THE [illegible]ESTER

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LA CONSERVACION DE LOS RECURSOS NATURALES: EL PROBLEMA, SUS DIVERSAS FASES Y LA IMPORTANCIA RELATIVA DE ESTAS

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(Continuación del número anterior)

LOS BOSQUES Y LA CULTURA

Si nosotros consideramos la cultura—a diferencia de la civilización que es algo internacional que puede ser alcanzado por todos los pueblos que se encuentran en cierto nivel de desarrollo—como algo que brota del suelo y de la raza, que está arraigado en el campo y que ha crecido de él como una planta, entonces sí podemos entender las numerosas ligazones orgánicas entre el territorio y su cultura. En estas relaciones entre el campo y la cultura de un país los bosques juegan un papel prominente.

Los bosques han influenciado grandemente la vida espiritual y religiosa de los pueblos situados dentro o cerca de ellos. Tales pueblos han derivado de los bosques su carácter conservador y aristocrático; sin esta nobleza de carácter no puede haber cultura.

De los bosques han recibido las artes sus motivos más distinguidos; de ellos ha obtenido la literatura sus baladas y poemas más delicados, han provenido muchas inspiraciones para la música, y la pintura ha recibido sus impresiones supremas.

De las mismas entrañas de los bosques nació el espíritu de la arquitectura gótica que ama y busca la penumbra. Las catedrales góticas son como los interiores de los bosques: como troncos esbeltos de árboles robustos, las columnas y pilares se extienden siempre altos desplegándose airosamente en arcos poderosos como las copas de los árboles, mientras que desde la cumbre y justamente como en los bosques, un haz luminoso penetra la semi-oscuridad mística como un rayo de bendición divina que transporta el alma hasta las alturas de una reverente adoración. Similarmente, las cadencias armoniosas del órgano—voz solemne de la Catedral—nacieron del eterno susurro de los bosques.

Por otra parte, los bosques ayudan a preservar las tradiciones, ideales y características nacionales, promoviendo de esta manera un mejor entendimiento de las fases históricas del progreso nacional.

Finalmente, los bosques constituyen fuentes inagotables de donde manan materiales para la ciencia y normas para la educación.

CLASIFICACION DE LOS VALORES FORESTALES

Los beneficios más grandes que la humanidad deriva de los montes corresponden a tres clases distintas, cada una de las cuales es de importancia

primordial, y que son: producción, protección y recreación. Los valores forestales pertenecen, pues, a uno de los tres grupos generales siguientes:

I. Valores Comerciales
II. Valores Protectores
III. Valores Recreativos

El valor total de una propiedad forestal debe entenderse como la suma de estos tres valores forestales junto con el valor de los demás recursos naturales contenidos en ella.

I. Valores Comerciales

Los montes tienen valor comercial como fuentes que son de materiales en bruto para consumo doméstico e industrial.

(a) Los montes producen grandes cantidades de productos forestales primarios, tales como: madera, postes de telégrafo y teléfono, estantes para cercados, traviesas o durmientes de ferrocarril, pulpa y papel, leña y carbón vegetal.

(b) Ellos producen productos forestales secundarios, tales como: cortezas, raíces, frutos, nueces y materiales decorativos.

(c) Ellos producen productos forestales derivados, tales como: colorantes, proteinas, aceites, resinas, taninos, gomas, lanas, ceras y celulosas.

(d) Ellos pueden contener productos forestales accesorios, tales como: carbón mineral, gas, petróleo, arcilla, arena, piedra y otros minerales y metales.

(e) Ellos pueden constituir una fuente abundante de forraje.

(f) Ellos pueden contener animales silvestres de gran valor.

II. Valores Protectores

La influencia protectora de los montes es múltiple y constituye el valor dominante sobre considerables áreas de terreno. Los montes—mediante el dosel formado por las copas de los árboles, el sistema radical y la capa de hojas desprendidas—forman una cubierta protectora sobre la superficie terrestre. Es más: tal influencia protectora no se limita al área subyacente sino que se extiende sobre gran parte del territorio circundante.

Los valores protectores de los montes pueden a su vez ser divididos en las siguientes categorías:

1. Influencia sobre el clima
2. Influencia sobre las aguas
3. Influencia sobre la erosión
4. Influencia sobre las corrientes aéreas
5. Influencias sanitarias
6. Influencia sobre la vida animal

No existe una línea absoluta de demarcación entre estas diferentes categorías; algunas se superponen. No obstante, una mayor claridad y facilidad de exposición justifican esta nueva división.

1. Influencia sobre el clima.- Al elaborar este punto se hace necesario discriminar entre el macroclima o sea el clima de una región extensa, y el microclima o sea el clima de áreas muy pequeñas—el clima local.

(a) Los montes y el macroclima.- La influencia de los montes sobre el macroclima no ha podido aún ser bien determinada a pesar de las celosas investigaciones llevadas a cabo con tal propósito.

Entre las diferentes teorías que han sido presentadas en relación con la influencia de los montes sobre la precipitación—uno de los factores climáticos más importantes—la que tiene más advocadores y la que en mi concepto tiene más visos de verdad es aquella que considera los montes como meros condensadores. Partiendo del supuesto de que la humedad atmosférica, que luego se convertirá en lluvia, proviene principalmente de la evaporación marítima y oceánica y es transportada por masas aéreas marítimas y oceánicas, esta teoría sostiene que los montes constituyen un factor decisivo en la precipitación de la citada humedad atmosférica.

El Doctor H. Pittier es de este mismo parecer cuando asienta que: "Se puede afirmar casi con absoluta certeza que las sequías dominantes en los llanos de Barquisimeto, el Tocuyo y Carora y en las lomas circundantes, se deben a la destrucción de los inmensos bosques que en tiempos no muy remotos cubrieron esa región. El resultado es un calentamiento exagerado del suelo, el que provoca a su vez corrientes ascendentes de aire que, debido a su elevada temperatura, impiden la condensación de las nubes."

(b) Los montes y el microclima.- La influencia de los montes sobre el microclima es indiscutible. En efecto, el carácter (tamaño, forma y disposición) de la cubierta vegetal indudablemente afecta las condiciones de temperatura local, puesto que de tal carácter depende la intensidad de la sombra proyectada y la magnitud de la influencia atemperante sobre vientos excesivamente calientes o extremadamente fríos.

2. Influencia sobre las aguas.- La importancia de los montes en la regulación de la economía de las aguas de un país es generalmente reconocida. Europa y el resto del Viejo Mundo ofrecen vívidos y trágicos ejemplos al respecto. Los altamente civilizados Estados del Mundo Antiguo, Grecia, Italia y España, finalmente perecieron porque permitieron la destrucción de sus montes. En los días de esplendor de aquellos países montañosos la civilización estaba concentrada en las estrechas llanuras costaneras donde la irrigación hacía posible cosechas repetidas, una densa población y una cultura urbana; mientras que las montañas estaban cubiertas de bosques impenetrables los cuales constituían recipientes naturales de agua que permitieron la práctica de la irrigación y, consecuentemente, contribuyeron a la prosperidad de aquellos Estados.

Debido al instintivo reconocimiento de esta—entonces misteriosa—interrelación se creyó que los dioses moraban en los bosques y en las montañas.

El aumento de poder, la ambición política y la expansión territorial con sus exigencias de una marina mercante y guerrera ocasionaron grandes mermas

en las existencias madereras mientras que la implacable práctica del pastoreo en los bosques frustró todas las intentonas de éstos de reproducirse por sí solos. La destrucción de los bosques y la consecuente desolación de las montañas trajo consigo una irregularidad catastrófica en el régimen de las aguas y por lo tanto, en todo el sistema de irrigación. Las estaciones lluviosas subsecuentes vinieron acompañadas por crecientes devastadoras que traían consigo grandes masas de lodo y detritus, las cuales sepultaron las planicies que habían sido cultivadas como jardines; por otra parte, durante la estación seca la escasez de agua fué casi total y las cosechas se malograron.

Estos disturbios de la fuente principal de la vida nacional destruyeron finalmente el poderío y la gloria de aquellos Estados. Sicilia, Turquía, Persia, India y China ofrecen otros tantos ejemplos dolorosos del mismo proceso.

Los montes afectan las aguas conservándolas, purificándolas y controlándolas:

(a) Conservación de las aguas.—El carácter y la extensión de la influencia conservadora de los montes sobre las aguas varía según se trate de las montañas o las planicies:

En las montañas.—La influencia vivificante de los bosques montañosos sobre las aguas reside, de acuerdo con ideas modernas, en la estructura porosa y suelta del suelo forestal. Tal suelo absorbe el agua de lluvia como una esponja y la conduce a capas más profundas haciendo innumerables rodeos y a través de millares de canalitos abiertos por las raíces y raicillas causando su filtración hasta que es reunida en un arroyo subterráneo el cual se desliza a lo largo de un estrato impermeable y por último, alcanza la luz del día en la forma de un manantial.

Es clásica la comparación del suelo forestal con un papel secante. En efecto: si se deja caer una gota de agua sobre un trozo de dicho papel, ésta es absorbida rápidamente aun cuando hayamos colocado el papel con una gran inclinación. Si en lugar del papel secante hubiéramos usado un papel satinado, la gota de agua se habría escurrido enseguida. Esto nos da una ligera idea de la función desempeñada por la capa vegetal, principalmente cuando se trata de terrenos de gran pendiente.

Por otra parte, el dosel formado por las copas de los árboles y la capa de hojas desprendidas moderan la fuerza mecánica de la lluvia que cae y así previenen que ésta compacte al suelo y disminuya su capacidad absortiva.

Finalmente, los bosques montañosos pueden robar gotas de agua a la neblina transeunte; de esta manera ellos vienen a ser la causa de la llamada "precipitación horizontal."

Los bosques montañosos, por lo tanto, constituyen recipientes naturales de agua de cuyo incólume funcionamiento depende el bienestar del país.

En las planicies.—La vegetación de las planicies es también muy importante en la conservación de las aguas. La cantidad de agua total que existe en una región determinada depende principalmente de tres factores: precipitación, capacidad de absorción y retención del terreno, y evaporación.

La influencia de la vegetación de las planicies sobre la precipitación y sobre la capacidad absortiva y retentiva del terreno es, aunque menos efectiva, análoga en líneas generales a la ejercida por los bosques montañosos. En cambio, la influencia de la vegetación de las planicies sobre la evaporación es de mucha más trascendencia que la de los bosques montañosos. En efecto, la vegetación de las planicies mediante su acción moderadora sobre la temperatura y el viento es a menudo de decisiva importancia, puesto que en tales circunstancias la influencia de estos agentes se hace sentir con una máxima intensidad.

(b) Potabilidad de las aguas.- Los montes afectan la potabilidad de las aguas que están dentro de su radio de acción, de dos maneras:

Aumentando su pureza, es decir, reduciendo la cantidad de microbios patógenos. Un número grande de enfermedades de cuyo contagio el género humano es susceptible, son transportadas por las aguas. Si las aguas que contienen estos microbios han corrido sobre regiones cubiertas de vegetación antes de caer sobre los ríos, riachuelos y recipientes, dichas aguas sufren un proceso purificador que los filtros artificiales más eficientes no podrían aun igualar.

Aumentando su limpieza.- La calidad del agua potable también depende de su claridad relativa o ausencia de sedimentos y otras partículas que le dan una apariencia nebulosa. El agua proveniente de una vertiente intensamente cubierta de vegetación tiene una claridad y una limpieza máximas y los recipientes o depósitos que la almacenan permanecen libres de suciedad.

(c) Control de crecientes.- Aun cuando el clima, el suelo, la topografía del terreno, y las condiciones meteorológicas juegan el papel más importante en la determinación de las crecientes, la deforestación (ausencia de vegetación) debe ser también considerada un factor digno de tomarse en cuenta, y lo que es más, uno que está bajo el control del hombre. Los montes influencian las crecientes de dos maneras, a saber:

Mediante su efecto sobre la erosión del suelo. La influencia de materias térreas que las aguas llevan en suspensión es extrema en caso de crecientes. Es posible que un río desbordado lleve consigo hasta sesenta por ciento de su volumen en la forma de sedimentos, provocando de esta manera una elevación en la altura del nivel del agua desenfrenada y una disminución en la capacidad retentiva del lecho o canal natural. Impidiendo la erosión del suelo y, por lo tanto, la formación de estos sedimentos, los montes reducen apreciablemente la intensidad de las crecientes.

Aparte del control de los sedimentos, la cubierta forestal impide el desarrollo de las crecientes o las modera notablemente por intermedio de la acción trifásica siguiente: aumentando el porcentaje de lluvia que es evaporado antes de llegar al terreno y el porcentaje que es absorbido y retenido por el mismo; obstruyendo el movimiento del agua superficial y retardándolo mediante la presencia y acción de la capa vegetal que cubre el terreno y de las barreras formadas por las ramas desprendidas y los troncos de los árboles, disponiéndose de esta manera de mayor tiempo para la absorción del agua por el suelo; y, por último, distribuyendo el flujo sobre un período más largo de tiempo con lo que se reduce sensiblemente la altura de las crestas que son las que ocasionan mayor daño.

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.

3. 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 fondo 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.

4. 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 a 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 ganado, y para la fijación de dunas.

Errata: Por error, esta página fué incluída en el Vol. 2, No. 4 como página 178.
Through an error, this page was included in Vol. 2, No. 4 as page 178.

5. Influencias sanitarias.—Los montes influencian favorablemente la salud humana de varias maneras. Esta significación sanitaria de los montes es bien reconocida por higienistas y demás expertos en la materia como lo demuestra el hecho de estar situados los sanatorios dentro o cerca de áreas extensamente pobladas de vegetación. Las influencias sanitarias son:

(a) Producción de oxígeno.—Esta influencia es la más generalizada. Como quiera que los montes contienen la mayor parte de la vegetación sobre la tierra, constituyen un factor muy importante en la producción de oxígeno mediante la función clorofílico—lumínica, tomando al mismo tiempo de la atmósfera el anhidrido carbónico.

(b) Purificación de la atmósfera.—El aspecto principal de la significación higiénica de los montes reside en la influencia de éstos sobre la reducción de microbios patógenos atmosféricos. El aire que se respira en los bosques está siempre en una relativa calma y libre de polvo.

(c) Purificación de las aguas.—Este punto ha sido ya discutido. Podríamos añadir, sin embargo, la influencia favorable de los montes sobre áreas pantanosas, las cuales en los trópicos están generalmente infectadas con malaria. Este efecto beneficioso puede ser debido al rebajamiento del nivel del agua estancada.

(d) Efecto atemperante sobre el tiempo[1/].—El valor protector de los montes contra los más severos extremos de calor y frío, es generalmente reconocido. Esta protección, junto con la sombra proyectada por la vegetación alta y la moderación de la fuerza del viento, hacen el tiempo más confortable. Desde este punto de vista existen grandes ventajas no sólo para las personas enfermas sino también para las que gozan de perfecta salud.

(e) Efecto sobre la tranquilidad mental.—Las influencias psicológicas de los montes son particularmente beneficiosas a la salud. En épocas relativamente recientes se ha venido desarrollando una especie de amor sentimental por la naturaleza que constituye un nuevo factor higiénico mental. La gran mayoría de los bosques montañosos ejercen un efecto favorable sobre inválidos.

6. Influencia sobre la vida animal silvestre.—Las plantas constituyen probablemente el factor más importante dentro del ambiente de los animales terrestres. Todos los animales dependen directa o indirectamente de las plantas para su alimentación. Las plantas proveen también a muchos animales de abrigos contra las inclemencias del tiempo, situaciones para sus guaridas, materiales para sus nidos y protección contra sus enemigos.

III. Valores Recreativos

El uso de los montes para recreación constituye el contacto más directo con el hombre y que da a aquellas porciones forestales de tal manera utilizadas

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1/ No se confundan los conceptos "tiempo" y "clima". El tiempo es esencialmente local, incierto e irregular. Aun cuando siendo periódico, el clima es estable y puede ser referido a grandes extensiones de terreno. El clima puede ser considerado como la suma total de los tiempos medios que ocurren durante largos intervalos en un lugar determinado de la superficie terrestre.

un valor que puede fácilmente exceder todos los otros beneficios posibles que de ellas puedan derivarse.

Los bosques proporcionan saludables oportunidades recreativas al aire libre, pudiendo suministrar excelentes cotos de caza y áreas pesqueras—todo ello dentro del marco supremo de su belleza natural.

Los bosques realzan la belleza del paisaje, proveyendo santuarios por excelencia para descanso y regocijo espirituales.

El amor por la naturaleza debiera ser fomentado pues proporciona un placer que no puede ser pervertido, que eleva y dignifica y nunca rebaja; un placer que perdura desde la niñez hasta la edad madura.

El aspecto recreativo de los bosques es casi tan importante como el comercial, y solamente cuando el manejo económico y la satisfacción espiritual han sido coordinados dentro de la marcha general del progreso, estará asegurado el eterno rejuvenecimiento de la nación.

RESUMEN DE LOS VALORES FORESTALES

Los valores forestales más salientes pueden ser resumidos en la forma siguiente:

1. Los montes producen productos forestales primarios, secundarios y derivados, y pueden contener productos accesorios.

2. Ellos proporcionan forraje para el ganado y otros animales domésticos; alimento y abrigo para los animales silvestres.

3. Ellos regulan el régimen de las aguas.

4. Ellos conservan y enriquecen el suelo.

5. Ellos sirven como rompevientos y fajas protectoras, proveyendo salvaguardias contra la sequía.

6. Ellos actúan como agentes sanitarios ayudando a purificar la atmósfera y a suplir agua potable.

7. Ellos proporcionan abundantes oportunidades recreativas al aire libre.

8. Ellos embellecen la tierra y hacen la vida más llevadera.

9. Ellos proporcionan trabajo regular y de emergencia.

Resumen

El presente trabajo es una exposición sencilla y general del problema de la conservación de los recursos naturales en Venezuela. Forzosamente, pues, las conclusiones deben tener igualmente un carácter general.

Quedaría altamente satisfecho si el lector que haya seguido con detenimiento e interés la exposición de este trabajo, llegara a—y se diera cuenta cabal de la importancia de—las siguientes conclusiones:

Primera.—La conservación de los recursos naturales constituye la solución básica de casi todos los problemas de nuestra vida nacional, y por lo tanto, debería constituir la tarea fundamental de toda política gubernamental perspicaz y bien orientada.

Segunda.—La conservación de los montes, en particular, es de importancia primordial y, consecuentemente, amerita nuestros mayores primeros esfuerzos.

Tercera.—La magnitud y complejidad del problema son tales que la solución de éste requiere una técnica especializada, es decir, un personal debidamente entrenado. La fundación de un Instituto de Conservación, independiente, y que tenga por objetivo central la conservación de los montes es, pues, imprescindible y apremiante. Una erogación inicial de 600.000 bolívares y una asignación anual de 300.000 bolívares, aproximadamente, cubrirían los gastos de establecimiento y mantenimiento del citado Instituto.

Esta inversión sería provechosa como ninguna otra—ella aseguraría de una manera permanente el bienestar económico del país.

Summary

This paper is a simple and general exposition of the problem of conservation of natural resources in Venezuela. At the same time, conclusions are naturally of a general nature.

It is hoped that the reader of the article will arrive at or realize the importance of the following conclusions:

First.—The conservation of the natural resources constitutes the basic solution of the major part of our national problems, and should be the fundamental object of a well-directed and shrewd Government policy.

Second.—In particular, conservation of the forests is of primary importance and consequently merits our greatest attention.

Third.—The magnitude and complexity of this requires a special technique, or in other words, an especially trained personnel. The establishment of an independent institute of conservation, with the main object of conserving the forests is imperative and urgent. An initial allotment of 600.000 bolivars and an annual assignment of 300.000 bolivars would cover approximately the costs of establishment and maintenance of such an institute.

Such an investment would be more beneficial than any other. It would assure in a permanent way the economic well-being of the country.

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REPRODUCTIVE CYCLES IN PLANTS

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Rhythm is the law of nature. The motion of celestial bodies, the seasons, the tides, day and night, the beat of the heart, heat in animals, foliation and defoliation, the life-span of organisms, growth, and the sexual activities of plants, all are rhythmic. Certain natural phenomena appear not to occur in cycles. This may be true, but it is more likely that the cyclic character is masked, obscured, or disturbed. Thus, there would appear to be no rhythm in our mental activities, yet the brain manifests constant rhythmic pulsations which are revealed by electrometric determinations, particularly in sleep when other disturbing activities are at a minimum.[1] Rhythm in protoplasmic movement is now established beyond all doubt.[2] It was questioned because the observer failed to take interference phenomena into consideration, such as occur in harmonics.[3]

As a student I accepted without question the presence of annual rings in trees, as evidence of rhythm in growth. But it did not occur to me then that growth cylces were but one form of a very fundamental law in nature. A few years later this truth was brought home to me by an experience in Jamaica. I saw there miles of dead culms of the climbing bamboo, Chusquea abietifolia, a prolific grower on tropical mountains. The law of rhythm in nature took on far greater importance, for as an ardent student of Schimper, I had read his account of life cycles in oriental bamboos. [4] (p. 250).

In order to keep within the space allotment of a journal, I shall select four examples of reproductive periodicity, three of them rhythmic and one apparently not, and to these add one other wholly different type of rhythm in order to indicate the basic character of periodicity in life. The cases to be discussed are, (1) sexual periodicity in Chusquea abietifolia, (2) the gregarious flowering of the talipot palm, Corypha umbraculifera, (3) the flowering of the orchid Dendrobium crumenatum, (4) sexual rhythm in Dictyota—this is the work of Williams—and (5) the rhythmic flow of protoplasm.

It was in the summer of 1918 that I observed an abundance of dead Chusqueas in the mountains of Jamaica.[5] Disease could not have been the cause, for nearby the ground was covered with young and thriving seedlings. Obviously, a sexual cycle was responsible. On realizing that this climbing bamboo had flowered, seeded, and died throughout the mountains of Jamaica, I searched for a previous record of flowering and found it in the Gardener's Chronicle for 1886. Here Morris[6] writes, that when the seed of Chusquea was set "the stem

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1/ Harvey, R. N. etal, Jour. Neurophysiol., 2: 500, 1939.
2/ Seifriz, W., 88: 21, 1938.
3/ Kamiya, N. Protoplasm Monograph, Iowa State College Press, 1941.
4/ Schimper, A. F. W., Plant Geography, Oxford, 1913.
5/ Amer. Jour. Bot., 7: 83, 1920.
6/ Gardener's Chronicle, 20: 524, 1886.

began to die down, and apparently every plant on the Island died, root and all. At the present time the ground in the forests where Chusquea grew is covered with millions of seedlings, and in due time these will take the place of the former generation." As I had observed the same condition of Chusquea in 1916, the interim of thirty-two years is probably the life cycle of Chusquea abietifolia. Such a period is in full agreement with that recorded for other bamboos. Schimper, 4/ (p. 251) reports that Bambusa arundinacea on the west coast of Cisgangetic, India, blossoms at intervals of thirty-two years. The bamboo flowered in 1804, 1836, and 1868. Kawamura7/ states that the flowering of Phyllostachys puberula has been recorded in old manuscripts of China and Japan as occurring in the years 292, 813, 931, 1114, 1247, 1668, 1786, 1848, and 1908. These dates are about sixty years or multiples of sixty years apart.

In contrast to data which give a thirty-two year life cycle to bamboos are the reports from various sources which indicate that flowering in bamboos is sporadic. This is true of Arundinaria falcata var. glomerata which flowers almost every year on some of the old culms. Bean8/ mentions the case of Arundinaria Simoni which flowered on odd culms in the bamboo garden at Kew for several years. "Excepting that the flowering culms died, the plants were in no way affected. They continued to flower in this way every year up to 1903, by which time we had almost come to regard A. Simoni as a perennial. In that year, however, the plants flowered on every culm, and after producing an abundance of seed, died. After that not a single trace of leaf growth was ever visible and the plants were ultimately uprooted." It is said that the Philippine bamboos exhibit no gregarious or periodic reproduction whatever. In contrast to this is the situation in India and Burma where whole forests of bamboo are wiped out in one summer by flowering.

The Indian Forester contains frequent references to the general flowering of bamboos, of which the following are two: "The flowering of Bambusa arundinacea is reported....to be general this year in the Angul Division of the Bengal Presidence" 9/ (p. 178); "The flowering on a large scale of the ordinary bamboo, Dendrocalamus strictus. The area over which the flowering extends is estimated at 1200 square miles, and in this area, although a few clumps here and there have escaped, the phenomenon is universal." 10/ (p. 126).

