la fijación de dunas.

Nosotros apenas hemos empezado a comprender la magnitud e importancia del erosionamiento. Las pocas tierras que han logrado mantenerse intactas deben ser protegidas a toda costa y muchas de las ya arruinadas deben ser restauradas a su primitivo estado de vegetación si queremos prevenir que un nuevo Sahara—hechura del hombre—nos aprisione.

E. Conservación de las aguas.—El agua es una bendición y todo sitio donde hay agua abundante es un paraíso. El agua es, sin duda alguna, el producto inorgánico más importante: ella constituye la base de la vida, no solamente para el hombre sino también para los otros seres vivientes.

Innumerables son los usos de este precioso líquido. Ya nosotros, al establecer la clasificación general de los recursos naturales, hemos señalado los más salientes de una manera esquemática. A continuación exponemos otro arreglo más completo de tales usos en orden de importancia de mayor a menor:

1. Humedad atmosférica indispensable a la vida orgánica.
2. Agua potable para el hombre.
3. Agua usada en agricultura y ganadería.
4. Medio ambiente de la pesca y demás alimentos marinos.
5. Generación de fuerza hidráulica.
6. Para procesos industriales, mecánicos y químicos.
7. Medio de transporte.
8. Medio o vehículo para purificación y eliminación de deshechos.
9. Recreación.
10. Determinante de linderos naturales.
11. Usada en la forma de hielo.

No solamente deben tener las comunidades agua suficiente, sino que ésta debe ser de buena calidad. La calidad del agua, sin embargo, debe ser determinada por el uso a que se le vaya a someter.

En algunas localidades la situación de abastecimiento de agua es tan seria que es, con mucho, la fase más importante de la Conservación.

Las aguas han jugado siempre un papel dominante en el desarrollo de nuestro país; sin embargo, con el aumento de la población y de su concentración urbana, los problemas de abastecimiento de agua potable, control de crecientes, eliminación de deshechos, polución de corrientes, irrigación, drenaje y aprovechamiento de energía hidráulica han venido a ser más presionantes. Por otra parte, el agua dulce constituye una de las fuentes más sanas y agradables de recreación.

Todas estas actividades y necesidades humanas indican la importancia de elaborar y desarrollar un plan cuidadosamente coordinado de conservación de aguas y que tenga en cuenta tanto las necesidades presentes como las venideras.

F. Conservación de los montes.—Los montes constituyen la herencia común de la humanidad: ellos han sido colocados sobre la tierra por la pródiga naturaleza para el uso y goce de todos. Intencionalmente hemos dejado para último término la exposición de la Conservación de los Montes, entre otros motivos, porque ella implica indirectamente la conservación de los demás recursos naturales.

En efecto, desde el punto de vista forestal más amplio, la denominación Monte debe entenderse como "una compleja comunidad de vida vegetal y animal que está asociada con un área específica de tierra y en donde la vegetación predominante la constituyen generalmente los árboles"; de manera que tanto los recursos vegetales como los animales y los minerales son verdaderas partes integrantes de un monte.

Por estas razones, la Ciencia de los Montes o Ciencia Forestal rara vez funciona como unidad independiente; sus actividades están íntimamente relacionadas con el manejo de las tierras, las aguas, los animales silvestres y otros recursos naturales. Dentro de la Conservación—término administrativo que comprende el manejo colectivo de todos los recursos naturales—la Ciencia Forestal ocupa, pues, un lugar prominente.

En el sentido general arriba asentado, el monte puede referirse a, o comprender, una o varias de las entidades vegetales siguientes: al bosque o selva que no es sino un monte en el cual predomina la vegetación arbórea; el bosquete o bosque pequeño y aislado; el matorral, en donde predomina la vegetación arbustiva; y el pastizal, compuesto principalmente por vegetación herbácea.

Los montes tienen funciones públicas que ningún otro recurso natural puede aun igualar, representando generalmente un factor muy importante en la estabilización de la vida social de las comunidades situadas cerca o dentro de ellos. Tan cierto es ello que aun los liberales manchesterianos de principios del siglo XIX concedieron a los montes un carácter distintivo, justificando una excepción a la política de "dejar hacer, dejar pasar" que ellos aplicaban a los demás recursos naturales.