Similar to the gregarious flowering of bamboos is that of the talipot palm, Corypha umbraculifera.11/ Finest examples of this occurred in Peradeniya, Ceylon, in 1918 and 1922.11/ I saw the trees in 1920 after the first flowering. Their history is as follows: Among its several excellent avenues of palms, the Peradeniya Gardens have long had an avenue of superb specimens of the talipot palm, Corypha umbraculifera. The twenty palms formerly in this avenue were planted in situ in 1881. In June 1918, seven of them commenced flowering and remained in blossom until the end of the year, being at their best in October-November. In June 1922, eight more of the palms in the avenue commenced to flower. They were at this time forty-one years of age. The seven palms which

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7/ Bot. Mag. Tokyo 25: 294, 1911 (Japanese). Abstr., in Zeitschr. Pflanzenzucht (Fruwirth) 1: 96, 1913.
8/ Kew Bulletin, 228-233, 1907.
9/ Indian Forester 25: 178, 1899.
10/ Indian Forester 27: 126, 1901.
11/ Bull. Tor. Bot. Club, 51: 341-350, 1924.

followed in 1918 were thirty-seven years old. The second lot of Coryphas were in full flower in December, 1922. They began to set fruit visibly in March, 1923. The fruit ripened toward the end of 1923.

At the time of the first anthesis of the talipots, there also flowered in the Garden two species of bamboo, Dendrocalamus giganteus and D. strictus, and the liane, Bauhinia anguina. Bauhinia had never before been seen in blossom at Peradeniya. In addition, there was widespread flowering of talipots throughout Ceylon. From one observation point on the Island two hundred talipots were counted in flower.

Quite different from the foregoing examples of gregarious flowering, superficially different yet possibly fundamentally similar, is the simultaneous anthesis of the orchid Dendrobium crumenatum. Whenever a number of individuals of this orchid occur within the same general locality the plants flower simultaneously. But there are several striking differences between the simultaneous flowering of the orchid and that of the bamboos. The orchids live on and reproduce again. Reproduction is gregarious among the orchids of this species, but not rhythmic as in the case of the bamboos. The flowering dates reveal no rhythmic periodicity.

As the reproductive periods of the bamboos occur in rhythmic sequence whereas the simultaneous flowering of the orchids does not appear to be rhythmic, interpretations of the two phenomena probably cannot be identical. A third striking difference between the gregarious flowering of orchids and that of bamboos is that among the bamboos all individuals within a forest are of the same age, whereas the individuals in an assemblage of orchids are of quite different ages.

Among the specimens of Dendrobium crumenatum in the Botanic Gardens at Buitenzorg, Java, there are plants collected from nearly all parts of the Dutch East Indies, from Riouw (near Singapore), from Sumatra, Java, Borneo, Celebes, and Ambon (a small island at the eastern end of the Archipelago.) Shortly after these plants were brought to Buitenzorg, all flowered on the same day, if they flowered at all; yet in their native habitat the flowering periods do not at all coincide. Orchids growing in the virgin mountain forests flower on different days from those in the lowlands. Plants growing at two stations but three kilometers apart may differ in their times of flowering by one or two days. But wherever their original home and whatever the date of flowering there, the plants, when assembled in one locality, flower simultaneously with each other and with the plants which have always grown in that locality.

To this information on Dendrobium gotten in Java, I can now add data on Sobralia panamensis recently obtained in Panama. There I was told that this endemic orchid has the same remarkable habit as has Dendrobium in Java of flowering gregariously, but not rhythmically. All plants flower on the same day and repeat their simultaneous flowering days or weeks later. The periods between the days of flowering are not of the same duration, varying from 10 to 20 days. Plants growing miles away at Chilibre, at Panama City, and El Valle with an altitude of 2,000 feet, all flower on the same day. One may watch the buds in the Botanic Garden at Summit, and when they are ready to burst, drive into the country on the following day and find Sobralia in flower everywhere.

The gregarious reproduction of the brown alga Dictyota is a rather remarkable case of sexual rhythm, which, unlike that of bamboos, is very obviously associated with environmental factors. The study of periodicity in the reproduction of Dictyota is due primarily to—Williams.[12] He found that the brown alga, Dictyota, at Bangor, Wales, discharged its eggs and sperm two or three tides after the greatest spring tide every two weeks. As spring tides are the highest and lowest, occurring at or about the new and full moons every two weeks, with the neap tides in between, it is likely that maximum high water is a factor in determining periodicity, though other environmental conditions such as light may play a part. But an experiment by Williams seems to exclude all environmental influencies as causal agents. He brought two sexual plants of Dictyota into the laboratory in October and left them undisturbed during the winter. Next April they produced crops regularly at fortnightly periods, though removed from the alternating influence of the tides for six months. Williams concludes that "periodicity of the sexual cells is an hereditary character and consequently may be expected to manifest itself in seas and habitats where there are no tides." Hoyt[13] has repeated and amplified the experiments of Williams. Perhaps the situation is this: eons ago, the tides established the sexual rhythm, and once established the cycle was not easily upset; this is an important point.

With these four cases before us, we may proceed to a consideration of the probable causes of sexual rhythms in plants before turning to the special case of rhythm in protoplasmic flow. Many suggestions have been made on the possible causes of periodic flowering in bamboos. One of the oldest attributes the phenomenon to drought. That bamboos have flowered gregariously in India immediately after a drought is not to be doubted for droughts are of such frequent occurrence in India that it would be surprising if they did not occasionally coincide with the flowering of bamboo forests. It is also possible that severe dry weather may have some slight influence on the exact time of flowering. When many individuals of any species of plant flower simultaneously immediately after a drought, scientist as well as layman is likely to associate the two phenomena. The occurrence of each even separately passes unnoticed. If data for one locality warrant the conclusion that the gregarious flowering of a species is occasioned by drought, what is to be done with the flowering of the same species in another locality where there is no drought? Bambusa arundinacea flowers gregariously not only in India where it is subjected annually to a severe dry season and occasionally to a drought, but also in Buitenzorg, Java, where dry seasons are practically unknown. Then, too, we have the interesting fact that other species of bamboo flower gregariously following unusually wet periods as did, for example, the climbing bamboo, Chusquea abietifolia, in Jamaica in 1918.[5]

So far as I have knowledge no one has actually studied the rainfall data of the country where bamboos flower gregariously in order to ascertain if the dry season of the particular year in question was one of sufficient severity to warrant its being regarded as the direct cause of the gregarious flowering of the bamboos and whether or not if a drought did precede the particular flowering period under investigation, other flowering periods of the same species of bamboos in that country, and in other countries, were also preceded by droughts.

12/ Ann. Bot. 19: 531-560, 1905.
13/ Bot. Gaz. 14: 383, 1907: Amer. J. Bot. 14: 592, 1927.

The meteorological conditions prevailing in India are so extreme that one must be thoroughly aware of them in order to consider intelligently a question such as that here under consideration. The greater part of India is almost rainless for half the year. It is not an uncommon occurrence for no rain whatever to fall at certain stations during seven or eight months of the year. There are areas in the Caribbean Circle, as at Maisi in Cuba, Gonaïves in Haiti, and Guánica in Puerto Rico, where rainless periods may cover several months. What rain falls during the dry season, sometimes equalling 0.2 to 0.3 of an inch in a month, is of little consequence to plant life. In India, vegetation depends on the monsoons and when these fail, all plant life suffers. The chance flowering of bamboos at this time will most certainly be attributed to drought, in fact, the natives regard the bamboo seed as God-given in compensation for the loss in planted grain.

If droughts and the gregarious flowering of bamboos are compared, no consistent correlation can be found. There was a phenomenal failure of the rains over a large part of India during the 1899 monsoon, from June to September. As a consequence, a disastrous drought prevailed in the early months of 1900. The general flowering of Bambusa arundinacea in 1899[9] took place before the drought of 1900, and there had not been a previous drought for five years. The gregarious flowering of Dendrocalamus strictus reported for 1901[10] followed the drought of 1900. The two years immediately preceding the gregarious flowering of Chusquea abietifolia in Jamaica in 1918 were unusually wet ones. When drought is cited as the cause of gregarious flowering it has usually occurred in the same year as the flowering, or immediately preceded it, but Brandis[14] believes "that such stimulating conditions must act upon the plant at least a year before the flowering actually takes place."

As I have stated, certain bamboos do not follow the thirty-two year cycle. The sexual cycle of Dendrocalamus arundinacea and D. strictus are about thirty-two years in length, but Bambusa polymorpha is known to have a very long life period; no authentic records of two successive flowering dates exist.

In the Indian Forester for 1903 appears a statement that "the last recorded flowering of the Kyathaung was....in 1853."[15] The flowering of this bamboo, Bambusa polymorpha, was expected to recur shortly after 1883 on the general belief that the life of bamboos is about thirty years. The flowering of B. polymorpha in the forests of Burma has not yet occurred. Certain signs of an expected flowering have from time to time been seen." These signs refer to the well-known habit which bamboos have of producing no new shoots in the year of flowering.

The bamboo forests of B. polymorpha in Burma may be reckoned by hundreds if not by thousands of square miles. In this extensive region of bamboos there have been, since 1883, one or two false alarms of gregarious flowering when a clump or two has blossomed. In 1918 and 1919 an area of several hundred acres in two or three distinct but neighboring blocks in the Tharrawaddy Division flowered gregariously. The plants of B. polymorpha were at this time sixty-five years of age, or twice the expected thirty-two years. This was thought to be the forerunner of a general flowering, since the flowering of odd clumps

14/ Indian Trees cultivated in the British Indian Empire, London, 1906.
15/ Indian Forester 29: 244, 1903.

is considered to be an indication that the flowering of the whole area is imminent. But so far no general flowering has taken place.

During their sixty-eight years of existence the bamboos of these forests have endured many droughts which apparently have had no effect whatsoever on the sexual maturity of the plants. For at least the latter half of their life the bamboos must certainly have been mature enough to respond to an external stimulus, if this stimulus was of such a nature as to exercise any prominent influence on the sexual life of the plants.

In discarding drought as the primary factor in gregarious flowering, I do not wish to leave the impression that it may not have some little influence, even though the evidence for this is very slight. It is conceivable that if a plant is almost ready for flowering, a drought, should it come just at that time, might hasten reproduction. The natural law that favorable conditions tend to accelerate vegetative growth, and unfavorable conditions tend to bring on reproduction, holds in a general way, and may manifest itself in the effect of drought on flowering.

If climatic factors are responsible for the simultaneous flowering of plants, then these factors must show the same rhythm as the flowering. In the case of bamboos, this would mean a thirty-two year climatic cycle. Climatic cycles of greater length than the familiar yearly one are not known to exist with certainty. Climatic oscillations closely approaching the life cycle of bamboos have been suggested; one of them rests on scientific observation. Bruckner[16] postulated a cycle of thirty-five years, and a shorter alternation of wet and dry epochs of elevan years, coincident with the sunspot cycle.[16] It is not well established that climatic changes of long duration are periodic, and there is but little to support the idea that droughts occur rhythmically, especially with any great precision. However, hearsay evidence that cold winters and warm winters come in cycles is abundant. Bacon gives a delightful example of this: "There is a toy, which I have heard, and I would not have it given over, but waited upon a little. They say it is observed in the Low Countries (I know not in what part), that every five and thirty years the same kind and suit of years and weathers come about again; as great frosts, great wet, great drought, warm winters, summers with little heat, and the like, and they call it the prime; it is a thing I do the rather mention, because computing backwards, I have found some concurrence."

Were we willing to accept the popular belief in the existence of climatic cycles, we should still be confronted with the task of explaining why these cycles cause the talipot palm to flower in forty years whereas certain bamboos reach sexual maturity in thirty-two years; and why the climatic cycle should cause Chusquea abietifolia and Bambusa arundinacea to reproduce every thirty-two years although other bamboos flower most irregularly, as is generally true of many of the Philippine species.

Quite another environmental factor said to be the cause of the flowering of long-period bamboos is depletion of nourishment. Hori[17] is of the opinion that flowering in bamboos is a "physiological disease." He regards flowering in bamboos as a result of an increase in sugar content of the sap due to the

16/ Klimaschwankungen, Vienna, 1890.
17/ Bull. Imp. Cent. Agr. Exp. Sta., Japan 38: I, 1911.

inability of the plant to attain the necessary salts for nourishment owing to the dryness of the soil. This is essentially again a question of water scarcity or drought.

Macmillan[18] is also of the opinion that a depletion of nourishment is the cause of flowering in some bamboos. He says, "It would seem as if the exhaustion of nutriment rather than an infectious influence were responsible for the more or less simultaneous flowering of the Giant Bamboo. The vigorous growth of the plant is such that it cannot go on growing and extending indefinitely. The enormous demands it makes on the soil can be realized by any one who has seen the 'ruins' of an old clump, the huge crevices and upheavals formed by the elevated stumps as if the result of an earthquake."

Macmillan's description of the elevated base of an old bamboo clump is very graphic. But on such a mound of stumps measuring fully eight feet in diameter and three feet in height I have seen healthy culms growing as luxuriantly as those of any bamboo clump in the Buitenzorg Gardens.

Macmillan reports continued vegetative growth of two clumps of Dendrocalamus giganteus as a result of increased nourishment. It seems that two of the flowering clumps at Peradeniya, having regained a more vigorous condition, "gave up blossoming entirely, presumably because their circumference had struck richer soil."

This instance at Peradeniya is especially interesting because the bamboo in question happens to be of the same species as a young plant growing in the Buitenzorg Gardens, which was transplanted from an old clump and thus given an opportunity to regain a more vigorous condition by striking new soil.

There had been growing for many years in the Buitenzorg Gardens a magnificent clump of Dendrocalamus giganteus remembered for its size and beauty by all the older workers of the Lands Plantentuin. In 1918 this entire clump of bamboos flowered and died. Not wishing to lose the last specimen of so fine a bamboo (seeds are not produced), the director of the Gardens had a few culms, which were still in healthy condition, removed from the parent clump as soon as the latter commenced to flower. It was hoped that these transplanted culms would continue their vegetative growth without flowering. Such was not the case, however. One of the transplanted clumps soon flowered and died. The second clump lived scarcely more than a year after transplanting, when it too flowered and died. I saw this small plant when the long pendent blooms were still hanging to the then nearly dead culms. New and richer soil did not cause this Dendrocalamus giganteus to give up flowering and continue its purely vegetative growth. Similar observations must have been made by Brandis, since he writes that "offsets taken from a clump some time before it flowers came into flower at the same time as the parent clump."

Depletion of nourishment could never be cited as the cause of anthesis in those bamboos which flower gregariously. It is quite untenable that each individual of the multitude of plants in a forest of Dendrocalamus strictus, one thousand square miles in area in India, or of Chusquea abietifolia extending over a region ten miles in length in the mountains of Jamaica, should

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18/ Ann. Roy. Bot. Gard. Peradeniya 4, 1908.

simultaneously exhaust the supply of food in the soil where they are growing.

Several interesting cases have been reported which support the theory that injury may cause anthesis in bamboos. Injury has no bearing on the problem of natural causes of gregarious flowering in plants, yet it is worthy of consideration as a possible stimulus of sexual activity.

Gamble[19] states that single clumps of Bambusa Tulda, if badly treated by over-cutting or partly uprooting, will afterwards produce flowers without general flowering. Merrill reported a case of flowering caused by injury to a bamboo in the Philippines. In an extensive forest of Schizostychium one single culm was seen in flower. This culm had been cut by a bolo. The culm was about two-thirds severed and in full flower. Branthwaite[20] tells of the flowering of three clumps of Dendrocalamus strictus, as a result of injury. The flowers were borne on short stems which had their origin just below the surface of the ground from the base of culms which had been cut for a clearing.

Knowledge of these led me to suspect that two injured clumps of Bambusa arundinacea which I noticed in flower in the Buitenzorg Gardens had also flowered because of the injury received. In each clump several culms were in profuse flower, and these culms were broken off about midway of their length, whereas all those culms which were not in flower were healthy, uninjured shoots. It seemed possible, therefore, that the broken culms had flowered as a consequence of injury. On second thought, it was evident that there was no way of determining without previous data whether the culms had flowered as a result of injury or whether they had broken as a result of flowering. The culms of Bambusa arundinacea die after flowering. A dead culm is much less resistant to strain from wind which may be very great on a stalk forty to sixty feet in height. In order to ascertain which event, the flowering or the breaking, had preceded the other, I had several culms cut in a large and healthy clump of Bambusa arundinacea. These culms when observed one year after cutting had not flowered. The injured culms above mentioned had in all probability broken as a result of flowering and dying and consequent weakening of the culms.

I subsequently obtained far more convincing data from India. The Chief Conservator of Forests of the Madras Presidency informed me that in the bamboo areas, many of which are twenty square miles and more in extent, with Dendrocalamus strictus and Bambusa arundinacea predominating, the bamboo culms are worked on a rotation of three to four years. The periodical cutting over and clearing of the individual clumps has had no known effect on the periodicity of flowering.

As for other species of bamboo, there is abundant evidence indicating that injury affects the continued vegetational growth of the plants but little. The most common method of raising bamboos is by cuttings, and so far as I am aware, all species lend themselves satisfactorily to this method. The little slender Bambusa nana is commonly used as a hedge plant and is therefore subjected to frequent cutting without any apparent effect on flowering.

19/ Ann. Roy. Bot. Gard. Calcutta 7, 1896.
20/ Indian Forester 28: 233, 1902.

Another form of injury which is said to produce anthesis in bamboos is burning. From the Philippines comes the report that, in a clump of Dendrocalamus (species not given) which had been severely injured by fire the few remaining culms had produced flowers. The case was of especial interest because of an observation made by me in Jamaica. Fully ninety-eight per cent of the plants of Chusquea abietifolia seen in the mountains of Jamaica had flowered and died in 1918. Two small patches, however, contained green, healthy plants, and one of these patches had recently been burnt over. The charred stubble was still evident. The parent plants had been burnt to the ground before their life cycle was complete, and the living rootstocks had sent up new shoots which were continuing the growth of the plants and thus carrying on the vegetative portion of the life cycle beyond the normal limit. Burning here not only did not cause flowering, but had, on the contrary, apparently prevented it.

Although the total evidence is decidedly against the hypothesis that injury may induce flowering in bamboos, yet I do not wish to leave the impression that injury never brings on or hastens reproduction. The general natural law that unfavorable conditions tend toward reproduction, seems to hold in many instances, and that injury induces fruiting is sworn to by every French horticulturist. It is common practice in France to cut with a spade all superficial roots of fruit trees at a distance of five to six feet from the tree thereby forcing a healthy but unproductive tree to bear more fruit. Surely, if nature sees to it that species are to be maintained, then resorting to reproduction when unfavorable conditions approach would be the proper thing to do, but this is not always the rule in nature, certainly not in bamboos.

I can see but one possible conclusion, that monocarpy, whether it is the gregarious flowering of many individuals of one species, as in bamboos, or the flowering of a single plant as in the case of Agave and the palm Metroxylon, is an innate, heritable characteristic.

There is nothing remarkable in gregarious flowering in itself, for if all plants were seeded at the same time, they would all flower together, provided their life span is well established. The remarkable feature of the life cycle of certain bamboos is not their gregarious flowering habit but the fact that their number of years is so sharply fixed, that out of many thousands of plants only a few fail to flower and die at the appointed time. Monocarpy in Agaves is so poorly timed that a plant may live anywhere from ten to forty years before flowering. Man's life cycle is three score and ten but that is only an average. He may live less or some years more. In the case of certain bamboos the life cycle is very precisely established; fully 99 per cent of all species covering several square miles flower at exactly the same age. It is this exactness which has led some investigators to believe that external factors must be responsible and leads me to feel sure that the cause is internal. If the responsible factor is external, it is unknown.

In stating that the life cycle of a plant is an innate heritable quality, comparable to any other transmissible genetic factor, I do not thereby imply that one can wholly dissociate an organism from its environment. Change in environment has been shown in laboratory experiments to cause some remarkable changes in the development of organisms, and the forester is familiar with the striking difference in appearance of some prostrate alpine willows compared with the same species when growing in the lowlands. The pitcher plant,

Nepenthes forms leaf rosettes and pitchers when in marshland, but grows into a 30 foot vine without pitchers on dry soil. Polymorphism due to differences in environment are common, but at that, it is still generally assumed that the protoplasm of an organism is responsible for the egg growing into the same species from which it came. A rabbit egg does not grow into an oak tree and the environment has nothing to do with it.

Opposition to a hereditary disposition in plants which is responsible for periodicity in growth, reproduction, etc., is apparently based on a fear of giving support to any hypothesis which would attribute to a plant self-regulation and would thereby tend to dissociate the plant from its environment.

Klebs[21] was an ardent believer in the interrelationship of germ plasm and environment, and the dependence of the former on the latter. It is true, that among the many vital phenomena which are rhythmic in plants—leaf production, leaf fall, cambium activity, reproduction, the synthesis and solution of starch, the winter's rest, etc.—some are susceptible to environmental factors; but it is also true that the same rhythm varies in different plants in the readiness with which it can be influenced by surrounding conditions. Thus, the winter's rest in some plants is easily broken, whereas in others it cannot by any known artificial means be disturbed. Klebs first clearly showed that this is true, and herein lies his contribution to biology, but his experiments also proved that certain plants cannot be aroused from their winter's rest.[21]

The further question arises, whether or not the ability to alter the normal rhythm of a plant by a change in environment is an indication that this periodicity is the direct result of an environmental rather than of a germinal factor. There are some striking instances in which the normal alternation of growth and rest may be disturbed but the plant suffers in consequence. An excellent illustration of this existed at Tjibodas, Java, where a small apple tree had been growing in the mountain acclimatization garden for some twelve years. This temperate zone tree was attempting to survive in a tropical climate which had no pronounced seasonal change. The normal periodicity of growth and rest in the tree was disturbed but not done away with. The tree was undersized, but four feet high, and had never borne fruit. It stood there an unhappy specimen, when I saw it, with one branch in full foliage, another bare of leaves, and still another with well-developed buds. It seemed to be having a sad time of it trying to exist in a seasonless climate with an inherent periodicity of growth and rest manifesting itself at different times of the year on different branches. The periodicity was there, and a seasonal cycle would have determined when the rest and growth periods should occur. In a tropical climate the seasonal guidance was lacking, and the normal rhythm of growth and rest disarranged, but the inherent periodicity was still evident.

The fact that the winter's rest in plants can in many cases be disturbed has led other workers than Klebs to come to rather far-reaching conclusions. Thus, Howard[22], as a result of work on the treatment of dormant woody plants for forcing them into growth, concludes that "all forms of rest are caused by unfavorable external conditions." Would he care to apply that sweeping deduction to man?

21/ Biol. Centralbl. 32: 257, 1912.
22/ Univ. Mo. Agr. Exp. Sta. Bull, I, 1910

There may be unfavorable conditions which cause all kapok trees to become completely defoliated simultaneously each August at Buitenzorg, but what these are in so equitable a climate as at Buitenzorg it is difficult to know. Another case in point is that of Ceiba in Jamaica which annually loses its leaves, but not simultaneously with other silk-cotton trees. Why the unfavorable external conditions which bring about defoliation of one silk-cotton tree should not so affect another standing nearby is difficult to understand.

Having written the foregoing, I stopped long enough to see if Schimper, whose great work helped mold my thoughts in early years, would not give me further support. I shall quote only one of his general deductions, 4/ (p. 242) "The less pronounced the periodicity of the climate, the less dependent on its influence is the periodicity of the plant. Internal causes are mainly or solely responsible for the alternation of rest and activity in a nearby uniform climate. Such a rhythmic change is never abandoned, for it arises from the nature of the living organism and not from external conditions."—There is only one slight change that I should like to make in Schimper's conclusion. Although it is true that the rhythm is not abandoned and is not determined by but merely guided by present environmental factors, it may yet be true that the rhythm was established by the climate in past ages working over eons of time. The nicety with which the life cycle of annuals and the growth rhythm of perennials fit in with the seasonal changes of temperate regions leads one to believe that these periodic vital phenomena have been induced through the ages by climatic conditions, with the result that the periodicity has become innate, the habit being more firmly established in some plants than in others. The same may be true of bamboos of long life cycle, although in this case the climatic factor is apparently no longer active.

Opposition to reproductive and growth rhythms is often a matter of lack of familiarity with them. When23/ a two-week cycle in spore production in the slime mold Physarum was revealed, based simply on laboratory observation, without theory or postulate, it brought forth a flood of denial, and was dubbed "mythical." Biologists familiar with heat in animals, seventeen-year cicadas, the rhythmical discharge of algal eggs and sperm, and the several life cycles already discussed here, are not likely to be disturbed by a two-week rhythm in sporulation in a slime mold, yet some mycologists were.24/ Rhythm in growth and reproduction is no more extraordinary in a slime mold than in a bamboo or an annual.

Somewhat different is the case of the orchids Dendrobium and Sobralia. An interpretation of their gregarious flowering involves several difficulties. The flowering is gregarious but not rhythmic. It seems very probable that plant and environment combine to bring about gregarious flowering in these orchids, and in a manner which has been interpreted by Burkhill25/ from data obtained in the Straits Settlements. He comes to the conclusion that "climatic conditions some eight days in advance of the flowering are a controlling factor."

The data of Burkhill consist in the dates of simultaneous flowering of the pigeon orchid over four years, covering twenty-seven flowering periods, and

23/ New Phytologist XXV, No. 5, 472-476, 1936.
24/ Bot. Rev. 6, 356: 1940.
25/ Gardener's Bull. Straits Settlement 1: 400, 1917.

the daily rainfall figures for these years. When the two groups of data are arranged in a table, it is seen that in most instances the precipitation is unusually heavy on the eighth, sometimes the seventh or ninth, day before each anthesis. Especially evident does this fact become when one considers the total rainfall for each series of days preceding all the flowering periods. I repeated the tabulation with data obtained while at Buitenzorg, Java,26/ and found that the precipitation total of the eighth day preceding each flowering date, was in each case the greatest, as it was in the data of Burkhill. An interpretation of this was given by Rutgers and Went.27/

Flower buds on the orchids are developed to a definite, and in every case the same, stage of advancement, at which point growth stops. There are, therefore, at any one time many resting buds of the same age. This being true, it is evident that if a stimulus starts all buds growing again at the same time, they will all burst into flower on the same day, assuming that the time required to cover the final lap of their development is constant in all the individuals of the species. This is what Rutgers and Went believed to be the explanation of simultaneous flowering in Dendrobium crumenatum. The explanation is analogous to that of the "trigger type" of reaction (shock reaction) in animal behavior. The organism is responsible for everything, for preliminary development to a precise point, and for an exact time to complete development. The environment functions merely as a stimulus for releasing the "trigger."

Such an interpretation permits including orchids, which flower gregariously, in the general conclusion that all reproductive cycles are rhythmic.

The preceding observations, experimental data, and deductions therefrom would indicate that rhythm is a universal and a very fundamental law of nature. Instead of being surprised at the discovery of it in an unusual case as in spore formation in slime molds, I should be more surprised were it not present. The English authority on growth, Sir d'Arcy Thompson, expressed himself similarly in reference to another characteristic of growth to which I have devoted some attention, that of spirality. 28/, 29/ Trees frequently show a pronounced spiral twist which usually first becomes evident after peeling and barking.

When I first met Sir d'Arcy I told him that all the biological world knew of d'Arcy Thompson but that he had certainly never heard of Seifriz. "Who?", he asked: I repeated my name and he exclaimed, "Oh yes I have! You are the fellow who thinks everything grows in spirals. You're right and you're wrong," he said. "How's that," I asked. "Of course it does, but you think you've discovered something new. Find me a straight horn on an animal." I suggested the unicorn, but he called my attention to a spiral one over a shop door on the Strand!—And so it is with rhythm. The unusual thing is not its discovery in a vital process, but its absence, where this is true.

That rhythm is a very fundamental property of living matter is suggested by its presence in protoplasmic streaming. This is particularly well illustrated

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26/ Amer. J. Bot. X: 27-32, 1923.
27/ Ann. Jard. Bot. Buitenzorg II, 14: 129-180, 1916.
28/ Science, 77: 50, 1933 : 78: 361, 1933.
29/ Protoplasm, page 153, New York, 1936.

in slime molds where the protoplasm flows first in one direction then in the other, reversing every three-quarters of a minute. This rhythmic flow continues without cessation, until the plasmodium either sclerotizes, fruits, or dies. Environment has nothing whatever to do with the rhythmic movement of protoplasm except in so far as the protoplasm must remain normal. One does not search for a rhythmic change in temperature, in atmospheric pressure, moisture, or other environmental factor in the woods or laboratory in order to account for the perfectly timed rhythmic flow of protoplasm. The causes are internal, not external. The rhythm is a basic, heritable property of protoplasm.

Summary

Rhythm is the law of nature. Natural phenomena whether celestial, climatic, organic, belonging to plants and animals are all rhythmic.

Examples of reproductive periodicity are quoted and the effect of environmental factors analyzed.

The weight of evidence leads to the conclusion that while a rhythmic change is never abandoned and is not determined by, but merely guided by present environmental factors, it may yet be true that the rhythm was established by the climate in past ages working over eons of time.

Observations, experimental data, and deductions would indicate that rhythm is a universal and very fundamental law of nature and a basic property of living matter. The causes are internal, not external and the rhythm is a basic heritable property.

Resumen

El ritmo es ley de la naturaleza. Rítmicos son sus fenómenos, ya sean estos celestiales, climáticos, orgánicos o pertenecientes a plantas o animales. A continuación damos cuatro ejemplos, tres de ellos rítmicos, de periodicidad reproductiva:

1. Periodicidad sexual en Chusquea abietifolia.
2. Florescencia gregaria de la palma talipote, Corypha umbraculifera.
3. Florescencia de la orquídea Dendrobium crumenatum.
4. Ritmo sexual en Dictyota.

Además puede añadirse el flujo rítmico del protoplasma.

Para algunas especies del bambú se han informado ciclos evolutivos de treinta y dos y de sesenta años, aunque algunas fuentes informan florescencia esporádica. En la India y en Burma, florestas enteras desaparecen en verano durante la época de florescencia. Se dice que el bambú filipino no exhibe

reproducción periódica o gregaria, mientras que en Burma se ha esperado en vano durante sesenta y ocho años por la florescencia de la Bambusa polymorpha.

Los factores climáticos, aunque de escasa importancia no pueden considerarse factor determinante en la florescencia del bambú. Sin embargo, la ley natural de que las condiciones favorables tienden a acelerar el desarrollo vegetativo, mientras que lo contrario estimula la reproducción, influye de manera general. En la florescencia del bambú la evidencia se manifiesta en contra de una decisiva influencia de factores del ambiente, tales como, depleción de nutrimentos, incendios, y cortaduras o golpes, aunque tal influencia se ha registrado en otras especies.

Un organismo no puede separarse por completo de su ambiente y muchos fenómenos vitales que son rítmicos en plantas, como la producción y caída de las hojas, actividad del "cambium", reproducción, síntesis y solución de los almidones, reposo invernal, etc., son susceptibles a la acción del ambiente; aunque es verdad que el ritmo varía en las distintas plantas en la facilidad con que puede ser afectado por el ambiente. El ritmo normal puede ser alterado por cambios en el ambiente, pero hay muchos casos en que las plantas han sufrido las consecuencias.

Aunque el ritmo subsiste siempre y no es determinado, sino meramente guiado por factores del ambiente, puede todavía ser cierto que fué establecido por el clima en edades pretéritas a través de incalculable número de años.

El caso de las orquídeas Dendrobium y Sobralia es algo diferente. La florescencia es gregaria, pero no rítmica. Burkhill llegó a la conclusión que las condiciones climáticas ejercen una influencia determinante como ocho días antes de la antesis simultánea de la orquídea de paloma. Rutgers y Went son de opinión que las florecidas simultáneas de Dendrobium crumenatum tienen análoga explicación al tipo de reacción animal conocido como "trigger reaction," donde el organismo es responsable por todo hasta cierto punto preciso y por un período exacto antes de terminar el desarrollo. El ambiente funciona meramente como un estímulo para poner en marcha la acción biológica ya preparada por el organismo.

Las observaciones, los datos experimentales, y las deducciones indicarían que el ritmo es una ley universal, muy fundamental y una propiedad básica de la materia viviente. Esto está bien ilustrado en los mixomicetos donde el protoplasma fluye en un ritmo definitivo, continuando sin cesar hasta que el plasmodio se transforma en esclerocios, fructifica o muere. Las causas son internas y no externas. El ritmo es, pues, una propiedad básica y hereditaria del protoplasma.

NOTES ON PURE TEAK PLANTATIONS IN TRINIDAD

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Introduction

The first pure teak plantation in Trinidad was formed in 1913 and is thus now 28 years old. Since that date the annual teak regeneration area has been steadily expanded and has now reached the figure of approximately 400 acres per annum.

The technique of the formation of teak plantations has been stabilised for some years, and closely follows the Burma taungya system. Clear felling by charcoal burners is followed by the planting of stump plants at 6 feet by 6 feet, and the cultivation of the area in hill rice and corn for 1 year by peasant contractors who also tend the young teak.

At the time of writing the plantations cover an area of about 2,100 acres widely distributed at centres in the north, middle and south of the island, on a variety of soils. Plantations over 13 years old occupy a relatively small proportion of the total area, and are unfortunately often situated on soils unsuitable for the growing of first class teak.

Various problems have naturally arisen from time to time in connection with the formation and tending of these plantations and in March 1941 a conference of the technical officers of the Forest Department was held with a view to the pooling of experience and the standardisation, so far as was possible, of field treatment. The following notes on the decisions arrived at may be of interest to others engaged in growing teak in the Western Hemisphere.

1. Burning after clear felling.—The main objections which can be cited against burning after clear felling are the destruction of the soil humus and of the woody plants forming the ground cover, together with their seeds, and the subsequent invasion of grass. On the other hand, the soil humus will be lost anyway on an unburnt area through the effects of insolation following clear felling, whilst in practice woody accessory species are found rapidly to invade burnt areas through the action of wind and birds, provided they receive adequate encouragement. Further a good burn releases a supply of potash for the teak and makes planting and tending easier, and consequently cheaper, by the destruction of all debris left by the charcoal burners. When, owing to bad weather, the burn has been a poor one, the debris should be piled up into heaps (boucans) and burnt: undestroyed debris forms a focal point for invasion by weeds and vines, and also constitutes a fire hazard in young plantations.

2. Education of peasant contractors.—It is of vital importance that teak should make a successful get-away in its first year: failure to do so means considerable difficulty in forming a crop the second year in the face of increased soil deterioration, with consequently greatly enhanced expenditure.

During the critical first year the control of the area is in the hands of the peasant contractors, who must consequently be educated in the tending of the young teak and in growing their field crops in such a way as to avoid suppressing the teak. On some soils first year failure means permanently poor teak owing to advanced soil deterioration.

3. Drainage.—The formation of adequate drains in sites inclined to water-logging is essential and cheaper than prolonged tending of sickly chlorotic young teak. Large sites involving expensive drainage should not be planted in teak at all.

4. Thinning and pruning.—On the whole teak plantations in Trinidad have been underthinned, due largely to a reluctance to create temporary large gaps. Further, marketing considerations have been allowed to influence the time of thinning and thus to interfere with an operation which should be governed by silvicultural considerations alone. The following procedure for thinnings has now been standardised:

(1) During the period October - December of the year prior to that in which the thinning is due, assess the quality class in order to estimate the degree of thinning and make the first marking of the thinning. Doubtful trees should be left unmarked for later consideration.

(2) During the period January to mid April of the year of thinning sell as many marked trees as possible. Towards the end of this period, i.e. before the trees come into leaf, cut out all unsold marked trees.

(3) After the felling of all marked trees is completed, make the second marking: in this marking it is preferable to cause somewhat large gaps than to leave groups of congested trees. Marked trees must be felled immediately.

(4) All suppressed, diseased, dead and dying trees must be cut out at each thinning since such trees may become a source of infection to healthy trees. Coppice shoots from stumps of former thinnings must also be cut out for the same reason.

Pruning should form a normal part of the operations at 5 and 10 year old thinnings: by the expenditure of up to $2 per acre the appearance and ultimate timber value of a plantation can be considerably improved. Trees likely to be removed in the next thinning should not be pruned.

5. Soil erosion.—Soil erosion is inevitable during the year of formation of a teak plantation, particularly during the period between the completion of the burn and the establishment of a ground cover of teak and agricultural crops. Erosion is reduced by some agricultural crops more than others, but the suppression of the young teak caused by such crops as tannia and pigeon peas is usually more deleterious than the soil erosion.

In established plantations the destruction of the ground vegetation by fire or excessive shade of the teak crop may cause serious erosion: this can

be prevented by adequate fire protection and proper attention to thinnings.

6. Soil deterioration.—Temporary soil deterioration in the year of formation is inevitable: stress has already been laid on the need for establishing a successful teak crop in the first year.

There is as yet no evidence of soil deterioration under established teak plantations and this would appear unlikely as long as an effective ground cover is maintained. Soil deterioration experiments at Arena Reserve have demonstrated that soil fertility is rapidly restored in cleared areas once protection is again offered by regrowth.

7. Falling off in height increment.—So far marked falling off in height growth has only occurred in teak plantations established on soils unsuitable for teak e.g. porcellanite and Mount Harris grits.

8. Falling off in girth increment.—Falling off in girth increment is noticeable in some plantations, and appears to be due to one of two causes:

(1) The plantation is situated on a soil unsuitable for teak.
(2) The plantation has been underthinned.

9. Fluted boles.—It would appear that the race of teak established in Trinidad is not subject to severe fluting. Such fluting as does occur appears to be attributable to excessive branchiness, as in the case of trees on the outer edge of plantations, or to certain soil conditions, such as a high water table in flat alluvial areas.

10. Epicormic shoots.—It is considered that epicormic shoots owe their development to an over congested condition of the plantation, and that they may be prevented by adequately heavy thinnings.

11. Underplanting.—It is considered undesirable to underplant teak with timber species for the following reasons:

(1) The shelterwood formed by the teak is not suitable, as it cannot be treated according to the needs of the underplanted species.

(2) The underplanted species is likely to be severely damaged during teak thinnings.

(3) The rotation of underplanted shade bearers will inevitably be longer than that of the teak and consequently it would not be possible to regenerate the teak immediately after its final felling at maturity. Such a policy is most undesirable in view of the very limited area of soil suitable for good quality teak.

It is usually unnecessary to underplant teak with a soil protecting industry, as this comes in naturally: in cases where it is necessary, however, Flemingia is considered to be the most satisfactory species for this purpose.

Summary

Pure teak plantations in Trinidad were started in 1913 and are being expanded at the rate of about 400 acres per annum, with a present total area of 2100 acres widely distributed over the island. Various problems arising in connection with these plantations were discussed at a meeting of technical officers and based on the 28 years experience, the standard practices adopted by the conference are listed.

Resumen

En el año 1913 se empezaron a establecer las plantaciones puras de teca en Trinidad y se han ido extendiendo a razón de 400 acres por año aproximadamente. Actualmente hay un área total de 2100 acres repartidos extensamente por la isla. Varios de los problemas que han surgido en conexión con estas plantaciones se presentan a continuación:

(1) La quema hecha después de una corta total como preparación para la siembra es aconsejable debido a que las ventajas que se obtienen de la misma exceden cualesquiera otros resultados adversos.

(2) Un buen crecimiento en el primer año es de vital importancia, ya que lo contrario significaría un desarrollo inferior de la teca debido a suelos desgastados.

(3) Buen desague es esencial.

(4) La poda y entresaque se han reglamentado en vez de dejar que las determinen el mercado y otras consideraciones.

(5) La erosión del suelo es inevitable durante el primer año y debe evitarse la destrucción de la vegetación del suelo por medio del fuego o sombra excesiva.

(6) La fertilidad del terreno se restituye rápidamente una vez se obtenga protección de la vegetación.

(7) Estancamiento del crecimiento ocurre solamente en localidades desfavorables.

(8) Poco aumento en diámetro se debe aparentemente a suelos pobres o a falta de entresaques.

(9) En Trinidad, los troncos acanalados no han constituído problema alguno.

(10) Los renuevos de raíz se pueden evitar con entresaques adecuados.

(11) La siembra de la teca bajo sombra no es deseable.

CLASSIFICATION DES ESSENCES FORESTIERES DE LA MARTINIQUE D'APRES LEUR UTILISATION

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1o. Bois d'ébénisterie fine.—Mahogany du Honduras, Swietenia macrophylla King; Mahogany du Pays, Swietenia mahagoni L.; abricotier du pays, Mammea americana L.; galba, Calophyllum antillanum Britton; laurier-rose, Podocarpus coriaceus Schl. et Cham.; bois-chypre ou cyp, Phoebe elongata Nees; courbaril, Hymenaea courbaril L.; mancenillier, Hippomane mancinella L.; catalpa, Thespesia populnea (L.) Soland; laurier-caraïbe ou bois madame, Styrax glabrum Sw.; bois-amer ou bois noyer, Picramnia excelsa L.; tendre à cailloux, Acacia nudiflora Willd.; etc.

2o. Bois de marquetterie.—Magnolia, Talauma plumieri L.; gaiac, Guaiacum officinale L.; grand amourette, Acacia tamarindifolia Willd.; bois-jaune, Aniba bracteata Mez; etc.

3o. Bois d'ébénisterie courante, de menuiserie ordinaire et de moulure.—Acajou rouge, Cedrela odorata L.; acajou blanc, Simaruba amara Aubl., amandier, Terminalia cattapa L.; bois-rivière, Chymarris cymosa Jacq. var genuina Urb.; bois-fougere, Pithecolobium japunba Urb.; angelin, Andira jamaicensis L.; raisinier bord de mer; Coccoloba uvifera Jacq.; quinquina montagne, Exostema floribunda Benth; bois-côte, Tapura guianensis Aubl.; bois-gris, Ilex sideroxyloides Griseb, var. typica Loes, forma vulgaris Loes; bois de l'ail, Cassipourea elliptica Poir.; bois pistolet, Guarea ramiflora Vent.; bois coco, Guarea perottetiana A. Juss.; bois piquette ou bois graines rouges, Erythroxylon squamatum Vahl; bois de chypre marron, Cordia gerascanthus Jacq.; etc.

4o. Bois de grosse menuiserie, de construction et de parquet.—Manguier, Mangifera indica L.; bois-rivière, Chymarris cymosa Jacq.; bois-balata, Mimusops riedleana Pierre; bois contrevent, Guapeba semecarpifolia Pierre; acomat, Homalium racemosa Jacq.; châtaignier petit coco, Sloanea dussii Urb.; châtaignier petites feuilles, Sloanea massoni Sw.; bois de pommes-surettes ou jujubier, Zizyphus jujuba L.; bois - l'épreuve ou bois-vert, Ternstroemia obovalis Rich.; bois anonli, Freziera undulata Sw.; etc.

5o. Bois de charpente.—Bois rouge, Coccoloba diversifolia Jacq.; Genipa, Genipa americana L.; pomme-pain ou bois de pain d'épices, Lucuma dussiana Pierre; goyavier bâtard grands bois, Eugenia octopleura Kr. et Urb.; savonette, Loncho-carpus benthamianus Pittier; filao, Casuarina equisetifolia; mauricif ou bois-tan, Byrsonima spicata Rich.; acomat-hêtre, Homalium racemosum Jacq.; caconnier rouge, Ormosia monosperma Jacks.; orme du pays, Guazuma ulmifolia Lamk; bois vignot, Turpinia occidentalis; laurier-fine, Ocotea leucoxylon Mez; laurier noir, Ocotea eggersii Mez; bois arcoquois, Bucida capitata Vahl; palétuvier grand-bois, Tovomita plumieri Griseb.; mahot-anglais, Trichilia simplicifolia Spreng.; lépiné jaune, Zanthoxylum martinicense L.; etc.

6o. Bois pour travaux hydrauliques et emplois speciaux.—Bois gris, Licania ternatensis Sw.; bois de fer, Mayepea caribaea O. Kuntze; bois d'Inde, Amomis caryophyllata Urb.; bois amer, Picramnia excelsa L.; bois moudongue, Picramnia pentandra Sw.; bois balata, Oxythece hahnianum Pierre; bois de sept ans, Meliosma herbertii Rolfe; bois flambeau, Fagara microphylla Desf.; lépiné blanc, Zanthoxylum aromaticum Willd.; gommier blanc, Dacryodes hexandra Griseb.; courbaril, Hymenaea courbaril L.; mérisier, Eugenia lambertiana DC.

7o. Bois de charronage.—Raisinier bord de mer, Coccoloba uvifera Jacq.; bois noir, Albizzia lebbeck L.; bois noyau, Prunus Dussii Krug. et Urb.; graines bleues, Symplocos martinicensis Jacq.; sapotillier, Achras sapota L.; laurier-fine, Nectandra coriacea Griseb; laurier-chypre, Nectandra membranacea Griseb; quiquina caraibe, Exostema caribaeum R. et S.; bois lézard, Vitex divaricata Sw.; bois piquet ou bois baguette, Ixora ferrea Benth.; carette, Eugenia floribunda West; laurier caraïbe ou bois madame, Styrax glabrum Sw.; goyavier bâtard, Myrcia deflexa DC. var. Dussii Krug. et Urb.; bois petites-feuilles, Calyptranthes elegans Krug et Urb.; bois-etti ou bois de basse rouge, Calyptranthes sericea Griseb.; amandier, Terminalia catappa L.

8o. Bois d'aviation.—Bois pour appareils de l'Air et de l'Aéronautique: Calebassier, Crescentia cujete L.; Goyavier, Psidium guajava; poirier rouge, Tabebuia pallida Miers.

9o. Bois pour travaux de chemin de fer.—Filao, Casuarina equisetifolia Jacq.; campêche, Haematoxylon campechianum L.; tendre à cailloux, Acacia nudiflora Willd.; poirier blanc, Rheedia lateriflora L.; bresillet, Erythroxylon obtusum DC.; bois flambeau, Farara microphylla Desf.; bois noir, Capparis jamaicensis Jacq.; bois capitaine, Myroxylon martinicense Krug et Urb.

10o. Bois de fente, tonnellerie.—Mahot cochon, Sterculia caribaea R. Br. et Benn.; acomat franc, Homalium racemosa Jacq.; pois doux gris, Inga ingoïdes Willd.; poirier blanc, Tabebuia pentaphylla DC.; mangle chandelle, Rhizophora mangle L.; palétuvier gris, Laguncularia racemosa Griseb.; mangle blanc, Avicennia nitida Jacq.

11o. Bois de tours et de scupture.—Magnolia, Talauma plumieri L.; bois jaune, Aniba bracteata Mez.; châtaignier grande-feuilles, Sloanea massoni Sw.; bois de fer ou petites feuilles, Krugiodendrum ferreum Griseb.

12o. Bois de chauffage et de charbon.—Pommier cythère, Spondias cytherea Tuss; campêche, Haematoxylon campechianum L.; pois doux, Inga laurina Willd.; pommier rose, Eugenia jambos L.; raisinier bord de mer, Coccoloba uvifera Jacq.; mapou blanc, Cordia sulcata DC.; figuier maudit, Ficus laurifolia Lam.; mangier, Mangifera indica L.

13o. Bois de résines, glus, encens, caoutchouc, gommes et colles.—Amourette, Acacia farnesiana L.; flambeau noir, Pilocarpus racemosus Vahl; pois pétard, Calotropis procera Ait.; canelle-bois, Canella winterana L.; pruniers d'Espagne et du Chili, Spondias purpurea L.; pomme d'acajou, Anacardium occidentale L.; ciroyer, Rheedia lateriflora L.; bois chandelle blanc, Amyris elemifera Willd.; bois la glue, Sapium caribaeum Urb.; mancenillier, Hippomane mancinella L.; sablier, Hura crepitans L.; courbaril, Hymenaea courbaril L.; gommier blanc, Dacryodes hexandra Griseb.; bois d'encens, Icica

heptaphylla Aubl.; gommier rouge, Bursera gummifera L.; aralie zabricot, Clusia rosea L.; aralie montagne, Clusia pluckenettii Urb.; palétuvier grand bois, Tovomita plumieri Griseb.