El nivel de vida de un pueblo está cada día más asociado con el cuidado que se dé a los montes en el país habitado por ese pueblo. Finalmente, los montes constituyen una fuente abundante de trabajo regular y de emergencia (en caso de que el desempleo alcance proporciones serias), siendo tal trabajo saludable como ningún otro.

LOS BOSQUES Y LA CIVILIZACIÓN

Los bosques han ejercido una influencia importantísima en la distribución del género humano sobre la superficie terrestre. Al estudiar la relación entre los bosques y el progreso humano, podemos distinguir tres etapas bien caracterizadas, a saber:

1. La civilización dominada por los bosques.
2. La civilización sobreponiéndose a los bosques.
3. La civilización dominando a los bosques.

De la misma manera que la edad de piedra, la edad de bronce y la edad de hierro existieron al mismo tiempo sobre la tierra, estas tres etapas en la relación entre los bosques y la humanidad se presentan hoy simultáneamente.

En el Africa Central y en partes de Centro y Sur América los bosques todavía dominan la civilización; en gran parte de Norte América y Asia la civilización se encuentra en plena lucha con los bosques; y en Europa y parte de los Estados Unidos los bosques están bajo el dominio del hombre.

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LAND-UTILIZATION SURVEY OF TRINIDAD

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There is a legend, popular with guidebooks, handbooks, and encyclopaedias, that "the soils of Trinidad are to be ranked among the most fertile in the world." This is a myth which must now be quite definitely exploded. The provisional soil survey of the island recently completed by Dr. E. M. Chenery and described by F. Hardy in "A Provisional Classification of the Soils of Trinidad" (Tropical Agriculture, Vol. XVII, No. 8, pp. 153-158) distinguishes 23 soil types which are classified into 5 productivity grades according to their inherent fertility. Three types are accorded very high fertility, seven high, three medium, three low, and seven very low. Unfortunately, the low and very low type soils are by far the most widespread. None the less, the legend of universal great fertility was formerly popular with the agricultural community, and it appears that little or no thought was given to soil values when land was taken up for cultivation. Perhaps this was due to the luxuriant natural vegetation, giving an impression of lush fertility.

The climax type of vegetation in Trinidad is tropical rain forest, tall and dense, with large numbers of species and individuals in intense competition, laced with lianes and festooned with epiphytes. The general impression is certainly one of great richness, yet it must be remembered that virgin forest is in a state of equilibrium: dead vegetable matter is annually returned to the soil in great quantity as manure, and no crops are taken off. Further, moisture relations are at their best in forest, the dense growth restraining evaporation from the soil and the abundant humus keeping the soil porous and absorbent of air and moisture. These conditions are radically altered by removal of the forest. Ecological investigations have produced abundant evidence to show that the chemical composition of the soil—so important from the point of view of agriculture—commonly has little or no influence on the type of natural vegetation it supports. The idea that rain forest indicates an "inexhaustible tropical soil" cannot be too strongly discounted. Mora forest (consociation of Mora excelsa Benth.), the most luxuriant type of rain forest in the island with dominants 150 to 200 feet tall, is frequently found on some of the most infertile sandy soils.

It is, therefore, hardly surprising that Trinidad today possesses considerable and increasing areas of degraded bush and savannah which have succeeded abandoned cultivations. When land was purchased and cleared for agriculture, the cultivator might perhaps strike it rich and find himself on excellent soil, in which case his cocoa or his canes would be successfully established. More often than not, however, the soil would be of poor quality, in which case once the forest had been cut down and burnt and the customary few initial crops of corn and vegetables taken off, the permanent crops would either prove impossible to establish or would begin to die out after only a few years. In these cases, the next step is invariably that the land goes over to shifting cultivation with charcoal burning.

Shifting cultivation in itself, of course, is not inherently harmful, properly managed with a rotation of sufficient length. There seems no doubt