14o. Bois de tanin et matières colorantes.—Bois tan, Byrsonima spicata L. Cl. Rich.; bois tan montagne, Byrsonia martinicensis Kr. et Urb.; savonette montagne, Sapindus saponaria L.; campêche, Haematoxylon campechianum L.; palétuvier rouge, Rhizophora mangle L.; goyavier, Psidium guajava L.; goyavier bâtard, Myrcia deflexa DC. var. Dussii Kr. et Urb.; mangle blanc, Avicennia nitida Jacq.; acomat, Sideroxylon mastichodendron Jacq.; bois amer, Picramnia excelsa Lind.; icaque, Chrysobalanus icaco L.

15o. Bois a structure spongieuse, flotteurs, explosifs, matières filtrantes, etc.—Bois de liège, Cchroma pyramidale (Cav.) Urb.; fromager, Ceiba antillana (DC.) Chev.; mahot-cochon, Sterculia caribaea R.Br. et Benn.; mahot franc, Paritium tiliaceum A. Juss.; bois canon, Cecropia peltata L.; mapou grandes feuilles, Cordia sulcata DC.; mombin, Spondias mombin Jacq.; bois cachiman, Marila racemosa Sw.; laurier à cerise, Nectandra antillana Meissn.

Summary

The above is a list of tree species of Martinique classified according to their manner of utilization, such as furniture woods, construction woods, firewood.

Resumen

Lo que antecede es una lista de las especies de árboles de Martinica clasificadas de acuerdo a sus usos, tales como, madera para ebanistería, para construcción, para leña, etc.

PLAN D'AMENAGEMENT ET D'EXPLOITATION RATIONNELLE

DE LA FORET MARTINIQUAISE

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Fort-de-France, Martinique

Le double rôle technique du forestier, à tout échelon, doit être la protection et l'aménagement de la forêt tout en réalisant son exploitation convenable et raisonnée.

En outre du rôle répressif, il lui incombe donc un rôle de technicien de grande importance dans l'économie de l'île.

Le plan d'aménagement doit d'abord comporter la distinction entre les forets de protection et les forêts de rapport. Sur ces dernières, il convient de réaliser le programme suivant:

Aménagement des Forêts de Rapport

Cet aménagement doit comporter en études préliminaires des connaissances sylvicoles appliquées à la forêt locale relevant d'une économie forestière dirigée. Ce sont:

1o. La détermination exacte des espèces.—Les agents forestiers rassembleront les noms créoles des essences et adresseront, pour les espèces douteuses, des échantillons au Chef de Service qui en fera la détermination précise.

2o. La croissance en hauteur des essences.—Le développement des arbres aux divers stades du cycle végétatif doit être observé et noté par chaque garde dans son triage. Les brigadiers dirigeront leur travail, en effectueront le contrôle et surtout la centralisation des résultats.

La croissance en hauteur est, d'une manière générale, très rapide dans le jeune âge pour la majorité des espèces locales. La croissance en hauteur est très rapide jusqu'à l'âge de 5 ans puis elle se ralentit.

Une indication première pourra déjà être fournie par la mesure de peuplements d'âge connu avec certitude, mais il faut suivre les essences pour savoir, à quel stade de leur vie la croissance est la plus rapide et à quels moments se produisent les ralentissements.

3o. La croissance en diamètre des essences.—L'accroissement annuel en diamètre se déduit de mensurations périodiques faites sur des arbres bien repérés et marqués au marteau forestier.

L'accroissement annuel en circonférence à hauteur d'homme pour les espèces de la forêt martiniquaise (mahoganys, acajous blancs, poiriers rouges et cypes) est compris entre 40 mm. et 70 mm. C'est surtout apprès 5 ans que

cette croissance est notable car avant c'est surtout l'augmentation de taille en hauteur qui est sensible.

4o. L'évaluation du matériel ligneux sur pied.—Elle s'effectue par comptages sur les parcelles d'un hectare environ. On sépare en deux catégories pour faciliter cette évaluation d'une part les arbres d'un diamètre supérieur a 30 cm. de diamètre, d'autre part ceux d'un diamètre inférieur à 30 cm.

A la Martinique, dans les peuplements on peut compter à l'ha. 80 arbres de plus de 30 cm. de diamètre le plus commun étant celui de 40 cm., la hauteur moyenne varie de 15 à 18 m.

Le matériel ligneux en bois d'ouvrages peut être évalué sur les bases de 250 m^3 par hectare en moyenne. En admettant 50 ans, pour la reformation de la forêt martiniquaise, on peut donc adopter une possibilité de 5 m^3 par hectare.

L'aménagement des 8.000 hectares domaniaux soumis à la Martinique au contrôle du service forestier, donnera par conséquent, un rendement annuel de 40.000 m^3, production au moins égale aux besoins de la colonie. Le prix du m^3 de bois sur pied est variable avec l'essence, le diamètre, la quantité de ligneux par pied, la proportion de houppier, l'éloignement des chemins d'évacuation et l'intensité de la demande. Actuellement, les conditions sont favorables et les bois très demandés, le prix de 60 francs le m^3 m'apparaît en moyenne bien au-dessous de la réalité.

5o. L'évaluation du domaine forestier.—Ce travail incombe surtout au service topographique sous le contrôle de l'arpenteurjuré.

Les travaux de délimitation forestière ont abouti cette année à la réalisation d'un cadastre domanial. Le but à atteindre maintenant consiste dans le levé du plan des forêts et d'abord de celles qui doivent etre classées comme forêts de rapport sur proposition de chaque brigadier pour les triages relevant de leur autorité.

Le géometre délimitera également, en présence du Chef de Service ou de son délégué, les parcelles devant constituer des réserves, les peuplements a sauvegarder, les mises en défens, les emplacements de pépinieres volantes et définitives, les terrains a allouer suivant baux de gré a gré et les lieux choisis pour l'expérimentation sylvicole.

Entretien des Forêts de Rapport

1o. Organisation d'un réseau de chemins de pénétration et d'évacuation des produits.—Le Service forestier a déjà établi un réseau de traces évalué à 400 kms., ce qui représente déjà un effort sérieux. C'est seulement lorsqu'un réseau très dense de chemins forestiers sera constitué dans tous les secteurs de l'île que l'exploitation des bois deviendra efficace.

La réalisation de ce réseau, tant sur lisières qu'à l'intérieur, exige la plus étroite collaboration entre les deux sections active et topographique du Service forestier.

En général, la forêt martiniquaise est médiocrement desservie et des voies de vidanges sont à réparer.

Le plan des chemins d'arrivée jusqu'aux lisières, des traces sylvicoles et plus tard des chemins à travers les peuplements d'exploitation, sera dressé par l'arpenteur en fonction de la direction générale du transport qui donnera la voie principale où aboutiront les chemins secondaires desservant les coupes.

Des rapports préliminaires de chaque garde centralisés par chaque brigadier fourniront dès à présent et de façon progressive des précisions sur les divers peuplements de rapport dans leur triage et les possibilités actuelles ou prochaines d'exploitation convenable.

Il conviendra de mentionner très spécialement les essences, leur nombre, taille et diamètre, leurs qualités et utilisation, l'évaluation financière et les possibilités locales de vente.

Les brigadiers dans leur transmission à la direction du Service feront alors des propositions concrètes et devront faire ressortir nominativement, par des tableaux figuratifs, les possibilités des triages soumis à leur contrôle.

Une étude spéciale sur les méthodes à adopter pour la réalisation des chemins, leur tracé, leur empierrement, leur fascinage, l'évaluation des eaux en cours d'hivernage, puis leur entretien, sera réalisée ultérieurement.

2o. Adoption d'un traitement convenablement choisi.—Le régime à adopter dépend surtout des formations forestières. Il sera suivant le cas la futaie, le taillis sous futaie ou le taillis simple.

a. La futaie.—C'est la forme naturelle de peuplement a la Martinique. Ce sont des groupements essentiellement hétérogènes.

Il conviendra de leur appliquer le traitement de futaie jardinée. Une bonne rotation portera sur 10 ans. Le peuplement choisi par le garde sera divisé, en sa présence et celle de son brigadier, en 10 divisions égales délimitées avec précision par l'arpenteur, chaque division correspondant à une coupe devant être mise annuellement en exploitation. La régénération de la forêt pourra se faire en 5 périodes de 10 ans.

Les essences préliminaires sont d'utilisation recherchées pour menuiserie, charpente, travaux hydrauliques, etc.

Les essences secondaires, de qualité inférieure, ont également leur usage, comme bois de chauffage et de charbon.

Le jardinage se fera prudemment, par petites coupes, pour éviter l'envahissement trop rapide par les fougères calumets, Dicranopteris bifida Maxon, et les herbes coupantes, Cypéracées du genre Scleria.

Une étude particulière sur la conduite de ce jardinage appliqué à la forêt locale sera faite ultérieurement.

b. Le taillis sous futaie.—Quelques peuplements comportent une futaie

éclaircie sous laquelle poussent des pommiers-roses, Jambosa jambos L., ou des crécrés grands-bois, Miconia guianensis Aubl. Ils peuvent être traités en taillis sous-futaie et conduisant l'aménagement de telle sorte que la réserve augmente peu à peu.

c. Le taillis simple.—La facilité de régénération de certaines formations primaires comme la mangrove et de peuplements purs de seconde croissance comme les formations de pommiers-roses, d'origine régressive, permet d'envisager leur règlement en taillis simples. On peut les traiter sur un cycle de 15 ans pour les palétuviers et de 10 ans pour les pommiers-roses.

La réalisation a pour but l'obtention de bois de chauffage pour les usines et l'extraction des matières tannantes manquant actuellement sur le marché.

Amélioration des Forêts de Rapport

Dans la forêt hétérogène, comme l'est au plus haut degré celle de la Martinique, il convient d'abord de faire la distinction entre les essences intéressantes, dignes de conservation et celles qui sont à rejeter.

Ce travail de détermination accompli, des nettoiements et dégagements des bonnes especes en voie de développement seront nécessaires, enfin des semis et pépinieres seront réalisés.

1o. Distinction entre essences utiles et espèces à éliminer.—La détermination préalable ayant été le premier travail d'aménagement accompli, il convient de choisir avec soin les essences a conserver.

Les espèces progressives de dissémination facile qui appartiendront à la forêt primaire seront favorisées, les régressives de seconde croissance et de taillis de dégradation devront être éliminées.

Une note préliminaire comportant classification de la forêt locale par rapport aux essences à leurs diverses catégories fait l'object d'une deuxième étude.

Les formations de mahoganys, lauriers-fines, poiriers, galbas, cyps, entrent dans la catégorie des essences de valeur et espèces progressives.

Les taillis, simples ou sans-futaie, à crécrés du genre Miconia à bois-baumes du genre Croton et les peuplements purs à bambous, Bambusa, fougères arborescentes, Cyathea, bois-cannon, Cecropia, qui sont des groupements régressifs et inutiles seront éliminés.

2o. Nettoyages forestiers.—Les nettoyages répondent à une double fin: éliminer la compétition des plantes adventices d'une part et dégager les jeunes baliveaux et plants d'autre part.

Il n'est pas nécessaire que ces nettoyages soient réalisés avec autant de soin que des sarclages en agriculture. Le sabre d'abattis suffit pour couper les calumets, herbes coupantes et autres plantes adventices de forêt.

Ces dégagements réalisés à peu de frais sont très précieux pour les espèces sylvicoles. Le premier dégagement se fera apres la mise en aménagement, les autres à raison de 4 a 5 par an les années de réalisation.

3o. Semis et pépinières.—Pour suppléer aux semis naturels, des repeuplements artificiels seront établis par les gardes aidés de manoeuvres.

Il y a lieu de prévoir deux sortes de pépinières:

a. Pépinieres volantes.—Elles sont réalisées en pleine forêt, non loin des lieux de repeuplement. Les anciens fours à charbon et le voisinage des rivières et des points d'eau seront particulièrement recherchés.

b. Pépinières permanentes.—De telles pépinières répondent surtout aux reboisements de terrains dénudés et des trouées et clairières trop vastes. Une au moins dans chaque triage doit être instituée, sous le contrôle du brigadier et non loin du poste forestier. Un rectangle de quelques ares sera choisi en sol humifère ou sableux alluvionnaire ou silico-argileux.

Elle sera close par des moyens élémentaires: bambous, haies vives ou mieux par des fils de fer barbelés.

Les dimensions à adopter pour les planches sont de 5 à 6 m. de long et 1 m. de diamètre, elles seront séparées par des sentiers de 0 m 30 de largo et le défoncement du terrain sera fait sur 0 m 25 en moyenne.

La méthode à suivre pour ces semis, plantations et précautions pour certaines essences sera réalisée avec le plus grand soin.

c. Installation de prés-bois.—L'association de l'arbre à l'herbe dans le stade sylvo-pastoral me paraît la solution la meilleure à adopter pour les régions d'élevage du sud qui exigent l'entreprise de reforestation.

Des îlots boisés installés serviront à la dissémination et permettront l'évolution progressive en tache d'huile. L'ombre des arbres transforme le sous-bois, le taillis sous futaie s'améliore et le tapis herbacé se transforme favorablement. De plus, le bétail peut s'abriter sous les arbres aux heures chaudes.

Le poirier, l'acajou, le mahogany, le filao, le campêche, l'eucalyptus, le teck, sont les arbres à employer à cette fin.

Utilisation et Interet des Forêts de Rapport

1o. Mode de cession.—Les coupes seront mises en vente de préférence par adjudication publique, exceptionnellement par accord de gré à gré. Le morcellement des ventes sera le mieux indiqué, car il permettra aux petits artisans de les acquérir. Il sera indispensable de marquer les coupes au marteau forestier.

L'exploitation des coupes en régie sera recommandée au début pour donner l'exemple.

2o. Période d'abatage.—Les bois hors-sève sulement seront exploités.

J'ai souvent constaté que les bois sont coupés à n'importe quel moment dans les Antilles. La coupe doit se faire de façon rationnelle:

A la Martinique, il y a deux montées principales de sève par an qui correspondent chacune au printemps végétal: l'une de mars à juin et l'autre en Octobre-novembre.

De juin à octobre, les pluies d'hivernage s'opposent à l'abatage, il reste donc la période de décembre à mars comme meilleure. De plus, au cours de ces mois de carême, la lune descendante sera choisie car c'est le moment qui permet la conservation et surtout la plus grande résistance aux pousses des bois.

3o. Réalisation de la coupe.—On abat à la hache ou a la scie pass-partout. Les arbres sont souvent coupés à 1 m. audessus du sol, même lorsqu'ils possèdent des empâtements. C'est une très mauvaise pratique. On doit couper au ras de terre.

L'arbre doit rester sur le sol isolé par des traverses pendant quelques temps, pour subir une dessication préliminaire.

Lorsqu'un point d'eau est proche, étang, rivière, mare, un dessèvement par flottage, dont il conviendra de déterminer la durée est une excellente réalisation.

Un équarrissage grossier sera fait en forêt, le débitage définitif devant être réalisé en scierie où on soustraira les billes à l'action du sol, de la pluie et du soleil. Les planches et madriers seront empilés dans des hangars bien aérés; au bout de 6 mois à 1 an, suivant les espèces, elles seront convenablement séchées. Il conviendra de noter soigneusement les durées du séchage pour chaque essence.

Les houppiers, taillis dégradés et essences secondaires serviront à la fabrication du charbon de bois. Il y aurait intérêt à remplacer les meules, faites en général par des fours à carboniser, même élémentaires.

Conclusion

La Martinique, bien que ne possédant de la belle forêt native, comme c'est le cas pour la Guadeloupe, abrite encore des lambeaux forestiers dignes d'étude, d'aménagement et d'exploitation rationnelle.

Cette étude a précisément pour objet de montrer comment on peut affectuer cette réalisation et cela avec des moyens relativement modestes adéquats à la superficie réduite de l'île. Le plan d'aménagement ci-dessus exposé prévoit la création, l'entretien, l'amélioration et l'utilisation de la forêt martiniquaise avec la méthode à suivre pour obtenir rapidement les meilleurs résultats.

Cette étude est valable en majeure partie pour toutes les Petites Antilles et une simple adaptation locale permettrait certainement de l'y appliquer avec profit.

Summary

In addition to the protection of the forests, the forester must work out the most practicable management of the areas. The forest areas must first be surveyed and mapped, and subdivided into protection forest and production forest. Preliminary studies on the latter to serve as a basis of management consist of the exact determination of species, determination of growth rates, and evaluation of the standing timber. It is estimated that the 8,000 hectares of public forest land in Martinique will produce 40,000 cubic meters of wood annually.

A network of 400 kilometers of trails has been marked out already which will serve as the basis for future extraction routes. The method of cutting will depend on the forest composition and depending on this composition the method will be selection, coppice with standards or coppice. Through proper cutting and planting from temporary or permanent nurseries, the percentage of valuable species in mixed forest will be increased.

Timber sales will preferably be small for the benefit of the small operator and will be marked by the Forest Service. Cutting should be restricted to the dry season from December to March and proper methods of cutting, extraction and seasoning carried out.

Resumen

Además de la protección de los bosques, el selvicultor debe desarrollar el manejo más práctico del área. Primero debe medirse y localizarse en mapas, y subdividirse en bosques de protección y de producción. El estudio preliminar de las áreas de producción que han de servir de base para tal manejo o administración consisten en la determinación de especies, determinación de la cantidad de crecimiento anual, y la valorización de la madera en pie. Se estima que las 8,000 hectáreas de bosques públicos en Martinica, producirán anualmente alrededor de 40,000 metros cúbicos de madera.

Para facilitar en el futuro la extracción de la madera, se ha trazado una red de caminos como de 400 kilómetros. La composición del bosque es un factor que hay que considerar para determinar el método de corte a seguirse. De acuerdo con la composición del bosque, el método consistirá de selección, tallar con resalvos, o regeneración por renuevos. El por ciento de especies valiosas en un bosque mixto se aumentará notablemente siguiendo un sistema de corte apropiado y de siembras de plántulas procedentes de viveros temporeros o permanentes.

Las ventas de madera deben ser preferiblemente en pequeñas cantidades para beneficio del pequeño traficante y los árboles a cortarse deben ser marcados por algún agente del Servicio de Bosques. Además de limitar el corte a la época de sequía, de diciembre a marzo, métodos apropiados de corte, de extracción y de cura deben emplearse.

AN ISLANDER LOOKS AT THE MAINLAND

C. Swabey
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Travel today for the Britisher is not only a luxury but very nearly an impossibility, so the opportunity of taking a short busman's holiday in British Honduras this spring was welcomed. Added to this, the Forest Department of Honduras had built up for itself a reputation of efficiency particularly in its ecological reconnaissance surveys which promised a most interesting trip. To an islander, accustomed to high densities of population and limited land areas, the extensive forest areas of the mainland seemed doubly attractive.

So in due course I arrived off the low lying capital of Belize, where the shallow water of the anchorage is gradually being silted up and the little mangrove cays are steadily increasing in size. After a day or two in Belize I was packed off on a coasting launch to Stann Creek and passed the five hours of the trip in talking to a mahogany contractor: he had in the early days of the Forest Department resented strongly their restrictions on over-exploitation of mahogany, but he was now a complete convert and his main grouse was that there did not exist similar control on the private concessions. Many of the problems with which the mahogany industry is now faced are due to absolutely uncontrolled cutting on the private forest lands which dominate the more accessible mahogany areas.

After a night in Stann Creek I set off with Assistant Conservator Nelson Smith for the Silk Grass Reserve: for the first few miles we were able to go by car along the old Stann Creek railway line recently converted into a road, and then a ride first through broken Pine Ridge into the Reserve. Here are most interesting experimental areas mainly on mahogany regeneration and improvement fellings (the T.S.I. of the Americans). The artificial establishment of mahogany is complicated by the ravages of the Pyralid shoot borer, Hypsipyla grandella: the most effective control measures, now organized in other Caribbean countries, appear to lie in the provision of a suitable overhead shade. The British Honduras foresters apparently are not over-enthusiastic as to the value of quick-growing second-growth species as shade, as their length of life is not long: it would be interesting to know if the Puerto Rico banana shade for this mahogany is effective in the long run. For how many years, in fact, can Swietenia macrophylla be considered to be in a stage significantly susceptible to Hypsipyla?

From Silk Grass we walked through high forest (Calophyllum, Euterpe, Symphonia, Podocarpus, etc.) over Baboon Hill to a mahogany camp: extraction here is by tractor and 4-wheel trailer to the main camp and by "camión" (truck) and trailer from the main camp to Stann Creek. The use of the rubber-tyred camion, as seen here and on the South Stann Creek, south of Regalia on the Sittee River has opened up considerable areas of mahogany forest previously considered inaccessible. It is amazing the ease with which terrific loads are taken over broken and hilly country on unformed natural earth tracks, while the speed obtained on the more level, sandy pine ridge makes possible a length of haul which a few years ago would have been considered entirely uneconomic.

In a country almost devoid of roads and with over-exploited riverain strips, this form of transport is already showing its value.

A sad feature of the mahogany trade is the wastage of all material except the exceedingly large and high grade logs required for the normal export market.

We saw logs left to rot in the forest, which in Jamaica for instance, would represent practically unattainable perfection. It is argued, possibly quite correctly, that the cost of handling such material for a lower-priced market would be uneconomic: at the same time in all lumbering operations, there is a proportion of lower grade output which is not intended to produce cash profits, but merely to distribute overhead charges on the principal commodity. When shipping conditions return to normal, perhaps the possibility of a local West Indian trade might be considered. The same applies to the pine forests: the stuff is small but much of it is of very high grade, of a type that disappeared from the West Indian markets many years ago. These Pinus caribaea forests are open and understocked, while careful fire protection is necessary to ensure adequate regeneration: irregular seed years also appear to complicate the problem, while saw-mill outfits unsuitable to the local conditions have created a certain amount of distrust as to the economics of the venture.

I was lucky enough to get an unusual chance to see something of the uninhabited Maya Mountains towards the south: I had flown up to Cayo on what appeared to be a thoroughly inadequate little TACA plane with a pilot who had never flown there before, while the Cayo landing field was heavily populated by cows, goats and humans. My misgivings were allayed by a perfect landing and a cold beer miraculously provided by Mrs. Kinloch, who with her husband Assistant Conservator, had built an altogether charming house at Cayo. The use of heavy local woods gave a beautiful and airy home which I have not seen bettered in a longer trip back to Belize over the Maya Mountains. So we hurried south from Cayo skirting the mountain pine ridge and gradually leaving behind the tortuous "truck passes" (logging trails): as we flew over those rugged mountains, we could pick out the bright foliage of the mahogany trees as they were turning their leaves, but apart from a wild yellow flowered Tabebuia (?) my knowledge was not sufficient to spot much more. We turned round the flanks of the jagged Cockscomb mountains, which dominate this section of the country and flew back over Stann Creek and the coastal plains, thousands of acres of lagoon and burnt over scrub land and open pine forest.

Among other extremely interesting trips was a visit along the only real road in the Colony to the Rio Hindo on the Mexican border and a three day camping trip with Conservator Stevenson and Nelson Smith from Stann Creek on the old Cayo trail: the latter gave an indication of the arduous conditions which the Forest Department meets in its reconnaissance survey work.

Resumen

Este artículo trata de las impresiones de un silvicultor de una de las islas del Caribe en su primera visita a la Honduras Británica. Un viaje en lancha ofreció la oportunidad de hablar con un contratista en caoba, quien al principio se oponía tenazmente a la reglamentación del corte, pero que ahora

ha cambiado de opinión y cree que las mismas regulaciones que existen en los bosques del gobierno deben aplicarse a tenencias privadas y concesiones.

El trabajo de experimentación en Honduras Británica ha sido mayormente sobre cortas de mejora. El establecimiento artificial de la caoba se ha complicado con los estragos del taladrador del tallo, Hypsipyla grandella. Las medidas de combate más efectivas parecen ser la provisión de sombra alta apropiada.

El uso del camión con ruedas de goma ha facilitado el corte y transporte de caoba y ha abierto grandes áreas que antes se consideraban inaccesibles.

Lo que más impresiona al silvicultor visitante en la explotación de la caoba y el pino es el desperdicio de todo el material, excepto los troncos grandes y de primera calidad apropiados para la exportación. Para eliminar este método disipador, él recomienda el establecimiento de un mercado antillano. Los pinares son abiertos y poco poblados. Para asegurar la regeneración del pino se necesita protección contra incendios. La producción irregular de semilla complica más el problema.

International Forestry Centre

Prof. Dr. Dr. Köstler, Director of the International Forestry Centre, has been nominated corresponding member of the Finnish Forestry Society.