that this would be the only successful method of cultivation for the bulk of the poorer soils in Trinidad, since they are incapable of sustained production under most crops. The very poorest soils should not be cultivated at all. Unfortunately, the rotation in Trinidad is seldom long enough, and there is also a most serious menace in the frequent fires, which in the dry season escape from newly cleared areas that are being burnt over and run through the surrounding bush. In effect this reduces the rotation still further. The exact details of the vegetational succession have not as yet been determined, but to the writer it appears that the following takes place. First, the repeated burning during periods of years causes an enormous increase in the proportion of palms in the second-growth bush, since these are fire-resistant. Palms such as cocorite, Maximiliana caribaea Gris. & Wendl., grugru, Acrocomia aculeata Lodd., or trash palm, Scheelea osmantha Barb., according to soil, site and locality, eventually increase to such an extent that the bush is a practically pure stand of them. Meanwhile the soil, with repeated croppings and burnings, has become progressively more degraded and unproductive. At the pure palm-stand stage, there is no serviceable wood left in the bush to burn into coals, and this coupled with the poverty of the soil leads to a cessation of the shifting cultivation, the land being abandoned to the recurrent fires. If these are not too frequent, the bush may recover to a stage where, trees having come in, the whole melancholy cycle will recommence. Given, however, regular fires each year, the bush passes eventually through palm savannah, with an open stand of palms over grass, to an orchard savannah with Curatella americana L. or Byrsonima crassifolia H.B.K. This is the final stage in the deflected succession, a biotic climax, and an utterly worthless type of bush on an utterly degraded soil, a man-made desert. Yet under forest this land used to be productive, yielding timber.

Areas of biotic savannah in the final or Curatella-Byrsonima stage are to be found on the Northern Range above St. Joseph and on the St. John Estate near La Brea, and widespread on the plains of detrital sand and gravel at the foot of the Northern Range. Palm savannah is likewise widespread on the same plains and is increasing on the foothills of the Northern Range behind Port of Spain and other places. Bush in any of the other stages of degradation may be noticed almost anywhere in the island. This is certainly a formidable state of affairs, but it is doubtful if any simple measures could be taken to control it, since the land is in private hands.

It is, however, a matter of concern that such mistakes should be prevented in the future; in other words, there must be planned utilization of the remaining Crown Lands. Fortunately, in Trinidad there is no great pressure on the land. Approximately 46% of the total land area of the colony still belongs to the Crown, and remains under its natural vegetation. About half of this area has been set aside as permanent Forest Reserves, some designed as protective and sited to cover watersheds, others as production forests in the plains, usually on poor soils. The question of the disposal of the remainder of the Crown Lands is now under consideration by the Government. To this end, a special officer of the Agricultural Department has been working for several years on a soil survey of the island, and provisional maps have already appeared.

To parallel this, a combined land-utilization and ecological survey is now being made by an officer of the Forest Department. Two separate sets of

Fig. 1.—Natural vegetation: evergreen rain forest.

Fig. 2.—The forest is felled, shifting cultivation begins, and a soil-robbing cycle is set up.

Fig. 3.—Repeated croppings and burnings exhaust the soil; the cultivator moves off, leaving the land to recurrent fires. Result, a savannah of fire-blackened cocorite palms, Maximiliana caribaea, in grassland.

Fig. 4.—Man-made desert, the final stage. Orchard bush, burnt annually, of Curatella americana and Byrsonima crassifolia.

maps are in preparation, the one being a land-utilization survey of the alienated lands and the other an ecological survey showing the various types of natural vegetation on the Crown Lands. The starting point is an air survey which was made by a syndicate of the local oil companies in 1938-39. By arrangement, the Government has been provided with a complete set of the photographs, which are vertical, overlap to permit of stereoscopic examination, and work out to a scale of approximately 1:40,000. It is found possible to transfer the information to a 1:40,000 cadastral sheet sufficiently accurately without any elaborate device for rectification.

In the Land-Utilization Survey, three main classes are recognized, productive, semiproductive and unproductive. Under "productive," each type of crop is mapped separately—the different crops show up quite plainly in the aerial photographs—sugarcane (estates' and peasants'), cocoa, coconuts, citrus, rice pasture, and miscellaneous, the last including such items as rubber, tonka beans, nutmegs, timber plantations, etc., which occur in very limited amount. "Semiproductive" has only one subhead and includes areas under shifting cultivation, semiabandoned and moribund crops. "Unproductive" has three subheads which are self-explanatory, namely savannah and low bush, second growth and high forest, residential and industrial areas.

The Ecological Survey maps, on the same scale (1:40,000), such types of natural vegetation as can be distinguished. A good number are described by Marshall in his "Physiography and Vegetation of Trinidad & Tobago," published in 1934, and others have since been brought to light. This side of the work, however, is not as simple as the mapping of the crops, which is done directly from the aerial survey and checked by ground observation. The greater part of the forest types are indistinguishable one from another in the photographs, partly because the structure of rain forest is much the same whatever the floristic composition, and partly because the boundaries of the types merge gradually through ecotones and are not sharp. A notable exception is the mora forest, whose boundaries appear with pleasing clarity, being sharply drawn on the ground and provided with a 50-foot difference in canopy level. Swamp types also emerge clearly, but the others have to be sketched from ground survey. Strip enumeration surveys on a 1% basis have been run in most of the forest areas of the island at intervals since 1928, and provide the material for assessing the forest types. This material is now being checked over and reanalyzed with reference to the aerial photographs and the boundaries put in on the 1:40,000 maps.

At the end of the present year it is expected that this survey will be complete, and it is then hoped to publish the ecological maps together with a comprehensive explanatory work which will describe each vegetational type in detail on the lines laid down by Messrs. Richards, Tansley, and Watt in their "The Recording of Structure, Life-form and Flora of Tropical Forest Communities as a Basis for their Classification" (Imperial Forestry Institute Paper No. 19, Oxford, 1939).

The Land-Utilization Survey is being laid sheet by sheet as completed before the Lands Advisory Committee of the Trinidad Government—a body of which the Director of Agriculture is chairman, and the Conservator of Forests secretary—to be compared with the soil maps. It is hoped that a sounder policy of land settlement, land alienation, and forest reservation may result.

Summary

In Trinidad, of the 23 soil types classified into 5 productivity grades, 3 are accorded very high fertility, 7 high, 3 medium, 3 low, and 7 very low. A recent soil survey shows that the low and very low types are by far the most widespread.

The rich tropical rain forests have been taken erroneously as an indication of fertile soils, an idea which cannot be too strongly discounted. All too often, the agriculturist has found poor soils after felling the forest, and the land has gone over to a system of shifting cultivation, which under too-short periods of rotation coupled with repeated burning has resulted in worthless savannah.

To prevent such mistakes on the Crown Lands, which total 46% of the area of the colony and still retain their natural vegetation, land-utilization surveys are being made. With such data, in combination with previous soil and ecological surveys, it is hoped that a sounder policy of land settlement, land alienation, and forest reservation may result.

Resumen

Los 23 tipos de suelos de Trinidad clasificados en cinco categorías productivas, se dividen como sigue: a 3 tipos se les concede muy alta fertilidad, 7 se consideran de alta fertilidad, 3 como medianos, 3 como pobres, y 7 como muy pobres. Un reconocimiento de suelos reciente demuestra que aquellos clasificados como pobres y muy pobres son los tipos predominantes.

La exuberancia de la selva pluvial tropical se ha considerado equivocadamente como una indicación de tierras feraces, siendo éste un concepto a todas luces erróneo. Muy a menudo el agricultor se ha encontrado con suelos pobres al tumbar la selva. Esto ha resultado que se recurra al sistema de conucos, el cual bajo rotaciones muy cortas y uso constante del fuego ha producido sabanas inservibles.

Para evitar tales errores se están llevando a cabo reconocimientos sobre utilización de tierras en las áreas pertenecientes a la Corona. Estas constituyen el 46% del área total y aun conservan la vegetación natural. Es de esperarse que estos datos en combinación con reconocimientos ecológicos y de suelos hechos anteriormente, resulten en una mejor política de colonización y alienación de tierras al igual que de reserva de bosques.

OPPORTUNITIES FOR HEVEA RUBBER PLANTATIONS IN LATIN AMERICA

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At present the United States finds itself entirely dependent on foreign sources for rubber, adequate supplies of which are essential for many domestic purposes, and particularly important at this time for the national defense. A major use of rubber has been in the manufacture of tires for automobiles, trucks, and airplanes, but it has many other uses which make it the most nearly indispensable raw material not produced in the United States. For more than 25 years past the United States has annually imported more than 50 percent of the entire world production of rubber, and in 1940 these imports reached almost 60 percent. The Office of Production Management in Washington, in placing rubber under priorities control, has ordered a cut in rubber consumption beginning July 1, 1941, to a rate of about 600,000 tons annually; the rubber thus saved will go into stock piles for use in the defense program.