El Centro Internacional de Selvicultura

El Profesor Dr. Dr. Köstler, Director del Centro Internacional de Selvicultura, ha sido nombrado como miembro correspondiente por la Sociedad Forestal de Finlandia.

NOTES ON SOME FOREST INSECTS FOUND IN PINUS OCCIDENTALIS SWARTZ NEAR JARABACOA, DOMINICAN REPUBLIC

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Although the topography and climate of Puerto Rico and the Dominican Republic, which are separated by scarcely 80 miles of open water, are roughly similar, no conifers are native to Puerto Rico, while both Pinus occidentalis and Juniperus barbadensis L. are indigenous to Hispaniola (the Dominican Republic and Haiti.) Large stands of the former species are found in several areas in the mountains.

Pinus occidentalis, which is the only representative of the genus in Hispaniola, is of considerable economic importance on the island as a source of cheap lumber. Because nothing was known of the role played by forest insects in the economy of this species, a few days were spent in June 1940 near Jarabacoa, Dominican Republic, in making observations on forest insects in an area that was being logged. A few records on other insects are included in the observations recorded below because of their general scientific interest.

In the logging chance examined, no provisions were made for the disposal of slash, and cull logs and tops were everywhere abundant. In spite of the debris left, there was no indication that bark beetles were breeding up in the slash and attacking standing trees. Three species of Ips were collected, of which Ips interstitialis (Eichh.) was the most common in cull logs and stumps. A Gnathotrichus, very close to G. materiarius (Fitch), and Xyleborus affinus Eichh. were also found attacking stumps and cull logs. Ips grandicollis (Eichh.) and I. cribricollis (Eichh.) were generally found in the drier portion of the larger limbs and tops.

At the time of examination the Ips were in all stages of development, with the callow adult stage perhaps the predominating one.

The following annotated list gives the data on the insects collected from Pinus occidentalis. All determinations were made by specialists of the United States National Museum.

COLEOPTERA

Scolytidae

Hylastes pusillus Blackman. A single specimen was collected from under the bark of a cull log. The insect is a secondary, attacking only injured or recently killed trees.

Ips interstitialis (Eichh.). This was the most common Ips in the area. It was found in stumps and cull logs in all stages of development. Bluestain was abundant in the logs where these beetles were observed. The adult makes radiate galleries about 8 inches long. The galleries that extend along the

grain from the nuptial chamber are the longest. Usually there are three of these galleries, one extending in one direction and two in the opposite direction, with one, two, or three short galleries extending out from the nuptial chamber at more or less right angles to the longest galleries. The larvae apparently feed almost gregariously, and pupation occurs both between the wood and the bark and in the bark.

Ips cribricollis (Eichh.).

Ips grandicollis (Eichh.). A few specimens of these two species were collected from tops. A few others were taken in conjunction with I. interstitialis.

Pityophthorus, probably new species. This small black species was collected only from slash and from dead twigs on green trees.

Pityophthorus near bisulcatus Eichh. This was the more common of the two species collected. It was found in dead twigs on green trees, but as far as could be determined they did not cause the death of the twigs.

Xyleborus affinis Eichh.

Gnathotrichus very near materiarius (Fitch). These two ambrosia beetles were quite common attacking green stumps and recently felled logs.

Ambrosiodmus lecontei Hopk. A single specimen was collected boring into a large log.

Curculionidae

Pissodes, probably new species. Two adults were collected at the base of a freshly cut stump.

Cossonus near impressus Boh. This was a very common insect in the galleries of Ips interstitialis and under the slightly loosened bark at the cut surface of stumps.

Buprestidae

Chrysobothris chlorosticta Thoms. Two adults were observed on freshly cut limbs.

Cerambycidae

Parandra laevis Latr. Two adults were collected on the under side of a cull log.

Colydiidae

Bitoma longior Grouv. A single adult was collected from an Ips interstitialis gallery.

Lasconotus pusillus Lec. Adults were collected from the galleries of Ips interstitialis and from under the loosened edges of bark with Cossonus.

Cucujidae

Narthecius sp. A single adult was collected from an egg gallery of Pityophthorus near bisulcatus.

Monotomidae

Europs naculatus Grouv. A single adult was collected from the gallery of Ips cribricollis.

HYMENOPTERA

Pteromalidae

Cecidostiba sp. This was a fairly common species parasitizing the larvae of Ips. Only one adult was collected in the field. Larvae collected pupated shortly afterward, and transformation to the adult stage occurred within a month.

Pachyceras eccoptogastri Ratz. This widely distributed parasite was collected on the bark of a top infested with Ips.

Bethylidae

A single adult, close to Plastonoxus, was collected from the gallery of Pityophthorus near bisulcatus.

DIPTERA

Dolichopodidae

Medetera. Larvae that are almost certainly of this genus were collected in the larval galleries of all three species of Ips listed here.

The following insects are not associated with Pinus occidentalis but were collected in the pine area.

DERMAPTERA

Labiidae

Prolabia unidentata (Beauv.).

HOMOPTERA

Cicadidae

Odopoea cariboea Uhl.

HEMIPTERA

Coreidae

Hymeniphera crucifer (P.B.)

Reduviidae

Heza pulchripes Stäl
Leogorrus myrmecodes (H.S.)

COLEOPTERA

Oedemeridae

Oxacis sp. New to the United States National Museum collection.

Tenebrionidae

Pyanisia undata (F.)

Monommatidae

Hyporhagus sp.

Curculionidae

Mesocordylus, probably new species.

HYMENOPTERA

Formicidae

Camponotus (Myrmeurynota) saussurei Forel
Macromischa sp.
Cryptocerus sp.
Pheidole sp.

DIPTERA

Micropezidae

Micropeza sp.

Chloropidae

Hippelates sp.

Resumen

El autor relata en este artículo, sus impresiones sobre la visita que hiciera durante varios días a un pinar de Pinus occidentalis que estaba siendo explotado en Jarabacoa, República Dominicana en junio del 1940. A pesar de que no destruían la broza, los troncos rechazados o inferiores, y las ramas, no había evidencia alguna de que coleópteros descortezadores estuvieran multiplicándose en la broza o atacando al resto de los árboles. Se incluye una lista de los insectos coleccionados en Pinus occidentalis. Las determinaciones de los mismos fueron hechas por especialistas del Museo Nacional de Estados Unidos.

FOREWORD

At the beginning of the new year this number finds us and many other countries of the tropics involved in or vitally affected by war, so that now there is a greater need for collaboration and mutual help than ever before.

Wood is a vital war material and the emergency may force many countries previously importing wood products to the exploitation of their own forests. Such resources will help to win the war but to win the peace we must see that war production is carried on so that these valuable resources will be preserved for future generations. Both objectives can be accomplished by the practice of forestry.

We have been advised by Washington that the work of the Tropical Forest Experiment Station is to continue and that we should make every effort to serve and assist our friends and neighbors in Tropical America in those forestry problems which undoubtedly will be occasioned by the greater demand on local sources of supply. We will carry out these instructions to the best of our ability.

One of the unfortunate consequences of this conflict will probably be the temporary disappearance of such excellent publications as "The Philippine Journal of Forestry" and "The Malayan Forester." These are difficult gaps to fill and we do not claim ability to do so, however, we will be stimulated to a greater effort so that tropical forestry does not lack suitable channels of expression. We count as usual on your cooperation and encouragement.- - - - ARTHUR BEVAN, Tropical Forest Experiment Station.

cOo

Este primer número del año nos encuentra junto a otros países del Caribe, envueltos en o afectados por la guerra; de manera que hay ahora mayor necesidad de colaboración y ayuda mutua.

La madera es un material vital en la guerra por lo cual esta emergencia podría forzar a muchos países importadores a explotar sus propios recursos forestales. Tales recursos ayudarán a ganar la guerra pero para triunfar en la paz debemos asegurarnos que la explotación se haga ahora de modo que dicha riqueza pueda preservarse para el uso del futuro.

Desde Washington se nos ha hecho saber que esta Estación continuará sus labores ayudando en todo lo posible a los países amigos en la América tropical a resolver problemas que seguramente surgirán debido a la utilización de los recursos locales.

Lamentable consecuencia de esta guerra será probablemente la desaparición temporera de excelentes publicaciones como el "Philippine Journal of Forestry" y el "Malayan Forester." Será difícil llenar este hueco y no pretendemos poder hacerlo, sin embargo, esto nos estimulará hacia un esfuerzo máximo para que la silvicultura tropical no carezca de medios adecuados de expresión. Contamos con vuestro aliento y cooperación.- - - - ARTHUR BEVAN, Tropical Forest Experiment Station.

CONTENTS

ISN'T RESEARCH FUN

Willis R. Whitney, Vice-President
General Electric Company
Schenectady, New York

Last February, while tramping along the West Bay Road leading from Nassau, Bahamas, to the Golf Club, we found a tree which had very peculiar, large holes through its bark. They were approximately round and varied from about 1-1/2 to 2 inches in diameter. Over most of these holes were still attached the original bark coverings, nearly 1/4 inch thick. These reminded one of refrigerator doors, owing to their well-fitting beveled edges. But they seemed to be hung, in most cases, by a very thin outer-bark "hinge." This was not at the top, nor at the extreme sides of the "door," but at points corresponding to 10 or 2 o'clock. This may well have been accidental, but it aroused additional wonder. Thus hung, the doors might be easily opened from within and yet tend all the time to lightly close of themselves, while the whole weight of the door did not act to close as it would if hung at 12, nor be entirely useless, as if hung at 6. Some closing force existed which would not be present if the door were hung from 3 or 9 o'clock. This is mentioned just to show what fun it is to follow some hypothesis in pure research—even an erroneous one. Automatically, we at once spoke of these as "trap-doors." Behind each door (there were scores of doors on the single tree) was a hole nearly 1/4 inch in diameter which passed deep into the wood. So we imagined some large bug or insect which perhaps first cut through the thick bark, opened the door thus made, (leaving it nicely hanging by its thin hinge) laid an egg behind it, closed it, and went away. This would be like the act of the mother-turtle which, in the spring, plants her seed in the soil, and does not return until the next planting season, letting Nature take her course. The closed doors would defeat the birds to whom egg, grub, etc. might be good food; and yet at the proper time, the large full-grown "bug" might easily open the door and free itself. We "figgered" that there would be no sense in having a two-inch door for any smaller "bug", so our unseen friend was already about two inches over all. This was all pure fun and highly speculative. It started just as much random research as pure science starts. It was also quite unnecessary on the whole, but it seemed capable of yielding to wishful thinking and susceptible to external pressure. Thus, we were enjoying purely unprofessional, amateur, happy research. So why hesitate?

We also noticed that our particular tree was dead, but had been alive not very long before. Its tops were covered by a close-growing vine, still alive, so this might have killed the tree instead of any "bug" executioner. Naturally we searched for other such trees, and while we found hundreds of the same species, none had any of our "doors" upon it. One very old log in the woods, which the termites had nearly consumed, showed signs of having had two such doors on it. So our "bug" was apparently not common. Our good friend, Dr. C. G. MacMullen, made a close-up photograph of the tree[1] and gave us many copies. Thus we were in shape to "go places" at least by mail. We began in a modest way by writing much too long letters to such promising people as had listed entomological hobbies in that helpful Sigma XI "Who's Who." The harder we worked the more fun we found. We had no idea that so many different animals

1/ Illustrated on page 57 as drawn under the direction of Dr. G. N. Wolcott.

could be "suspect." Snails, lizards, bees, birds, caterpillars, etc. were said to be capable of doing such things, but no one knew that any had ever done them. Trap-door spiders were innocent, we were told. Our use of that word "trap-door" was surely amateurish and wrong. In fact we seem to have been the only person connected with this study who was not strictly scientific all the time. So we owe much to many scientific friends.

We soon felt that Gilbert White was right when he wrote in "Selborne" - "It is, I find, in zoology as it is in botany: all nature is so full that that district produces the greatest variety which is most examined." Our doctor-friend says this is equally true of the field of medicine and I am sure it applies to electricity and chemistry.

Anyone who has watched a new-born golden-rod-gall-fly force its way out through the lace curtain of the gall (concealing the larva from the birds) by hydraulically filling and pushing through the opening that white rubber balloon attached to its pupal head, is prepared to appreciate almost any well-ordered natural complexity. The fact that the Gold-finch does not know that this juicy morsel lies just back of the curtained window of the gall, forces that bird to patiently peck a new hole to it through the thick walls of the dried, wintered gall. The bluejay knows of the curtained window, but cannot see it, so he opens his beak and tests for it by jabbing pairs of tiny pricks all over the gall until he strikes the hole. Then he easily extracts the grub through it. So it was not hard to visualize natural complexity in our "trap-doors" which covered and concealed some "bug" as large as a silver dollar. And it was all new to us and fun, too.

Our first effort was that of stopping a native and asking him about the tree. He called it a "Gimbo-limbo" but had never seen the "doors" before. So we consulted that friendly naturalist, Dr. Sumner Dolley, of Nassau. He was much interested and gave us the name of the tree, "Gum Eleme." He also started our long list of correspondents. We think he is as highly allergic to factual novelty as anyone whom we know. As we failed, after much searching, to find any other tree with such "holes," it intrigued us almost painfully—sometimes ignorance is like that. A native of Long Island of the Bahamas, whom we consulted, had seen the "bee" (as he called it) on his home island; and he seemed to confirm our brightest suspicions. The following is a letter which he later wrote in reply to our efforts to find other such trees. No one could ask for a happier confirmation of our wishful thinking. "And yet we say that romance is dead," our Dr. says.

> "Now Dr. Whitney in regard to this piece of wood. Since I have been home I have been looking around and I know that I can get the wood with the (bug) or without, but sir I have also found out that I can't ship such wood with or without the (bug) unless you make arrangements with the U. S. Government and also inform the Bahamas Government and then I will be able to ship this piece of wood to you.
>
> "As you know the U. S. Government won't allow any wood with insects into the U. S. because of insect pests. However Dr. this elema wood is a kind of soft nature after it is dead. Therefore this bug augers or cuts this trap-door into this wood, after getting into this wood it forms something like a room, then carries its food into one of these small rooms and

stores it away. Thru another portion of this hole he or she lays eggs, after laying these eggs the bug goes back and closes the hole or trap-door and stays in there until the young ones are hatched. After this the bigger bug comes out and closes the door again, leaving enough food in there to support the baby bugs until they are old enough to come out. Then the mother bee opens the door again to let the young one out. That is about as much as I can help you now and if it is impossible for this wood to be shipped to you, when I leave to come to the Hotel again, I will bring a piece along with me. Hoping to hear from you again, Your friend, L. J. Darville."

We had about decided to write to kindly Dr. John W. Dye, American Consul at Nassau, asking him to contact the Governor of the Bahamas to see if our particular tree could not be cut down and officially shipped to us for American entomologists to study. But we postponed it.

Among the friends we imposed upon, was Mr. Henry Howard of Newport, R.I. In his motored ketch "Alice" he has for years voyaged among the West Indies and, together with Mrs. Howard, written illustrated articles for the "National Geographic." We had voyaged with him from Nassau to Spanish Wells ourself. He must at least have met people who knew about our "bug." So we wrote to him and included a photo.

From his reply of June 14, we extract a part:

"I turned it (the letter) over to Dr. Gilbert Grosvenor and he and his friends have had a lot of fun with it. I am enclosing his letter of June 5, a report made to him by Mr. 'X' and letters from three prominent entomologists."

We might expand this record by including all the above and many other related letters; but lack of space suggested abstracting. Our last thought would be to expose specific ignorance of this unusual subject on anyone's part. We feel embarrassed because we bothered so many experts. But there is more pleasure in the process of research than in its product. We made new friends too, so we repeat our thanks for all efforts. We add the confession that if every scientist (or even any) in Washington, had known the answer, we should have been chagrined but not surprised. None of them did. The following is part of Dr. Grosvenor's letter to Mr. Howard:

"I detailed Mr. X of the staff to investigate the problem. He is a very capable person with special scientific interest. He has devoted days in his effort to track down this mystery. I enclose his report. You will note that the entomologists in Washington consulted (several of them are members of the Nat. Acad. of Science i.e. Y, Z,) are unanimous that it will be necessary to obtain specimens of these trap-doors if the secret of their origin is to be solved."

Here was additional ground for writing to the former King of England for the help which it seemed only he, plus the American Consul, could supply. Authority to cut down that tree and get it ("buggy"), or not, into these United States was surely indicated. But a peculiar reserve of scientists stood in our way. So we kept on calling all entomologists. Practically each of them

modestly did his best, cheered us a lot, made suggestions, and finally told of other experts who might help us.

Apparently our careless use of the words "trap-door" sent most of them searching in the wrong parts of the indexes. But all, with one accord, asked to be told the whole story, whenever it was learned. Therefore we are now enjoying this writing of a letter.

For many years we had revered the genial Dr. Y, Acad. of Science, of Washington, referred to by Dr. Grosvenor, and long years ago had tried to tell him about a certain microscopic "blood-sucker" which lived in the waters of horse-hoof pools in our woods, and which eviscerated mosquito larvae for a living. So this report is written in part in hope that he will get some pleasure out of it too. He is the real dean of entomologists and for ages was a revered saint of the Cosmos Club. Long may he live.

The following is taken out of a good letter from the Connecticut Agricultural Experiment Station:

> "I should imagine anything as striking as these trap-doors would attract the attention of biologists and certainly someone ought to know about it. But who it is I cannot suggest. We do have up here twig-girdling beetles which behave in the following manner. The egg is laid on the surface of the bark of the twig. A young larva hatches from the egg and drills through the bark to feed on the cambium layer. This it does in a circular direction around the twig. Only when the insect is preparing to leave does it cut through the thin bark over the areas fed upon. By an extension of the imagination it is conceivable that your door might be formed in a comparable manner. Moreover there are many species of long-horned beetles, some of large size, in the West Indies. In the door which you sent me there is a small hole through which a young larva might have bored after hatching from an egg deposited on the surface of the bark. Also in the photograph, a hole appears in the center of each area covered by the door."

This was a promising line of thought and it fits well into the final picture. Thanks a lot!

One of our friends to whom the "bug" story was told, but who joyfully attributed it to the local hot weather or our customary accuracy, later helped the fun by consulting many Philadelphia zoologists. From one of his friendly early letters we take:

> "I protest against being called a 'doubting friend.' After all, I am always interested in your observations in the line of natural science. Of course, the story of that marvelous insect that not only bores into the bark of the tree, but arranges a door-hinge in a wonderful way so as to swing shut without effort, is remarkable. And it is a friendly gesture to demand proofs."

I recall now that I had once tried to educate him in the hypothesis that because of the solubility of cholesterol in alcohol and the fact that circulation-

obstructing-atheroma in our arteries contain this fat, and by reacting with lime in the blood, "calcification" resulting in arterial sclerosis could occur, therefore, mature folk should try internal alcohol experiments on themselves. So proof was in his mind.

The following is from one of my doubting friend's friends' letters:

"The mystery of the holes in the gum trees at Nassau is still unsolved. I had left the photo with Mr. R., Mr. P. and others, who are much interested but could be of no help. He then waited for the return of Mr. B. from Haiti and showed it to him also. The opinion of Mr. B. (an authority on birds) will rule out avian origin."

That reminds me of an examination in English which I lived through before entering Boston Tech. Here we are still on a mixed bee and bird trail. A sentence in that old examination to be corrected read: "Being fond of bees, he had an aviary in his garden." One never gets far enough ahead so as to cut connection with the past. If in '86 I had not substituted "apiary" for "aviary", I might never have been able to visit Nassau. My doctor-friend is reminded of the man who, when invited to visit his friend's apiary, declined because he didn't like monkeys.

Also as part of the above I add, "Mr. B. of our own laboratory, who has collected snails in the Bahamas, tells me that he has never seen these gum-tree holes, and does not know what produces them. He is sure they are not the work of snails at any rate."

Now "doubting friend" accepts the holes and sends us a letter containing the following:

"Mr. B. has just returned from Haiti and I have been able to show him the photo. He has never seen work of the character shown in the photo and is quite unable to suggest a possible explanation. The only species of woodpecker found in the Bahamas, he tells me, is our well-known yellow bellied sap-sucker."

But trusting "doubting-friend" also sent a long letter from the University of Pennsylvania. This helped the joy along and is, as in all such kindly cases, an actual contribution from science. Sorry to shorten it a bit:

"At last I think I have made some progress towards discovery of the hole-maker in the gum-trees. Nycterobius.—The caterpillar gathers leaves during the night and stores them in its cavity, to be eaten the ensuing day. In looking up the name, Nycterobius, I found that it is not a now valid name except for a moth of a very different family.—The similarity of habit leads me to suspect very strongly that the cavities in the gum-trees at Nassau are caused by the caterpillars of a moth of the same family as Nycterobius of McL's letter. This family is known by two names: Cryptophasidae or Xyloryctidae."

This letter also contains these words: "All to whom I showed the picture were interested and most of them insisted that I tell them what I learn of the agent that produces these cavities." So we try to help.

If at this stage, we could honestly have written our "doubting" friend that our whole story was a hoax, it would have satisfied all the indicated requirements. But science isn't like that, and we had to work along with Nature. Besides, we don't yet know how to make such "trap-doors" in a tree-bark dead or alive, even with a band-saw. We were getting more and more convinced that our duty to science called us to spend longer winter seasons in the delightful climate of Nassau. We wanted to pre-empt this entomological field of research, a fine ground for real attainment and active retirement.

We were especially encouraged by the following words. This is one of the foremost entomologists of the country:

> "Mr. Whitney and you have me puzzled. If the boy said that the hole was made 'by a large black bee,' I would be inclined to believe him. We are not entirely familiar with all the habits of the tropical Xyloxopa and as the case now stands, the boy is the only one who claims to be an eye-witness. Even in that case, I would be inclined to doubt the part about the mother-bee coming back to open the nest so that the baby bee could get out. However, that would be merely a simple mistake of interpretation. On the other hand, except that the boy said it was 'a large black bee' I would like your beetle explanation."

We had the same feeling about that "bee" coming back to open the door and so preferred the idea of a door so lightly hinged that any child-bee could open it. But we have so often noticed that the open eyes of the unprejudiced child seem better tools than those of us "who know what to look for," that this letter pleased us. Moreover we can never forget our surprise on noting that a boy in our porcelain factory could tell when the clay "mix" was right for molding, by merely feeling of it, when we could scarcely do as much by a complete quantitative chemical analysis. But really the boy was right. He'd had experience.

We don't intend repeating all our letters and giving all the evidence, for we like our way better. Of writing, Ben Franklin once wrote: "to be good, it ought to have a tendency to benefit the reader, by improving his virtue or his knowledge.--- Nothing should be expressed in two words that can be well expressed in one, that is, no synonyms should be used, or very rarely" etc. So even as for the scientific names of many of our good entomologists, we use them rarely. Though in the end we must add to knowledge locally the name of the real "bug,"

> "It is a very noisy insect, squeaking and chirping, even when not disturbed, and possibly is responsible for a 'singing tree' of acacia, Acacia farnesiana, reported to me a few weeks ago." (From a letter of George N. Wolcott of Puerto Rico.)

But to return to chronological order, I quote the following from Dr. Grosvenor to Henry Howard:

> "I have taken the liberty of making copies of the photos and of Dr. Whitney's letter to you.--- Please advise me when you solve it as everyone here has been much intrigued by it."

So it is time now to thank Dr. Grosvenor for his kindness. This we all

appreciate. Without his contribution, perhaps our inquisitiveness would have died out, but the fun in the unknown and a feeling that we must live to thank all and explain things generally to contributors, has kept us in motion.

Our "life-saver" was Dr. George N. Wolcott of the Agricultural Experiment Station of Puerto Rico. We have several fine long letters from him and feel that he has the right knowledge and the humorous powers of a thorough entomologist. So we quote first from one of his later letters, just to clarify things before "digging in."

> "This is to acknowledge receipt, etc.--- also the very interesting letter of your collaborator, Mr. Darville. What he has to say is entirely correct, especially as to the difficulty of sending wood to you infested with living insects. Most unfortunately, however, he is writing about two other insects, neither one of which is concerned with the injuries in which you are interested. Only social insects, such as the honey-bee, termites and paper-nest wasps, return to the nest and feed the young, as he describes."