Natural rubber is chiefly the product of the tree known as Hevea brasiliensis, which in respect to quality and quantity of its yields is the most important rubber-yielding plant known to science. It is commonly referred to simply as Hevea, although there are many other species of the same genus. The tree is a native of the Amazon Valley in South America, but is now widely cultivated in the Far East, mostly in the Malay Peninsula and in the Netherlands East Indies; other countries in the Asiatic tropics contribute to the world supply to a lesser extent, and relatively small quantities come from the African and American tropics, produced from Hevea and other rubber-yielding plants. Most of America's rubber comes from approximately halfway around the world, requiring 6 to 7 weeks by slow freighter for the ocean journey. This supply might be cut off or controlled by hostile nations in time of war. Access to it can be hampered also by a shortage of shipping facilities; such obstacles are already being met.

Prices also are subject in some degree to foreign control, since production comes principally from British and Dutch sources. Although the early British attempts to control rubber production and prices in 1922-28, under the Stephenson Restriction Act, were a failure, the International Rubber Regulation Agreement, operative from June 1934 through 1943 and including the producers of about 98 percent of the world's rubber supply, has been fairly successful. Rubber production, consumption, and value statistics for the period 1900 to 1940 are given in the following table.

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Rubber production, U. S. consumption, and prices, 1900-1940[1/]

Period	Average annual production[2/]						United States consumption		Average[4/] value
	Far East	Amazon Valley	Mexican guayule	Other America	Africa	World total	Net imports[3/]	Proportion of world production	
	Thousands of long tons							Percent	Cents per lb.
1900-04	.8	29.1		1.4	15.4	46.8	22.8	48.7	58.4
1905-09	4.8	36.0	3.6	5.3	18.3	68.1	31.3	46.0	74.0
1910-14	38.0	36.8	5.0	13.0	16.2	109.1	50.8	46.6	76.1
1915-19	205.9	30.8	1.1	10.0	8.6	256.5	155.5	60.6	50.1
1920-24	347.2	10.0	.8	4.1	4.8	376.9	269.3	71.5	25.2
1925-29	618.0	24.1	3.5	2.1	7.1	654.8	425.0	64.9	36.4
1930-34	825.7	10.3	.3	.3	2.8	839.3	433.0	51.6	7.5
1935	855.0	11.3	.5	.6	5.0	872.4	455.8	52.5	11.4
1936	833.7	14.2	1.2	1.2	6.1	856.4	475.6	55.0	14.9
1937	1,108.7	15.6	2.7	.5	7.9	1,135.4	592.5	52.3	18.5
1938	864.1	14.3	2.5	.6	7.9	889.4	406.3	45.9	14.1
1939	972.1	13.9	2.2	.9	15.7	1,004.9	486.5	48.6	16.0
1940	1,352.9	17.6	4.0	-	17.3	1,391.8	811.2	58.3	17.4

1/ Data from statistics gathered by the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.
2/ Based on rubber shipments (net exports).
3/ Gross imports less reexports (includes latex and guayule).
4/ Highest average annual price from 1900 to 1940 was $1.03, in 1910; lowest was 3-1/2 cents, in 1932; prices of Standard Ribbed Smoked Sheets on the New York market during the first half of 1941 ranged from 19-1/8 to 24-7/8 cents per lb.

Synthetic rubber is a possible substitute in the event of a shortage, and its production will undoubtedly increase as a result of the ever-increasing use of rubber. Yet synthetic rubber costs considerably more to produce than the natural substance. Its manufacture involves the erection of costly plants; the time required for construction and placing the plants in operation is also an important factor. Output of synthetic rubber in the United States in 1940 was less than 10,000 tons. Synthetic rubbers offer no marked advantages over natural rubber in their mechanical properties, but some are superior in a few respects, such as resistance to sunlight, gasoline, and oils; for most purposes, natural rubber is preferable to the synthetic product. Costs of synthetic rubber on a large-scale production basis may average as low as 25 cents per pound. Costs of production from the more efficient Hevea plantations may average under 10 cents per pound. Reclaimed rubber also can be looked to for part of the rubber needs of the United States.

Another possible source of rubber is guayule (Parthenium argentatum), a desert shrub that is native to Mexico and has been cultivated on a limited scale in the southwestern part of the United States. Best results are obtained from guayule as a 4- to 7-year crop, the entire plant being used for rubber extraction and the land replanted. Guayule rubber contains 16 to 20 percent resins

and sells at a discount of about 20 percent in comparison with Hevea rubber. After deresination, however, it can be used instead of Hevea rubber for most purposes. On a 4-year crop cycle guayule can be produced for 20 to 30 cents per pound and probably would be cheaper than most types of synthetic rubber.

Almost 98 percent of America's present rubber supplies come from the Far East. Prior to 1914, however, the center of world rubber production was the Amazon Valley. The change in the center of world production of rubber from South America to the East Indies came as the result of English ingenuity. Back in 1876, an Englishman, Henry A. Wickham, brought 70,000 Hevea rubber seeds from Brazil to England. Seedlings were grown from them in the Royal Botanical Gardens at Kew, near London, and the 2,700 that developed were shipped to Ceylon, whence they were distributed throughout the East, thus beginning the plantation rubber industry. By 1910 there were 1 million acres under cultivation in the Far East and this has expanded to almost 9 million acres at the present time, three-fourths of this area being in British Malaya and the Netherlands East Indies.

The situation just described presents the Latin American countries with an opportunity to regain or newly assume prominent roles as producers of rubber. Although the Hevea tree is indigenous to the Amazon Valley, there are many millions of acres of land throughout tropical Latin America where soil, climate, and other factors are in the main suitable to its growth and development. Labor in tropical America is not so abundant or so cheap as in the Far East, where it can be had for 20 to 35 cents per day. Another major handicap to be overcome is the South American leaf-disease problem, a formidable obstacle to the establishment of successful plantations in the American tropics.

Today, more than ever before, closer relations between the Americas are essential to promote hemisphere defense and good will. The United States needs rubber; the republics to the South need an increased and stable purchasing power to create a permanent foundation for better trade relations, and to provide a higher standard of living for their citizens. Where all parties stand to benefit, we may anticipate a coordinated effort to take advantage of such opportunities; this is in fact now coming to pass.

On June 22, 1940, the President of the United States signed a deficiency appropriation act which included $500,000 "to enable the Secretary of Agriculture to conduct investigations directed towards the development of rubber production in the Western Hemisphere, including production, breeding, and disease research; surveys of potential rubber-producing areas; establishment and operation of experiment and demonstration stations in suitable locations; acquisition of land for such purposes; construction of necessary buildings," etc. A 3-year plan of action was set up and immediately put into effect, and surveys have been conducted in the 15 Latin American countries involved. In addition to the preliminary surveys, experimental nurseries and plantings have been established in several localities, to carry out the objectives outlined by the Congress. The details of the program, however, will not be covered in this discussion.

Many factors will influence the success of Hevea culture in Latin America. The Hevea tree, which is native only to the Amazon Basin, can undoubtedly be grown in many parts of Latin American territory which lie within 18 to 20 degrees from the Equator. Of course, soil, topography,

rainfall and other conditions must be favorable. Hevea seems to thrive best on deep, fertile, well-drained soils, on relatively level sites (measures to conserve soil and prevent excessive erosion must be taken on rolling lands), at elevations below about 2,000 feet, with ample rainfall (70 to 80 inches or more annually, well distributed throughout the year, with no long dry season, and with a high percentage of dry mornings), and away from the paths of tropical storms. Furthermore, if the plantation is to be economically successful the cost of production must compare favorably with that of plantation rubber in the Far East. This means that high-yielding stock must be utilized, the trees must be sufficiently resistant to overcome ravages of the South American leaf disease, and the plantation development and rubber harvesting techniques must be so efficient that labor-cost differentials favoring the Far East can be offset.

Following the rubber boom in the early part of this century, with the attendant high prices paid for the crude product, numerous attempts were made to cultivate Hevea and other rubber-bearing plants, notably Castilloa (Castilla sp.), in practically every country in tropical America. But with the falling off in rubber prices when the Far Eastern Hevea plantations came into production, further attempts to develop rubber plantations in the American tropics practically ceased, and the previous plantings were allowed to revert to jungle. Investigations of the rubber-producing capacity of two of these abandoned Hevea plantations, made by the author in Nicaragua and Costa Rica in 1924, indicated yields comparing favorably with those obtained in the Far East. An experimental tapping of Hevea trees in Haiti by a representative of the United States Department of Agriculture in 1924-25 also gave favorable comparisons with Far Eastern plantations.