We were getting warm. Dr. Dale of Union College and Dr. Beard, Assistant Entomologist at Connecticut Agricultural Experiment Station had suggested or had written to Dr. Wolcott. From one of Dr. Beard's letters from Dr. Wolcott I extract:

> "I still cannot tell you what does make the hole. Dr. P. to whom I showed the door, assures me that it definitely is not the work of a wood-inhabiting trap-door spider, and although he has spent considerable time in the tropics, he has never seen anything like it. Also the door is quite certainly not the work of a carpenter bee. Judging by the appearance of the cut surface of the door, I should think that it was made by the emerging insect, rather than by the adult insect which went there to deposit an egg. It would seem possible that an insect, perhaps a beetle, could deposit an egg in a small hole in the bark of the tree. The larva which hatches from the egg then might feed on the wood and eventually cut out the circular 'door' through which it could escape."

From a letter of Dr. Wolcott, to Mr. Baird, May 17, we extract:

> "Trap-door and tree. Something very similar is often noted in trees of the West Indian Birch, or 'almacigo' Bursera simaruba in southern Puerto Rico, but as almacigo is an almost worthless tree, I have never paid much attention to the phenomenon except to consider it caused by some Cerambycid beetle.--- Mr. M. who is working on forest entomology, was going to the south coast this week, so I asked him to make a special search for the injury, but he reported only a few old specimens. Possibly my idea that it is caused by a Cerambycid is incorrect, for we seem to have reared all the more common species in Puerto Rico, and not one of them produces an injury at all like that in almacigo.
>
> "I shall make a special point of looking for this type of injury before the adult has emerged, as opportunity offers, but it may be some time before it is possible to report anything definite".

As an "aside" at this point, we wish all sorts of research work might get along as rapidly and well and as interestingly to us as that on our play-time "bug."

The following is from a letter of Dr. Wolcott to Dr. Beard of May 27:

> "While on a trip along the north coast of Puerto Rico with Mr. M. last week, I noted an almacigo tree near Camuy, part of which had been cut down. Upon closer inspection, the typical injury described by Mr. Whitney was noted on the dead part of the tree, and on cutting into some of the other parts of the tree, Cerambycid larvae and pupae were found several inches below the bark. It would appear that the chamber just under the bark is built by the adult in which to rest until its wings are hardened.2/ At the time of collection we could not be sure of the identity of the larvae and pupae, but last night an adult emerged. It is Lagochirus araeniformis L. etc."

We are very thankful for several recent letters direct from Dr. Wolcott. As we want to be informative, we quote rather fully. The only way to really appreciate such detailed facts would be to first go through the months of inquisitive anxiety or interest which we experienced in preparation for it. But isn't that just like most research too? Again we say in different words; It is often not the absolute value of a new-found product that counts, but it is the process by which it is found. We always continue beyond the acquired product by new processes, anyway. We seem to like mental motion.

Parts of his letter of June 12 are given below. He had enclosed a cut from a Journal of the University of Puerto Rico and now sends a beetle specimen itself.

> "Eight specimens have emerged from a single West Indian birch (or almacigo) log since we brought it in to the laboratory, and nothing else, thus I presume it to be the insect responsible----- In reading over what I've written, I'm not sure that even yet the explanation is clear. It is like one of those adventures in which Dr. Watson explains to Sherlock

2/ Editor's Note: Dr. Wolcott and Mr. Martorell now inform me that they were in error as to the stage of the insect using this chamber. In the original log, one pupa was found in the heartwood, and several almost fully-grown larvae in the chambers under the bark. On the basis of what ought to be, instead of what was actually observed, it was thought that the location of this pupa was exceptional, and that it should have occurred in a chamber. Later rearings have shown that its location was typical. Thus the chamber is not for pupation, despite the fact that fully-grown larvae are found in them. Apparently the larvae are able to grow on the nourishment derived from almacigo heartwood, but for the changes involved in pupation and transformation to adult, nutrients present in greater amount in the sapwood and cambium of the tree are required. In the quiet of the laboratory, one can hear the larvae chewing just beneath the bark and note exactly its location. But a day or two later, the "trap-door" begins to crack loose, and nothing is present in the deserted chamber but the hole back into the center of the log where pupation will occur. The intriguing chamber is only a feeding cavity and nothing else.

Holmes what he has seen and what he thinks to be the clues, to which Holmes replies by indicating that his companion hasn't even noticed the evidence of importance, which all points to an entirely different explanation. Possibly I should do the same.

1. The female beetle lays her eggs under the bark of a tree.
2. The larvae hatch and burrow into the heartwood of the tree, continuing to eat and burrow until they approach full size.
3. Each larva now burrows towards the outside of the tree and just under the thin bark constructs a large and extensive chamber in which to transform to pupa and adult.
4. The adult pushes aside the thin bark covering over its chamber, and flies off in search of a mate.
5. The female lays her eggs under the bark of a previously uninjured tree, and starts another life-history cycle."

From his letter of June 25, I extract the following:

"Concerning Cerambycid beetles, I can find not one of economic importance in the United States which has a life-history exactly similar to that of the insect in which you are interested; but that you may get a general idea of how the insect lives, I'm enclosing a publication of the Bureau of Entomology on 'The Southern Pine Sawyer,' which may prove of interest. Its larva does not prepare a pupal chamber just under the bark, but many kinds of larvae do exactly that, especially boring caterpillars, so that the adult moth will have little difficulty in escaping to the outside. You might call the 'trap-door' and 'emergence flap;' and the caterpillar or beetle larva is very careful to make the edges just thick enough so that they will not break, and just thin enough so that the emerging adult has no difficulty in breaking through to the outside when it is ready."

Still wondering whether the larva used a saw or depended on the drying and cracking of the bark cover of its nest thereunder, for the opening or cutting process, we bothered Dr. Wolcott again to ask about the "saw." The "flap" edges seemed altogether too smoothly cut to be anything cruder than the work of some tiny saw. Was there one on the larva anywhere?

Dr. Wolcott's reply of July 5 contains much for use but we quote in part only:

"The emergence flap is cut by the larva and not by the mother insect--- It has powerful jaws for eating wood, and while its tolerance for bark-thickness is hardly that of an airplane mechanic, yet it is sufficiently exact so that in most cases it works out just right. That is the Darwinian theory of natural selection exemplified; the larvae which cut the emergence-flap just right survive and leave numerous progeny, while those which cut to the outside, or leave too thick a flap, by just that much, fail to survive, that is, if the character of the flap is vital to the survival of the insect.-----
Up to now, my observations on the almacigo log have shown nothing exciting; new to me, but today I found my assistant chopping up the log, from which he eventually recovered six predaceous wire-worm larvae

and none of the Cerambycid larvae that had originally made all the tunnels through the trunk and under the bark. The native predaceous wire-worm, Pyrophorus luminosus, lives in the ground and feeds on white grubs, and seems to take delight in killing for killings sake, but grows up to be a harmless click-beetle, with two luminous spots above (a miniature Ford before there were any Fords) that is a delight of all children. Even the larvae and pupae are luminous, when disturbed, but those found today in the almacigo log were not. Thus I presume them to be a recent immigrant from Santo Domingo Chalcolepidius silbermanni, of which we knew practically nothing before, not even the specialists."

Unlike this letter, research never need be ended. We are still interested in novelties of our "bug" friend. We gladly accept the conclusion of Dr. Wolcott, that the "emergence-flaps" were cut by the wise larvae of a Cerambycid beetle called "Lagochirus araeniformis L." 3/ We are glad that the discovery of the unexpected and predaceous wire-worm seemed exciting, but particularly, that it did not raise any question of a symbiosis, or the possible use of wire-worms to cut out the "doors."

And now we stop bothering entomologists, and again express our appreciation for the pleasure and excitement which we on our part have experienced.

Postcript.--If additional data were necessary to illustrate the fact that research is seldom completed, we might continue our summary indefinitely. After we thought that our story was complete and copies had been made, a good letter came from Dr. Dolley of Nassau, Bahamas. A very relevant quotation from it is the following:

"Now as regards the Gum Elemi tree: I wrote to the Board of Public Works for authority to cut down the tree that I might saw it up and try to ascertain the cause of the trap-door borings. They replied that they would cut the tree down and burn it, which in spite of my remonstrances and the help of George Murphy they proceeded to do, and I was given no chance to find any larvae or other evidence as to the insect that cut the trap-doors. It was a great relief, therefore, when your letter advised me that Prof. Wolcott had been able to identify the insect, and I await with interest the final account you are preparing."

3/ Illustrated on page 57 as drawn under the direction of Dr. G. N. Wolcott

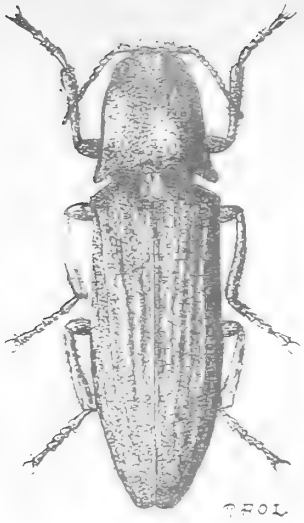

Fig. 1—Adult Chalcolepidius silbermanni Chevrolat.

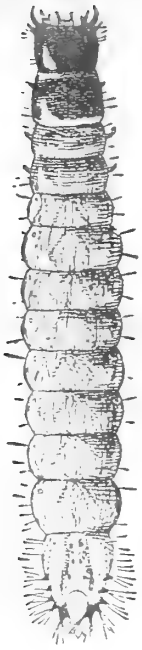

Fig. 2—Larva of "cucubano" Pyrophorus luminosus Illiger predaceous on white grubs.

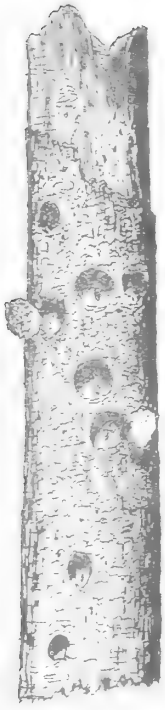

Fig. 3—Log of "almácigo" Bursera simaruba showing exit holes of Lagochirus.

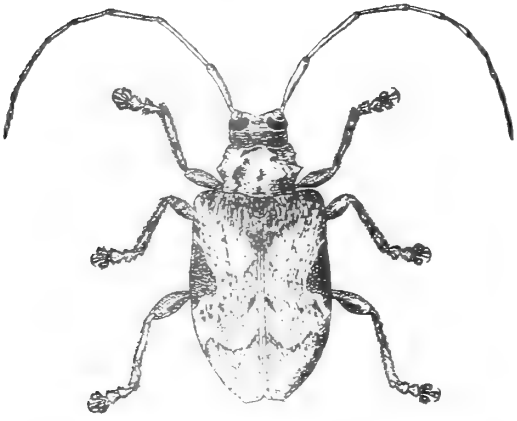

Fig. 4—Adult Lagochirus araneiformis L.

THE ACCIDENTAL INTRODUCTION OF A BENEFICIAL INSECT INTO PUERTO RICO

George N. Wolcott, Entomologist
Luis F. Martorell, Asst. Entomologist
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Travelers' tall tales, even when supplemented by photographic evidence, are subject to suspicion, but when investigated may lead to the most surprising conclusions. As a case in point, the requested explanation of deep oval chambers as large as two and a half inches long and an inch and a half wide in the bark of trees in Nassau, Bahama Islands, with a so-called "trap-door" of outerbark, necessitated the investigation of the cause of similar cavities in the bark of "almacigo" or West Indian Birch, Bursera simaruba L. The almacigo is an almost worthless tree. Consequently, the professional foresters had never thought to request information regarding any of its insect pests from entomologists, and no entomologist had thought to investigate the cause of these oval cavities in its bark. A log from Camuy, with typical pupal chambers and emergences flap "trap-doors", contained numerous cerambycid larvae and pupae, which on rearing proved to be Lagochirus araeniformis L. Thus the primary inquiry was answered, but chopping up the log several weeks after the last cerambycid beetle had emerged, half a dozen large elaterid larvae were found living in the tunnels of the cerambycid larvae, and presumably predaceous on their previous inhabitants. Some of the elaterid larvae were as large as fully-grown cucubano larvae, and on comparing them with a drawing of the cucubano larva, appeared to be identical.

Cucubano larvae live in moist soil in the more humid sections of Puerto Rico, and, as shown by the investigations of Mr. Francisco Sein, feed primarily upon white grubs, and to a lesser degree on other soil-inhabiting insects. The cucubano adult, Pyrophorus luminosus Illiger, is a singularly delightful insect, with two brightly luminous spots on the prothorax, and a resounding click that makes it a favored plaything for children. Furthermore, it is quite harmless. It does not bite, normally feeding on fruit juices of mango and other tropical fruits, in this respect offering a most striking contrast to its larva, which appears to take delight in killing its prey, attacking white grubs by piercing their skull. One large white grub is ample for a meal, but it is a regular game-hog, continuing to kill as long as there are any grubs in its immediate neighborhood. In recent years the cucubano has become very much less abundant in Puerto Rico, mostly because the number of white grubs has greatly decreased since the introduction and spread of the giant Surinam toad, Bufo marinus L. Not only does the cucubano suffer by having the main source of its food in the larval stage cut off, but itself is also a favored food for the toad. Its luminosity, previously no detriment, is now a distinct liability, leading directly into the mouth of Bufo.

The luminous spots on the prothorax of the cucubano are sharply defined, even in the pupa. The larva, however, is luminous generally in the prothorax, and slightly so on the rear edge of following segments. The elaterid larvae from the almacigo log, so closely resembling cucubano larvae morphologically,

are not luminous at all, even when repeatedly stimulated in a photographic darkroom. Dr. W. H. Anderson, of the U. S. National Museum, to whom material was submitted, notes that the cucubano larvae are separable from them also "on the shape and ornamentation of the ninth abdominal segment, on the structure of margin of nasale and on the sculpture of dorsal surface of head". Reared to adult they prove to be Chalcolepidius silbermanni Chevrolat, a large, non-luminous elaterid, dark chocolate-brown in color, with deeply furrowed elytra, until recently not known to exist in Puerto Rico. Chalcolepidius silbermanni is comparatively common in Hispaniola, the larger island to the west of Puerto Rico, and one often sees the adults sunning themselves in a sun-lit spot on the bark of a tree in woodland glades. Some years ago the students of the late Dr. Stuart T. Danforth, at Mayaguez, began bringing in specimens collected in Puerto Rico, and the junior writer collected one specimen at what is now Punta Borinquen Air Base, and reared another from a log of Albizzia lebbeck at Ponce infested with larvae of Elaphidion irroratum L. and E. spinicorne Drury. Hispaniola is to the windward of Puerto Rico, both for the prevailing trade winds and for hurricanes. Unquestionably Chalcolepidius was brought to Puerto Rico by commerce, for lumber, both as mahogany planks and as unbarked railroad ties, has formed an important item of commerce from the Dominican Republic to Puerto Rico for many years past. The unpeeled ties are often heavily infested with cerambycid larvae, fortunately all species already occurring in Puerto Rico, and in some of these presumably, Chalcolepidius larvae were also present: the predator accompanying the host insect. This appears to be one of the few instances of the accidental and quite unanticipated introduction of a beneficial insect, quite the opposite of the results elsewhere of allowing the unrestricted entry from foreign countries of unbarked tree trunks.

Summary

Mr. Whitney's article was occasioned by the discovery of large holes in a tree of "Gum Eleme" on the Island of Nassau, Bahama Islands. These oval holes appeared to be made by some insects and had a covering of bark described as "trap-doors". The article describes the writer's efforts and the fun enjoyed in tracking this insect to its lair which was variously attributed to snails, lizards, bees, birds, caterpillars, etc. Through the perseverance of the writer and after an amazing and interesting investigation, the mystery was solved by Dr. George N. Wolcott of the Agricultural Experiment Station at Río Piedras, Puerto Rico by rearing the insect from similar holes in "West Indian Birch" or "almacigo", Bursera simaruba. It proved to be a Cerambycid larvae, Lagochirus araeniformis. The chamber and trap-door is apparently a feeding cavity as pupation takes place in the interior of the log.

An interesting aftermath of the investigation started by Mr. Whitney is that the work done by Dr. Wolcott and Mr. Martorell led to the discovery of the accidental introduction of a beneficial insect, Chalcolepidius silbermanni, a

large non-luminous elaterid which was preying on the larvae of the cerambycid responsible for the "trap-doors". As this predatory insect is common in Hispaniola, its introduction must be due to the importation of lumber and ties from that country as it lies to the windward of Puerto Rico, both for the prevailing trade winds and for hurricanes. This is one of the few instances of the accidental introduction of a beneficial insect, quite the opposite results elsewhere of allowing the unrestricted entry from foreign countries of unbarked tree trunks.

Resumen

El artículo del señor Whitney lo motivó el descubrimiento de varios barrenos profundos encontrados en el tronco de un árbol de ("Gum Eleme") en la isla de Nassau de las Bahamas. Estas perforaciones, de forma ovalada, estaban cubiertas por unas tapas que se les dió el nombre de "puertas de trampa". Aunque hechas por insectos, algunas personas las atribuyeron erróneamente a otros organismos tales como caracoles de tierra, lagartijas, avispas, pájaros, orugas, etc. Después de una larga e interesante investigación asistida por la perseverancia del autor, el misterio fué descifrado por el Dr. George N. Wolcott de la Estación Experimental Agrícola en Río Piedras, Puerto Rico, quien crió varios de estos insectos en barrenos similares hechos en "West Indian Birch" o almácigo, Bursera simaruba, y que resultaron ser larvas del cerambícido, Lagochirus araeniformis. Los barrenos y las llamadas "puertas de trampa" son aparentemente el resultado de la nutrición de la larva, ya que la formación de la ninfa se lleva a cabo en el interior del tronco.

Puede anotarse como consecuencia interesante de esta investigación el hecho de que el trabajo llevado a cabo por Dr. Wolcott y el señor Martorell trajo el descubrimiento de la introducción involuntaria de un insecto beneficioso, Chalcolepidius silbermanni. Este es un elatérido, no luminoso, de gran tamaño, depredador de la larva del cerambícido responsable de las "puertas de trampa". La introducción del mismo en Puerto Rico es de suponerse se deba a la importación de madera y traviesas de la República Dominicana donde es muy abundante este insecto.

Esta es una de las pocas ocasiones en que un insecto beneficioso ha entrado accidentalmente a un país; lo contrario ha ocurrido donde se permite la entrada sin restricción de ninguna índole, a troncos no descortezados.

MONTANE VEGETATION IN THE ANTILLES

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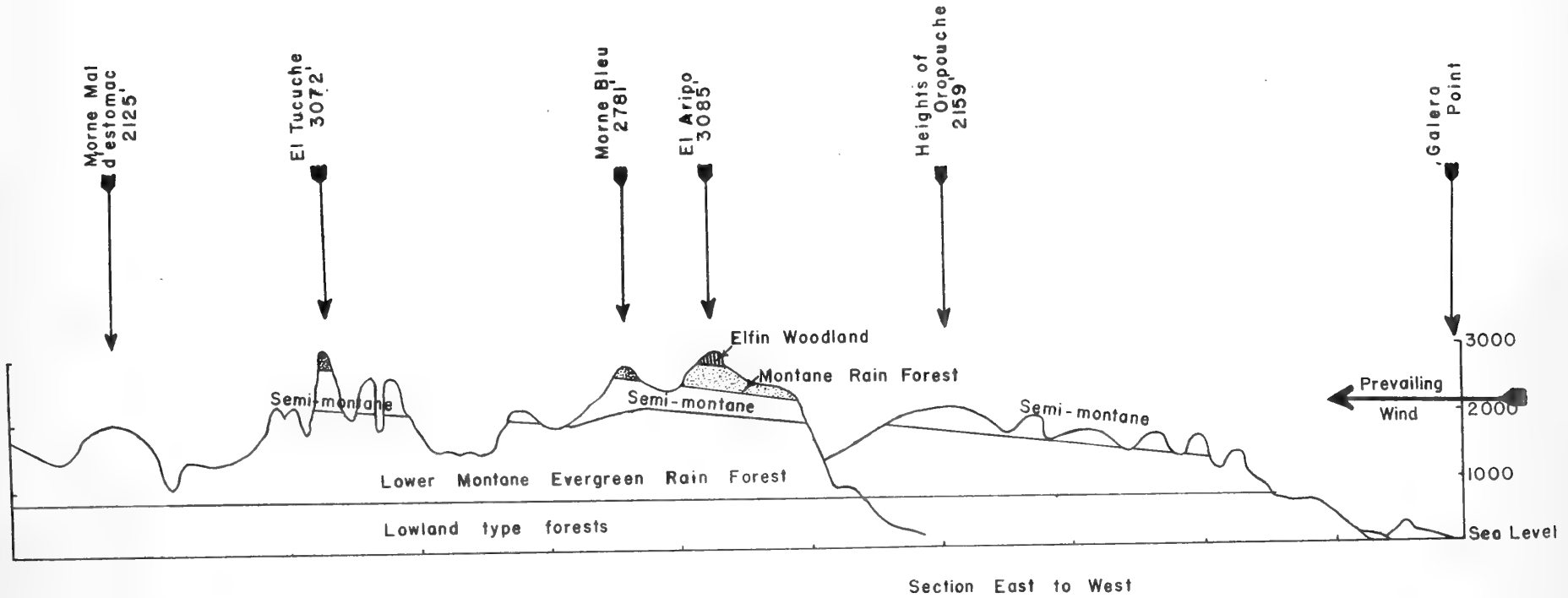
It is a matter of common observation that different zones of vegetation are encountered on ascending mountains, corresponding to changes of habitat brought about by altitude, since all vegetation is an expression of the factors of its environment. Elevation means increased exposure to wind, with a corresponding increase in the evaporating ability of the air. At the same time temperature is falling and, usually, precipitation increasing: together these factors imply the appearance and gradual increase of physiological drought. At the base of tropical mountains one finds commonly higher precipitation than in surrounding lowlands so that the forest is of a more luxuriant type. Conditions at the start remain otherwise lowland. With the ascending elevation the first response the vegetation shows to altered conditions reflects the exposure to wind, the canopy becoming lowered and the general leaf type simple (as opposed to compound) leathery and cutinised. Higher up, falling temperature begins to cause physiological drought which together with still greater exposure lowers the forest canopy still further. Precipitation ever increasing with altitude, the soil becomes wetter and wetter and finally waterlogged, further aggravating the physiological drought. At this point ordinary forest gives way first to alpine woodland and then to various herbaceous types culminating in alpine meadow. It appears to the writer that all variations in montane vegetation can be explained in terms of physiological drought, considered relatively to the evaporating ability of the air. Increasing difficulty in drawing water from the soil, coupled with increasing atmospheric power of evaporation from the leaves, places greater and greater strain upon the plant's physiological processes calling for the appearance of more specialised types.

Trinidad possesses a range of mountains running from east to west across the north of the island. The average elevation of its main ridge is about 2000 feet, but several peaks exceed this, notably El Tucuche, 3072 feet and El Aripo, 3085 feet. These are not very considerable elevations, compared with mountains in other West Indian islands, but several distinctly montane types of vegetation none the less appear. Four major plant formations can be recognized. Their range of altitude depends very largely on presentation to the prevailing wind, which is the north-easterly or south-easterly blowing Trade Wind. This is made clear on the accompanying diagram 1, which is a profile of the Northern Range drawn from east to west, in the wind direction. The lowland forests which are evergreen semi-monsoon forests comprising associations of Carapa guianensis Aubl., ascend the outer fringes, foothills and lower slopes of the range up to about 800 feet elevation. At this point the effects begin to be felt of increased precipitation and condensation, particularly during the dry season, and of exposure, so that the formation changes to Tropical Lower Montane Evergreen Rain Forest. This formation has all the essential characteristics of rain forest but has points of difference from the true lowland type. It is described below.

Above 2500 feet precipitation and the evaporating ability of the air have increased still further and falling temperature begins to cause physiological



Vertical Scale . . . . 2000' to 1 inch.

Horizontal Scale . . . . 4 miles to 1 inch.

DIAGRAM I.

NORTHERN RANGE OF TRINIDAD.

drought and the formation of mist. This is the zone of Montane Rain Forest, or Temperate Rain Forest within the Tropics, characterised by poverty of tree flora, great luxuriance of epiphytes, low open structure and the presence of large tree ferns. There are unfortunately no meteorological stations at this altitude, but from the writer's observations the rainfall appears to be some 200 inches annually (5-1/2 meters) distributed fairly constantly all the year round, and the average temperature between 60°F and 68°F. (16°- 20°C.) The temperature figures make the climate temperate rather than tropical.