When supplies and prices of plantation rubber in British Far Eastern territory were brought under control by the Stephenson Plan in 1922, American rubber pioneers, led by Harvey S. Firestone, stimulated renewed interest in having America's rubber needs produced in lands closer to home. As an outcome of this interest, the Departments of Commerce and Agriculture cooperated on a series of rubber surveys between 1923 and 1927 to investigate the rubber-producing possibilities of tropical America, as well as of other parts of the world. Independent surveys were made by some of the large United States rubber companies, and new plantations on a limited scale were launched in Liberia by Firestone (1927) and in the Philippines by Goodyear (1928). In 1927, Henry Ford negotiated a 2,500,000-acre government concession on the Tapajos River, in the State of Para, Brazil, part of which was exchanged in 1933 for another concession of 700,000 acres not far distant, where conditions for rubber-plantation development were deemed more favorable. Here several thousand acres are being planted to Hevea, using bud-grafted material from high-yielding stock obtained from the Far East. In 1935, the Goodyear Company acquired a 2,500-acre concession near Gatun, Panama, and in the following year 1,000 acres in Costa Rica. In both countries plantations have been established, using high-yielding stock obtained from the company holdings in the Philippines, in an effort to develop a very productive and disease-resistant tree. The Goodyear Company is cooperating with the governments concerned in employing the citizens of these countries to the greatest practicable extent in their operations. The company has delivered to their respective agricultural departments, each year for several years, a number of seeds and trees for their use and distribution to the native farmers who may be interested. As these Hevea trials develop, further expansion may be anticipated, these plantings serving as a nucleus for additional plantings both by the company and by local native growers.

Under plantation conditions Hevea trees, which are usually set out with a density of about 200 per acre, can be tapped for rubber beginning at 5 to 7 years of age. In the Far East, present yields average around 400 pounds of dry rubber per acre per year. By cross-breeding and the use of budding stock from high-yielding trees it has been possible to increase yields to 1,200 and more pounds per acre annually.

By utilizing and developing sources of disease-resistant and highly productive planting stock, training local labor in efficient practices, and stimulating small landowners to develop their own planting, there is good reason to believe that many parts of Latin America can compete successfully with the Far East as a source of natural rubber. Certainly, with the potential growing areas located in close proximity to the centers of the world's principal rubber-utilization industries, Latin American production would seem to offer decided advantages to both the Americas.

The United States, as the principal consumer of rubber, should lend encouragement to such efforts, not only better to assure continuous supplies of this essential peacetime and wartime raw material, but also to establish an added safeguard against unstable and rapidly fluctuating prices. Furthermore, the United States now, more than ever before, needs outlets for its surplus agricultural and manufactured products. The successful establishment of a Hevea plantation industry in tropical America appears feasible and basically sound, besides offering an outstanding opportunity for further cementing trade relations between the United States and its Latin American neighbors to the South.

Resumen

El caucho, materia prima que encuentra tan diversos usos para fines domésticos y que es de singular importancia para la defensa nacional, es el material más indispensable que los Estados Unidos no produce dentro de sus límites. La magnitud de tales importaciones se comprende por el hecho de que durante los últimos 25 años compañías norteamericanas han adquirido más del 50% de la producción mundial de goma.

El Hevea brasiliensis, árbol nativo del valle del Amazonas en Sur America suministra la mayor parte de la producción mundial de caucho. Antes del 1914 el valle del Amazonas era el centro de la producción mundial, pero el Lejano Oriente, principiando en 1876 con semillas obtenidas del Brazil, ha levantado plantaciones que alcanzan en la actualidad alrededor de 3,500,000 hectáreas. Casi el 98% de nuestro abastecimiento viene del Lejano Oriente en un viaje de 6 a 7 semanas en lentos buques de carga los cuales podían ser entorpecidos seriamente en tiempos de guerras. Además producir goma sintética cuesta más que la goma natural y en el presente la capacidad de las factorías es extremadamente limitada.

Estas circunstancias le ofrecen a los países latinoamericanos una oportunidad de reconquistar una posición prominente en la producción de goma. Investigaciones hechas por el gobierno norteamericano y por compañías privadas han demostrado que la goma puede producirse satisfactoriamente en muchas partes de los trópicos americanos. Desarrollando y utilizando material altamente productivo y resistente a enfermedades, adiestrando obreros locales eficientemente y estimulando a pequeños terratenientes a desarrollar sus propias plantaciones hay razón para creer que America puede competir ventajosamente con el Lejano Oriente. Para mantener un mejor balance comercial y por muchas otras razones, sería conveniente para ambas Americas desarrollar la producción de la goma en el Hemisferio Occidental.

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