The factor of exposure may bring about a transitional phase between 1800 and 2500 feet, where the floristic dominants of the montane rain forest hold sway but without tree ferns and in association with many typical species from the lower montane forest below. This "semi-montane" type occurs on the exposed tops of ridges, indicating the cause as a combination of cold and evaporating wind. The zone is characterized by a mist belt which forms at varying altitudes according to presentation to the Trade Wind (Diagram 1.) The air currents first strike the Heights of Oropouche and are forced up and cooled, causing condensation and/or precipitation. A cloud cap or belt of mist commonly forms on the summit above 1800-2000 feet during the night throughout the year and in the rainy season frequently during the day also. Above 1800 to 2000 feet is also the zone of transitional montane forest. Further west on Aripo, the air currents still rising, the mist belt rests commonly at 2500 feet but may descend to 2000 feet in rainy weather. These basal levels are also those of montane and transitional montane forest respectively. Still further to leeward on the less massive height of Tucuche, mist-belt conditions are not nearly so regular and the forest is nowhere purely montane in character: large tree ferns for example are not present even at the summit at 3072 feet.

One further type is found in Trinidad, confined to a small area on the most exposed of sites, the summit of Aripo above 2900 feet. This is the formation usually termed Elfin Woodland, a disagreeable title, originated by Schimper. A thicket rather than a forest, it is characterised by a short, often gnarled or oblique stem and long serpentine branches. Precipitation and/or condensation are probably almost incessant, the soil waterlogged and temperature low so that physiological drought is undoubtedly present. The area is also swept by strong winds.

In detail, the foregoing vegetation types may be described as follows:

1. Lower montane evergreen rain forest.—Diagram 2 shows the structure, which is that of true rain forest with more or less broken canopy formed by the upper storey. Diagram 3 is inserted to show for comparison the structure of the semi-monsoon forests of the lowlands. Owing, however, to the exposed mountain situations, it is never as tall as lowland rain forest, the canopy being formed between 70 and 100 feet. The average height of a mature dominant tree is about 90 feet, though it may reach 120 feet in sheltered places. There are no trees emergent above the canopy layer. Below the canopy layer there is no properly definable stratification but an agglomeration of trees of heights from 10 to 50 feet. The canopy layer shows gaps due to wind damage.

The average girth at maturity is 7 to 8 feet, sizes not running as large as in lowland rain forest. The clear stem is commonly of some length, a mature

DIAGRAM 2. LOWER MONTANE EVERGREEN RAIN FOREST.

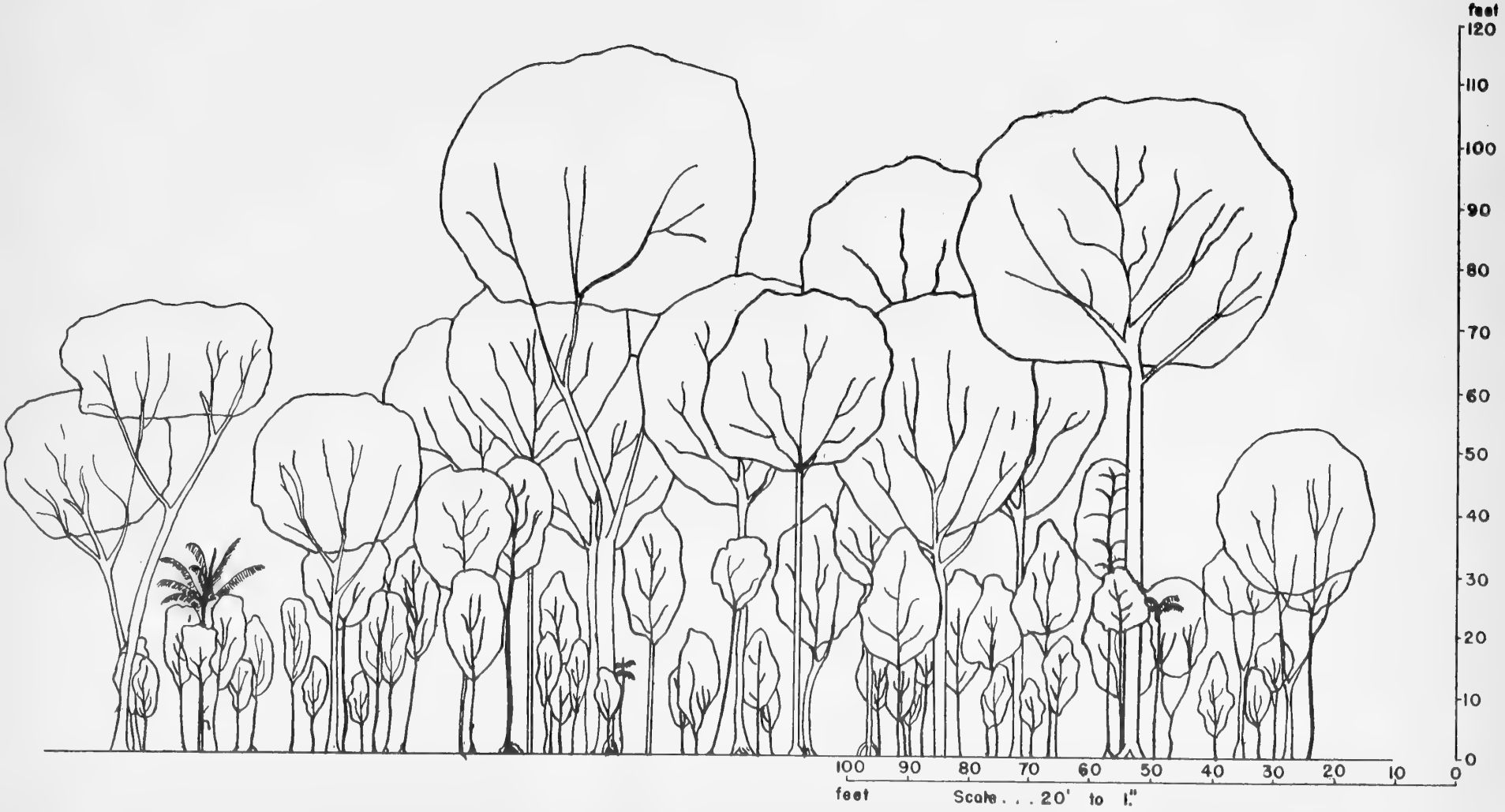


DIAGRAM 3.

EVERGREEN SEMI-MONSOON FOREST.

tree having rarely under 50 feet of clean bole and sometimes up to 80 feet. Except in late life, crowns of the dominants are narrow and ramification restricted; old trees tend to have a whorl of heavy flat branches crowing their tall stem. The dominated trees have conical crowns. The general impression in this type of forest is of crowded long thin stems running upwards to a high canopy. The average number of trees per 100 acres over 1 foot girth is about 16,000; over 6 ft. girth 800; and over 10 ft. girth 80.

Lianes are poorly represented and may be described as rare. Epiphytes are more or less confined to the dominants' crowns by the dense canopy and are likewise poorly developed. Buttressing of the trees is not a character, the large trees typically having merely a small spread at the base. It is however noticeable that many trees develop a single buttress on the uphill side of the trunk. Palms are very rare and tree ferns represented only by some small Alsophilas, seldom attaining over 5 feet in height. The forest is practically 100 per cent evergreen. Leaves are predominantly simple, and "mesophyll" in Raunkiaer's leaf classes, with a drip-tip, shiny above and slightly leathery. Ground vegetation is extremely sparse. The accompanying list shows the floristic composition of this formation in Trinidad. There is only one association, Licania ternatensis - Byrsonima spicata (Bois gris - serrette.) The family Leguminosae is surprisingly poorly represented for the geographical region. In the semi-monsoon forests of lowland Trinidad, the Leguminosae are 17 per cent of the species and 30 per cent of the individuals; in the lowland rain forests of Guiana described by Davis and Richards they form from 14 to 59 per cent of the individuals. Here there are only seven leguminous species, representing 6 per cent of the individuals. This may be connected with the generally large size of leguminous seeds which would lead to difficulties of distribution in mountainous country. The leguminous species present have fairly small seeds. No one family is at all predominantly represented. The Lauraceae provide most species (10) but these are of low abundance.

2. Montane rain forest.--Structure (see Diagram 4) is still typically rain forest, though the canopy is down to 60 feet and exhibits a great deal of wind damage. No tree exceeds 75 feet in height. Below the canopy layer one may distinguish an irregular stratum of small trees 20 to 40 feet high, which are principally of species on their way up to the canopy layer, and an understorey of tree ferns and small palms.

The average girth at maturity is only 4 or 5 feet and girths of over 7 feet have not been recorded. Clear stems are relatively uncommon, the trees branching or forking low down. Branching appears heavy and crowns wide considering the height of the trees. The average number of trees per 100 acres over 1 foot girth is about 11,000 and over 6 feet girth 100.

Lianes are extremely abundant here and epiphytes flourish to a tremendous luxuriance. Branches and trunks of the trees are entirely covered right to ground level with colonies of aroids, Carludovica, ferns, bromeliads and orchids, between masses of moss and lichen. The covering is so thick that it seems to strangle the trees.

Trees are not buttressed. Several species of dwarf palm are abundant, and large tree ferns flourish up to 30 feet in height. They colonise particularly any wind gaps in the forest. The forest is 100% evergreen; leaves are

DIAGRAM 4.

MONTANE RAIN FOREST.

predominantly simple, mesophyll, and inclined to be leathery. Epiphyllae are common. Ground vegetation is most frequently restrained by the dense palm-fern lower storey, but in places shows a dense growth of herbaceous plants.

The accompanying list shows the floristic composition, there being only one association, the Eschweilera - (?)Ternstroemia. The relative poverty of the flora will be apparent. Several of the more important trees have not yet been botanically determined, due to the inaccessibility of this area; B. Broadway and Smith have recorded that most of Trinidad's endemic species of bromeliad occur here, and probably the other types of epiphyte show a similar tendency.

3. Elfin woodland.--The canopy is formed by a very dense layer of tree ferns and small palms at about 10 feet. From this emerges the tree layer, with a somewhat open appearance, attaining 20 to 25 feet in height and girths seldom of over 1 foot.

Lianes and epiphytes in the ordinary sense are not present. All vegetation is completely enveloped and festooned with moss, lichen and epiphyllae.

The principal species, Clusia intertexta, is stilt-rooted; this is not an epiphytic Clusia. The trees divide low down into a system of long rambling branches without a definite trunk, the branches tending to point away from the wind. Leaves are thick and fleshy, evergreen, simple, mesophyllous. Tree ferns and small palms compose the lower storey almost wholly. A ground layer is virtually absent.

Over 90 per cent of the tree layer is formed by Clusia intertexta Britton (mountain mangrove). Other species are:

Keskidee	Vismia sp.
"Mountain guatecare"	Eschweilera sp. "B"
Laurier petite-feuille	Ocotea canaliculata (Rich) Mez.
"Mountain jereton"	Oreopanax capitatum (Jacq.) Done. & Planch
"Wild toporite"	?
Wild tapana	?

The flora is very poor. The lower storey contains the tree ferns Cyathea tenera and C. caribaea and the dwarf palms Euterpe broadwayana and E. pubigera.

It would be interesting to have similar comparative data for types encountered in the other islands. Nearly every island is very mountainous, and many rise to much greater heights than Trinidad, so that there must be a great many types for study. A number of floristic descriptions have already been published for vegetation types in other islands, but for comparative purposes physiognomic descriptions are necessary.

In Grenada the writer has seen forest around the Grand Etang at approximately 2,000 feet which appeared homologous with the montane rain forest of Trinidad. Its floristic composition was unknown to him.

In Martinique and Guadeloupe, thanks to the excellent descriptions of M. Stehlé 1/, 2/ and 3/, fairly accurate comparisons can already be drawn. The forests appear to bear a very close resemblance to those of Trinidad. From 400 to 1,000 meters (1200 to 3000 feet) is "foret hygrophytique" which appears from the physiognomic descriptions to belong to the formation lower montane evergreen rain forest. Floristically, even it is very close to the Trinidad type: of 34 species listed by Stehlé as typical for Guadeloupe, 9 occur in the Trinidad type, and nearly all the genera are held in common. Montane rain forest appears to occur round about 3,000 feet, and again to resemble closely the Trinidad type. Elfin woodland comes in from 3,000 to 3,300 feet, represented by Clusieta as in Trinidad; Clusia venosa Vacq. in Guadeloupe and C. pluckenettii Urb. in Martinique. Since the mountains of the French islands range higher than those of Trinidad types of a more alpine character appear at the higher levels. Alpine shrubland is found from 3,300 to 3,600 feet, with stunted bushes and Lobelia; higher still, associations of terrestrial bromeliads or palm stands occur, and finally only sphagnum.

Gleason and Cook's "Plant Ecology of Porto Rico" lists "rain forest" up to 2,000 feet on the Luquillo mountains, which appears to belong strictly to lower montane evergreen rain forest. At higher elevations the palm stands of the French islands are repeated (sierra palm forest) and there is elfin woodland (mossy forest.)

Those conversant with them will be able to tell what position in the series of types is occupied by the coniferous mountain forests of the Greater Antilles, which are absent from the Lesser. According to Chardon (Caribbean Forester, Vol. 2, No. 3, page 126) Pinus occidentalis ranges in Hispaniola from 500 to over 9,000 feet, but only forms pure pine forest above 6,000. It would be interesting also to hear of the [illegible] in the Caribbean region of mountain bamboo forest such as is found in parts of Africa and India; perhaps it is replaced here by the palm stands, which do not seem to be known in the old world.

Various writers on plant formations in Africa and India have described the same montane types as are found in the Antilles, but a striking fact is the great difference in the altitude at which these occur. Montane rain forest is described at the following levels:

5,000 to 7,000 feet	Nyasaland, S. Rhodesia, Transvaal,
7,000 to 10,000 feet	Kenya Colony,
5,000 feet	Hills of Southern India

Elfin woodland is found on Mt. Kilimanjaro at 8,500 to 10,000 feet.

Apparently altitude must be assessed as the height above the general level of lowlands and plateaux lying to windward, and not as the height above sea-level, i.e. as the relative exposure, at any rate until markedly lowered

1/ Essai d'écologie et de géographie botanique, Flore de la Guadeloupe. Basse-Terre, 1935.
2/ Esquisse des associations végétales de la Martinique, in Bull. Agr. Martinique, Fort-de-France, 1938.
3/ Conditions éco-sociologiques et évolution des forets des Antilles francaises. Caribbean Forester Vol. 2, No. 4, 1941

temperatures are encountered. The Antillean mountains rise directly from the sea and the effective altitude therefore is that above sea-level; montane rain forest 2,500 feet, elfin woodland 3,000 feet. Mountains Kenya and Kilimanjaro rise from a plateau at 4,000 to 5,000 feet; montane rain forest comes in at 6,000 to 7,000 feet, effective altitude 2,000 to 3,000 feet, and elfin woodland at about 8,500 feet, effective altitude 3,500 feet. These altitudes roughly agree with the Antillean.

Naturally the comparative altitudes cannot be assessed quite as simply as this in all cases, since it is clear that a great many other factors than pure altitude are at work. Within the [illegible] of the tropics it is doubtful if variations in latitude affect altitude very much, but one must consider direction and strength of wind, amount of precipitation, aspect and so on. Rain bearing winds will bring about alpine conditions at lower levels than dry winds, since heavy precipitation, by causing waterlogging of the soil, leads to physiological drought. Habitat criteria for montane plant formations must therefore be assessed from particular conditions such as degree of physiological drought and not from general conditions such as height above sea-level.

Descriptions of plant communities are seldom drawn up in such a way that comparisons are easily made with other communities elsewhere. Usually we are given distinct details of floristic composition but only vague characterisations of physiognomy and habitat, which do not provide comparative data, since floristic composition is a purely local matter. The plant association found in a given area reflects the local habitat; 200 miles away the habitat may be exactly the same but a different association will be found, due to changes in regional flora. In such cases however, the two associations will exhibit similar structure and life-form because they reflect an essential similarity of habitat; they will belong, in fact to the same <u>formation</u> which is a physiognomic unit just as the <u>association</u> is a floristic unit. Comparative studies in vegetation can only be made if the communities can be arranged into a physiognomic classification. Could we not have such a classification for the vegetation types of the Antilles? It would enable exact parallels to be drawn between the vegetation of the different islands. The writer has ventured to put forward the foregoing descriptions of the montane formations of Trinidad as a start in the general direction. It is hoped that the data on structure and life form will be adequate for comparative purposes, assisted by the forest profile diagrams. The latter have been used with great success by Dr. P. W. Richards[4] to whom acknowledgement is due for the idea.

4/ The recording of structure, life-form and flora of tropical forest communities as a basis for their classification. Richards, Tansley and Watt. Imperial Forestry Institute Paper No. 19 of 1939, University of Oxford, England.

Licania-Byrsonima Association (Bois gris-serrete)

Composition in order of frequency

Creole Name	Botanical Name
Canopy Layer	
Bois gris	Licania ternatensis Hook f.
Mahoe	Sterculia caribaea R. Br.
Serrette	Byrsonima spicata Rich.
Wild cocoa	Tovomita eggersii Vesque
Wild kaimit	Chrysophyllum sp.
Olivier	Terminalia obovata (R. & P.) Steud. Buchenavia capitata (Vahl) Eichl.
Bois charbon	Diospyros ierensis Britton
Guatecare petite-feuille	Eschweilera sp. "A"
Bois noir	Sloanea trichostica Williams & Sandwith
Bois riviere	Chimarrhis cymosa Jacq.
"Arena sardine"	?
Yellow mangue	Symphonia globulifera L. fil.
"Gommier montagne"	Burseraceae sp. (?Dacryodes)
Cabrehash	Sloanea trinitensis Sandwith
Laurier pulcherro	Acrodiclidium canella (Meissn.) Mez Aiouea Schomburgkii Meissn.
Laurier petite-feuille	Ocotea canaliculata (Rich.) Mez
Gommier viande biche	Tapirira guianensis Aubl.
Contrevent	Lucuma hartii Hemsl.
Jumbie bead	Ormosia monosperma (Sw.) Urb.
"Mountain redwood"	? Ternstroemia sp.
Balata	Manilkara bidentata (A.DC.) Chev.
Yellow Poui	Tabebuia serratifolia Nichols
Puni	Pithecellobium jupunba (Willd.) Urb.
Laurier canelle	Aniba panurensis Mez Aniba trinitatis (Meissn.) Mez
Jereton	Didymopanax morototoni Done. & Planch
Galba	Calophyllum lucidum Britton
Acoma	Sideroxylon quadriloculare Pierre
Tapana	Hieronyma caribaea Urb.
Bois toucan	Laetia procera (Poepp & Endl.) Eichl.
Matapal	Clusia rosea Jacq.
Laurier stinker	Ocotea arenaensis R. L. Brooks
Cajuca	Myristica surinamensis Rol.
Yoke	Astronium obliquum Griseb.
Wild pine	Podocarpus coriaceus Rich.
Figuier	Ficus tobagensis Urb.
Hogplum	Spondias monbin L.
Locust	Hymenaea courbaril L.
Black fiddlewood	Vitex divaricata Sw.
Laurier mama 'zenfants	Phoebe elongata (Vahl) Nees
Lower Storey	
Carimbo	Guarea glabra Vahl
Niaure	Calliandra guildingii Benth.

Creole Name		Botanical Name
Lower Storey (continued)		
Bois l'ail		Cassipourea latifolia Alston
Wild calabash		Tabebuia stenocalyx Sprague & Stapf.
Mapoo		Cordia sp.
Red mangue		Marila grandiflora Griseb.
Keskidee		Vismia cayennensis Pers.
		Vismia falcata Rusby
Wild cashima		Rollinia mucosa (Jacq.) Baill.
Malbalata		Chrysophyllum sericeum A. DC.
Wild guava		Myrtaceae sp.
Sardine		Miconia sp.
Wakamy		Warszewiczea coccinea (Vahl) Kl.
Wild debasse		Licania biglandulosa Griseb.
Bois tatou		Rudgea freemani Sprague & Williams
Monkeybone		Mouriria rhizophoraefolia DC.
Cocochat		Hirtella racemosa Lam.
Cuchape		Coccoloba latifolia Lam.
Wild tapana		?
Bois la glie		Ryania speciosa Vahl
Biscuitwood		Ilex arimensis (Loes) Britton
Bois canon		Cecropia peltata L.
Wild coffee		Eugenia confusa DC.
Soiebo		Rheedia sp.
Pois doux		Inga sp.
Honeywood		Alchornea glandulosa Poepp
Palma real	P	Jessenia oligocarpa Gr. & Wendl.
Manac	P	Euterpe oleracea Mart.
Gatia		Brosimum aubletii Poepp & Endl.
L'epinet		Zagara martinicensis Lam.
"Gibon's" jiggerwood		Piscnia eggersiana Heimerl.
Cooperhoop		Brownea latifolia Jacq.
Laurier cacapoule		Lauraceae sp.
Bois pois		Swartzia pinnata Willd.
Beefwood		?
Bois bande		Richeria grandis Vahl
Cocomacaque		Rheedia lateriflora L.
Camayung		Amaioua corymbosa H.B.K.
Laurier cypre		Ocotea oblonga (Meissn.) Mez
Redwood		Guarea trichilioides L
Petite-feuille		Maprounea guianensis Aubl.
Cypre		Cordia alliodora Cham.
Acurel		Trichilia oblanceolata Rusby
Gommier		Protium insigne Engl.
Bois sang		Croton gossypifolius Vahl
Laurier 'zaboca		Ocotea glomerata (Nees) Mez

Eschweilera - (?)Ternstroemia Association

Composition in order of frequency

Creole Name	Botanical Name
Canopy Layer	
"Mountain guatecare"	Eschweilera sp. "B"
"Mountain redwood	? Ternstroemia sp.
Wild cocoa	Tovomita eggersii Vesque
"Wild toporite"	?
Pois doux	Inga hartii Urb.
"Redbark"	?
"Mountain jereton"	Oreopanax capitatum (Jacq.) Dcne. & Planch
Puni	Pithecellobium jupunba (Willd.) Urb.
Bois riviere	Chimarrhis cymosa Jacq.
Under Storey	
Wild guava	Myrtaceae spp.
Laurier petite-feuille	Ocotea canaliculata (Rich) Mez
Mapoo	Cordia sp.
Sardine	Melastomaceae spp.
Keskidee	Vismia sp.
Bois l'ail	Cassipourea latifolia Alston
Bois la glie	Ryania speciosa Vahl
Bois noir	Sloanea trichostica Williams & Sandwith
Laurier cacapoule	Lauraceae sp.
Wild debasse	Licania biglandulosa Griseb.
Palm-fern lower storey	
	Cyathea tenera
	Cyathea caribaea
	Pteris multiserialis
	Euterpe broadwayana
	Euterpe pudigera

Summary

The Northern Range of Trinidad rises to just over 3,000 feet (1,000 meters). Four major plant formations can be distinguished there, viz:

1. The lowland forests up to 800 feet.
2. Lower montane evergreen rain forest, 800 to 2,500 feet.
3. Montane rain forest, 2500 to 2900 feet.
4. Elfin woodland, 2900 to 3085 feet.

Detailed descriptions of structure, life-form and flora are given and correlations attempted with the montane vegetation types of the French Antilles, as described by Stehlé, and of Puerto Rico as described by Gleason and Cook.

It is pointed out that to enable accurate comparisons, descriptions of plant communities must embody such data that they can be classified on a physiognomic basis, and the hope is expressed that ecologists round the Caribbean will so draw up descriptions of the vegetation types with which they have to deal, that eventually a general physiognomic classification for the region can be attempted.

Resumen

La Cordillera Norte de Trinidad se eleva hasta poco más de 3,000 pies (1,000 metros). Se distinguen cuatro asociaciones botánicas principales, a saber:

1. Las selvas de las llanuras hasta elevaciones de 800 pies.
2. Selvas pluviales intermedias desde 800 hasta 2,500 pies.
3. Selvas pluviales templadas desde 2,500 hasta 2,900 pies.
4. Bosques enanos desde 2900 hasta 3085 pies.

Se ofrecen descripciones detalladas de la estructura, la forma y la flora y se trató de establecer correlaciones con la vegetación de las zonas montañosas de las Antillas Francesas según descripcion de Stehlé; y de Puerto Rico, según descripción de Gleason y Cook.

Se señala que para permitir comparaciones exactas, la descripción de comunidades de plantas debe reunir datos de manera que puedan clasificarse sobre bases fisonómicas y se expresa la esperanza que ecólogos en el Caribe describan los tipos de vegetación con los cuales trabajan, de manera que más tarde pueda intentarse una clasificación fisonómica general de la región.

THE FORMATION AND MANAGEMENT OF MAHOGANY PLANTATIONS AT SILK GRASS FOREST RESERVE

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Plantation work was commenced in 1925 and the site selected lies some five miles inland at a point where the foot-hills merge into the coastal plain. The elevation is sixty feet above sea-level and the topography is flat to gently undulating. The rainfall approximates 100 inches a year with a marked dry season from February to May during which period the precipitation is usually less than 1/4 of the year's total. The soils consist of fairly deep, red to brown porous loams of metamorphic origin containing grains of quartzite and traces of mica and manganese.

The original vegetation was High Forest with Orbigyna cohune and contained such species as Virola koschyni, Calophyllum globulifera, etc. with scattered individuals of Chamaedorea sp. and Synechanthus sp. This bush was felled during 1914-18 to make plantations of food crops with the result that at the time of commencing plantation work in 1925 the vegetation consisted of a stick growth 30 to 40 feet in height with a few scattered emergents as relics of the former forest. The principal re-growth species were Vismia spp., Melastomaceae spp. Ochroma limonensis, Belotia Campbellii, Inga spp., Bursera simaruba, Cecropia mexicana and Schizolobium parahybum.

The method of establishing a plantation was to clear fell the selected area and sow mahogany seed 10 by 10 feet apart with two seeds to each peg. Corn was also sown to offset the cost of establishment. Subsequent treatment entailed an annual cleaning of the mahogany lines thus freeing the seedlings from any suppressing vegetation but no attempt was made to thin out associate species as the plantation increased in age. Plantations, varying in size from eight to twelve acres, were made in this manner annually, but although the same method of procedure was followed in each case the results were anything but constant and taken as a whole were not highly satisfactory. One reason for failure was due to the use of seed that had been stored for several months and had lost its virility or by using seed that gave a low germination. With regard to this it may be mentioned that seed is now being collected from trees that yield a virile crop and germination is satisfactory. Resowing of the areas of low initial germination usually met with little success which was due to an insufficient opening up of the second growth species resulting in inadequate light conditions. Provided good quality seed is used the present method of establishment is satisfactory and under local conditions more economical than transplanting methods.

Once the plantation has been fully stocked with seedlings subsequent treatment should be based on the following considerations;

1. Mahogany requires plenty of light if maximum growth is to be maintained and the species will in fact thrive in full sunlight

2. The species is very susceptible to attack from Hypsipyla grandella and such damage is always more severe when the seedlings or saplings are exposed to full light.

3. Under conditions of medium to heavy shade the seedlings tend to stagnate and if this continues for any length of time the response to a subsequent opening up of the vegetation is often negligible.

It is, therefore, apparent that in order to obtain optimum conditions of growth there must be a sufficient quantity of light to stimulate growth but also a certain amount of shade to protect the seedlings or saplings from shoot-borer attack. To maintain this fine balance cosistently is the basic problem of plantation practice.

In these circumstances the presence of suitable nurse species is all important, such species having a rate of growth similar to or slightly faster than mahogany, a fairly compact crown habit and not too dense a foliage. A number of high forest species such as Vochysia koschnyia, Virola merondonis, Aspidospermum megalocarpum, Calophyllum brasiliense, etc., appear to be suitable for this purpose and it was hoped that these would introduce themselves naturally into the plantations. In actual fact the colonization by these individuals has been meagre and they form a very small proportion of the associates now found growing with the mahogany. It is to be expected that in plantations established in second growth that the natural regeneration of high forest species would be low, but there is reason to believe, judging from observations of plantations made in virgin forest, that these species do not readily establish themselves until the soft wooded and faster second growth species have died down. This may mean a lag period of several years.

The type of vegetation that arises on abandoned milpas (maize plantations) is typical throughout the Stann Creek Valley i.e. on soils of metamorphic origin. The original vegetation is normally felled at the beginning of the dry season in February and burnt towards the end of April before the commencement of the rains. The soil is then almost entirely exposed. Maize is sown immediately and germination and growth is rapid and this together with the carpet of hard-wood seedlings that arises provides the soil with considerable protection three to four weeks after the burning.

The hardwood species that predominate are Ochroma belizensis, Belotia Campbellii, Cecropia mexicana, Vismia sp., Inga sp., Bursera simaruba, Schizolobium parahybum, Melastomaceae sp., etc. These are usually very abundant and together with Heliconia sp., which is especially thick on the damper sites, form a dense mass of vegetation, which tends to preclude the natural regeneration of true high forest species.

If subsequent practice is restricted to clearing the mahogany lines the only species available as nurses are those listed in the previous paragraph and they by no means possess the characteristics of individuals suitable for this purpose. They all have a rate of growth far in excess of that of mahogany, they have for the most part very branching habits and many of them cast a heavy shade at an early age. It is, therefore, wellnigh impossible under these conditions to maintain the correct balance of light and shade and although a thinning of associate species in the second year, which in fact is absolutely

necessary, does improve conditions temporarily, efficient control in later years is in jeopardy.

In plantations where the taller second growth species such as Ochroma, Inga, and Schizolobium were present the mahogany was well below the canopy and verging on the stagnation stage and it was often extremely difficult when making a crown thinning of the associate species to avoid wide gaps which exposed the mahogany to shoot-borer attack.

The reverse of this occurred in plantations where Vismia and certain Melastomaceae spp. were predominant as these species seldom attain a height of more than 30 to 35 feet. Once the mahogany has forced its way through this canopy it becomes fully exposed to borer attack and severe branching takes place. A closer stocking of mahogany would alleviate this problem in that the species appears to clean itself readily but success would depend on absolutely full stocking and a more or less uniform rate of growth throughout the plantation, a state of affairs upon which it is by no means safe to rely. In one area where Vismia ferruginea was abundant this species was inflicting considerable mechanical damage on twelve year old mahogany and subsequent thinnings had to be carried out with extreme care, especially when tie-ties were present in the crowns of the trees.

It is, therefore, apparent that it is not sound practice to rely on natural regeneration for the provision of nurse species. It is also equally certain that until there is a very thorough knowledge of the regenerative powers, rates of growth and habits of the species that it is intended to introduce there is little chance of producing well formed trees from plantations. Research in this direction has only recently started and as yet there are insufficient data on which to base any definite policy.

Other difficulties that have arisen include the control of Wee wee ants and the defoliating caterpillar Egchirites nominus, both of which are capable of causing considerable damage to the foliage of young mahogany. Destruction of ant nests is usually an expensive business and little control has been practised in the past. If plantation work is to proceed over any extensive areas, however, systematic control is indicated and may best be carried out by locating and destroying the nests on the areas allocated for plantations, before the bush is felled. No control of the defoliating caterpillar has been undertaken but probably the best all round remedy is to ensure that the seedlings and saplings are given optimum conditions for healthy growth.

Summary

1. Introduction of mahogany by felling and burning, and sowing seed has proved satisfactory provided a good strain of fresh seed is employed.

2. Mahogany is best grown under light shade conditions, these conditions being such that there is sufficient light for satisfactory growth and yet enough protection by the surrounding vegetation to discourage shoot-borer attack.

3. It is not sufficient to rely on natural regeneration to provide suitable associates for mahogany in sufficient quantities or with the regularity of distribution required for systematic control.

4. Mixed plantings are expensive and the results hazardous unless there is adequate knowledge of the regenerative powers, rates of growth and habit of the species utilized.

5. Given maximum light mahogany will grow from 8 to 10 feet a year in early life. Under conditions of light shade the rate of growth is from 5 to 6 feet a year.

Resumen

1. La regeneración de la caoba, Swietenia macrophylla, por medio de siembra directa precedido por cortas y quema ha dado buenos resultados siempre que se use semilla fresca y de buena clase.

2. Lo mejor para esta especie es una sombra ligera que permita, crecimiento satisfactorio pero que ofrezca protección contra el taladrador del tallo.

3. No se puede depender de la regeneración natural para proveer especies complementarias en suficiente cantidad o con la debida distribución de manera que se asegure un dominio sistemático.

4. Las plantaciones mixtas son costosas y de resultados dudosos a menos que se tengan datos adecuados de la habilidad de regenerarse y del crecimiento y hábitos de las especies utilizadas.

5. La caoba, durante los primeros años, crecerá de 8 a 10 pies anualmente bajo un máximum de luz y de 5 a 6 pies durante el mismo tiempo bajo sombra ligera.

STUDY OF GRADES OF BROADLEAVED MAHOGANY PLANTING STOCK

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The broadleaved mahoganies, comprising the Honduras mahogany, Swietenia macrophylla King and the Venezuelan mahogany, S. candollei Pittier have been planted on a large scale in reforestation work in Puerto Rico since 1934. Botanically they are very similar. Their site requirements here have been found to be the same, and they react similarly to the various nursery and planting practices. Broadleaved mahogany is particularly satisfactory for reforestation because of its easy propagation, its adaptability to extensive areas on the island, its rapid growth, and the high value of its timber.

So far, the chief difficulties in established plantations in Puerto Rico are caused by attacks of the cedar shoot borer, Hypsipyla grandella Zell. which however, is not very serious on good sites, and a small amount of windthrow during the sapling stage. Experience with disease and insect attacks in Trinidad has led to the recommendation[2]/ that broadleaved mahogany be grown in mixed plantations. This practice is also recommended in Puerto Rico. Additional findings here indicate that establishing plantations under an overstory in addition to other benefits reduces insect attack.

Oversize planting stock has been considered a factor contributing to initial losses in plantations. It has been generally possible to plant the bulk of the seedlings before they become oversize, but often considerable amounts have reached 6 feet in height before they are lifted. The seeds are generally sown during the late fall or in March or April. The seedlings grow rapidly reaching heights up to 4 feet when 6 months old. Though planting may start in May or June it is continued into November in the humid regions or even later in areas of high rainfall.

The reasons for the delay in lifting nursery stock before it becomes oversize are as follows:

(1) Seed has been secured from Venezuela and Panama and is usually received in February and March but sometimes it has not been obtained in time to make early spring sowings. This results in the shortening of the planting season and the holding over of part of the stock to be used in the next season.

1/ This study was designed by Messrs. Philip C. Wakely and L. R. Holdridge and was carried out under the supervision of the latter. Field Assistants L. E. Gregory and L. Mongil were in charge of the field execution and of taking the data. The writer analyzed the results and prepared this report. The Caribbean National Forest provided all labor connected with the establishment and maintenance of this experiment.

2/ Marshall, R. C. Silvicultural Notes on the More Important Timber Trees of Trinidad and Tobago, p. 26-27

(2) Unfavorable weather conditions in the field have delayed planting by land-owners so that seedlings have had to remain longer in the beds.

(3) Seedlings from sowings made in the fall soon become more than 4 feet tall if planting is not possible during the early spring.

Mahogany seed properly stored could be sown in smaller amounts throughout a greater part of the year. This would prevent a large percentage of the seedlings all being ready to lift at the same time. Without proper storage facilities the danger of loss of seed viability necessitates immediate sowing.

Broadleaved mahogany seed stored at a temperature of 35° to 40° F. for 8 months showed small loss in viability. Although the use of cold storage plus good organization of nursery and planting schedules could reduce considerably the amount of overgrown stock, such production cannot be completely eliminated because of unexpected circumstances and uncontrollable weather factors.

A study to determine a means of using such stock to the best advantage in order to increase survival was undertaken in 1938. A comparison was made between the survival of 2-to 3-foot stock and 4-to 6-foot stock at several different periods after planting.

The success of the British[3/] in using stump plants of teak and other species even in preference to medium sized seedlings is well known, so it was decided to determine the effect of cutting back oversize stock for comparison with average sized seedlings.

Experimental Procedure

The study was designed to test the survival of planting stock of different sizes some of which was cut back to different heights. The trees were planted under each of two types of site preparation at four different localities within the Luquillo Unit of the Caribbean National Forest.

One half of the seedlings were planted on parcelero[4/] lands which are clean cultivated. The other seedlings were subjected to a different cultural practice called corona in which the weeds and vines were chopped down with a machete along the row, removing all weed growth in circular spots around every seedling. Weeds or other growth between the rows, not interfering with the seedlings were allowed to grow. Most of the coronas were in open sites in competition with weeds and vines.

Culls, regular, and overgrown Honduras mahogany stock from seed collected in Panama, were lifted from the Mayaguez Nursery in May. In all 1,280

3/ Marshall, R. C. Silvicultural Notes on the More Important Timber Trees of Trinidad and Tobago.

4/ This name is given to special use permittees who raise timber trees among their food crops on Government lands, a system similar in some respects to the Taungya system of the British.

seedlings were used in the study. Some of the seedlings were cut back to various heights, producing the following eight grades:

A. Culls. (less than 2 ft. high, spidly), stem not cut back.
B. Average stock (2 ft. to 3 ft. high), stem not cut back.
C. Average stock (2 ft. to 3 ft. high), stem cut back to 12 inches.
D. Average stock (2 ft. to 3 ft. high), stem cut back to 4 inches.
E. Tallest stock (4 ft. to 6 ft. high), stem not cut back.
F. Tallest stock (4 ft. to 6 ft. high), stem cut back to 2 feet.
G. Tallest stock (4 ft. to 6 ft. high), stem cut back to 12 inches.
H. Tallest stock (4 ft. to 6 ft. high), stem cut back to 4 inches.

Leaves were removed from all seedlings. The stock was bundled in packages of 10 trees each, distributed to the four projects and planted on the third day following lifting. There was little difference as to the time that seedlings were planted at each locality.

Two balanced, randomized blocks, rectangular in shape, were established under each cultural treatment, located at El Verde, Pizá, Ciénaga Alta (tract 105) and Del Valle. Survival examinations were made at the end of 10 days, 30 days, 60 days, one year and two years. The data presented are those collected at the end of one year. Reliable survival information is best obtained after this period because the seedlings have passed through their first winter dry spell.

Description of the Sites

The four sites are typical of the cut-over lands recently acquired in this unit of the forest. They range from about 500 feet elevation at El Verde to about 1,500 feet at Del Valle. Del Valle and Ciénaga Alta are located on steep, rough slopes, while Pizá and El Verde are not so steep and are more uniform in topography.

It is known that "conuco" farming has been responsible in part for the great variation in the fertility of these soils, which made it difficult to select uniform sites. The steep, rough topography also contributes to the variations in soil fertility. In the depressions the soils are deep and fertile compared to the shallow, worn-out soils near the crests of the knife-like ridges.

Rainfall is high, varying somewhat in total amount and distribution between the localities, but it is uniform within each project. On the wetter sites annual precipitation is in excess of 100 inches. Variation in rainfall in the order of lowest to highest is as follows: Ciénaga Alta, El Verde, Pizá and Del Valle. Humidity is high especially on sheltered sites under an overstory.

Table 1.—Survival data for the entire study[1]

Treatment	Del Valle				El Verde				Cienaga Alta				Pizá				Total
	Cult.		Corona		Cult.		Corona		Cult.		Corona		Cult.		Corona		
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
A	10	8	10	8	7	9	10	10	9	7	4	1	6	5	7	6	117
B	10	8	10	10	10	10	10	8	4	3	4	5	8	10	6	9	125
C	10	10	10	10	9	10	10	9	9	2	3	3	10	9	7	9	130
D	9	9	9	9	10	8	9	5	3	6	3	2	4	7	6	8	107
E	7	8	9	9	7	10	7	7	2	4	3	4	9	7	6	6	105
F	10	10	9	10	10	10	10	8	5	6	2	0	8	9	6	7	120
G	9	9	9	10	8	10	8	9	6	1	4	1	10	9	6	9	118
H	8	10	9	10	8	10	10	9	7	8	4	1	7	8	8	9	126
Total	73	72	75	76	69	77	74	65	45	37	27	17	62	64	52	63	948

[1] One-year survival by rows of ten.

Table 2.—Analysis of variance of survival data

Source of Variance	D.F.	S. S.	M. S.	F	F at 5%	F at 1%
Places	3	566.312	188.7707	55.4197[1]	4.07	7.59
Cultural treatment	1	19.531	19.531	5.7340[2]	5.32	11.26
Place x cult. treat.	3	32.032	10.6773	3.1347	4.07	7.59
Error (1)	8	27.250	3.4062			
Blocks	15	645.125				
Class	7	33.375	4.7679	2.7038[2]	2.19	3.00
Class x pl.	21	37.688	1.7947	1.0177	1.76	2.23
Class x cult.	7	9.719	1.3884	1.3389	3.32	5.85
P x cl x cult.	21	64.218	3.0580	1.7341	1.76	2.23
Error (2)	56	98.750	1.7634			
Total	127	888.875				

[1] Significant at 1% level.
[2] Significant at 5% level.

The soil types fall into the following groups:

El Verde.—Múcara silty clay loam, Catalina stony clay loam.
Pizá.—Los Guineos clay.
Del Valle.—Rough stony land.
Ciénaga Alta.—Múcara silty clay loam.

The soil types can be described as follows:

Catalina stony clay loam.—Deep, heavy, red clays with fairly good drainage, and acid in all horizons.

Múcara silty clay loam is friable, grayish in color, shallow on steep slopes, of greater fertility, well drained and neutral to slightly acid.

Los Guineos clay is a grayish brown to red, deep, plastic clay, acid to strongly acid. Vegetation present indicates low fertility.

Rough stony land is found in shallow, rough, broken land at high elevations in very humid areas, drainage good to excessive, and acid in all horizons.

Results and Discussion

Table 1 shows the number of seedlings surviving per row of ten for the entire study. Totals are given by pruning treatment as well as by block for each locality and cultural treatment.

Analysis of the variance, as shown in Table 2 shows a highly significant difference between the survival at the different localities. The difference between the effects of the two cultural treatments was slightly more than that required for statistical significance. Although as a whole the survival was better in the areas under cultivation, the difference was significant only at Ciénaga Alta when taken by individual projects.

Table 3.—One-year survival by locations and cultural treatments

	Del Valle		El Verde		Pizá		Ciénaga Alta		Total	
	No.[1]	%	No.[1]	%	No.[1]	%	No.[1]	%	No.[1]	%
Cultivation	145	90.6	146	91.2	126	78.7	82	51.2	499	78.0
Corona	151	94.4	139	86.9	115	71.9	44	27.5	449	70.2
Total	296	92.5	285	89.1	241	75.3	126	39.4	948	74.1

1/ The difference between survival in different localities necessary for significance at the five per cent level is 34.10 seedlings, at the one per cent level (high significance) it is 49.61 seedlings. The difference between survival with different cultural practices necessary for significance at the five per cent level is 24.12 seedlings, at the one per cent level it is 35.08 seedlings.

From Table 3 it is seen that Del Valle had the highest survival, while Ciénaga Alta had the lowest survival. There was a significant difference between each of the four localities except that between Del Valle and El Verde.

The relative survival of these four sites agrees with plantation records except for the relative position of Ciénaga Alta and Pizá. Plantation records show better survival in tract 105 of Ciénaga Alta than in Pizá. The lower survival in the former can be attributed to the particular site conditions under which this test was made.

This study of 1-year survival shows that broadleaved mahogany requires definite and specific conditions for its best behavior. This might be shown better by growth figures. Although all the projects are well within the range of elevation and rainfall where this species grows well, in El Verde and Del Valle soils had been maintained under second growth, sites were sheltered, humid, well surrounded with forest and if worked for agricultural crops at all they have been protected by an overstory. In Ciénaga Alta and Pizá soils had been cleared long ago and cultivated with crops. It is, therefore, natural to expect greater soil deterioration. These two sites were not protected from wind and sunlight so that moisture conditions, a very important factor in survival, were less favorable.

It might be argued that difference in soil types influenced the results. However, there are reasons to believe that this has not been the case. While the rough stony soil in Del Valle gave the highest survival and Los Guineos clay and Múcara silty clay loam in Pizá and Ciénaga Alta respectively the lowest, experience has demonstrated that the latter soil types under suitable conditions of cover, and previous land use are generally satisfactory for broadleaf mahogany, especially the clays of Los Guineos and Catalina series. Rough stony land compares favorably in this experiment because the maintenance of a second growth forest cover and the absence of agricultural use provided suitable site conditions.

The cultural practice of corona is most effective where weed competition is not severe. Where seedlings are growing under an overstory, removing the competition closest to the tree is all that is necessary since the cover keeps the weeds partially in check. The corona was not effective at Ciénaga Alta where Guinea grass, Panicum maximum Jacq. proved to be a very aggressive competitor.

This relationship between the method of culture and the severity of competition is shown by the relative survival at Del Valle and Ciénaga Alta. At Del Valle where a second growth overstory has been maintained trees under corona showed a better survival although such superiority was not significant. Plantations at Del Valle have been maintained exclusively by means of the corona with excellent results. On the other hand, at Ciénaga Alta clean cultivation was clearly the better practice. Growth data in addition to survival data would have further emphasized this relationship.

Table 4.—Survival data for cutting back treatments

Kind of stock	Culls	Normal stock 2 to 3 ft. tall			Oversize stock 4 to 6 ft. tall			
Treatment	None	None	cut back to 12"	cut back to 4"	None	cut back to 24"	cut back to 12"	cut back to 4"
Designation	A	B	C	D	E	F	G	H
No. of trees living	117	125	130	107	105	120	118	126
Survival percentage	73.12	78.12	81.25	66.87	65.62	75	73.75	78.75

Table 5.—Grade comparisons in survival

Comparisons	No. of seedlings	Survival percentage	Significance[1]
A minus Av. rest	-1.71	-1.07	None
B minus A	8	5	None
A minus E	12	7.50	None
B minus E	20	12.50	Almost highly significant
C minus B	5	3.12	None
F minus E	15	9.37	Almost significant
G minus E	13	8.12	None
B minus D	18	11.25	Significant
H minus E	21	13.12	Highly significant
H minus D	19	11.87	Significant

1/ The minimum significant difference is 15.02 seedlings at the five per cent level and 20.06 at the one per cent level.

It is evident from the data that: There was no difference in survival between the culls and any one of the rest of the treatments or between culls and the average of the rest of the grades. The use of growth data might have indicated inferiority of the culls.

Survival of the 2-to 3-foot stock is not affected by pruning to 12 inches. When pruned to 4 inches, the survival is reduced. Cutting back to this height is probably too drastic a treatment with stock that has not developed an extensive root system or accumulated sufficient stored food.

Oversize stock unpruned gives a survival as low as normal stock pruned back to 4 inches. Pruning to 24 or 12 inches had only a slight effect in improving survival. However, pruning to 4 inches made the survival equal to that of unpruned normal stock.

Experience with plantations of both Honduras and Venezuelan mahogany shows that from one to two years after planting the stump caused by pruning is completely absorbed, and it is difficult to determine where the seedling was cut back. Pruning does not affect growth habits since a leader is formed immediately and forking does not occur on good sites. Plantations established with stock so treated have been successful and compare favorably as to growth and thriftiness with those where normal plants were used.

Conclusions

The general conclusions which can be drawn from this study are as follows:

(1) The 1-year survival of broadleaved mahogany plantings in different localities within a climatic range suitable to the species may vary greatly.

(2) Physical properties of the soil resulting from past and present land use apparently are important factors partially responsible for this variation.

(3) On very weedy sites clean cultivation is clearly superior to corona, while on less weedy sites, such as under an overstory, the superiority of clean cultivation is reduced.

(4) The 1-year survival of cull seedlings is not inferior to either unpruned normal or unpruned oversize stock.

(5) Unpruned oversize stock is decidedly inferior to unpruned normal stock.

(6) Pruning of normal stock does not increase survival at the end of 1 year. In fact, pruning to 4 inches is definitely injurious.

(7) Pruning of oversize stock to 24 or 12 inches has no marked effect on survival at the end of the first year, but oversize stock pruned to 4 inches has as great a 1-year survival as unpruned normal stock.

Summary

Because of easy propagation, rapid growth, and the value of the timber the broadleaved mahoganies have been planted to a considerable extent in Puerto Rico.

Mahogany grows very rapidly in the nursery, and because of frequent unpredictable delays in planting schedules stock often becomes oversize. It was believed that this oversize stock had given a lower survival than normal sized stock.

A study was established in 1938 in the Luquillo Unit of the Caribbean National Forest to determine the relative survival of oversize stock and how

to best use it. A test was also made to determine the reaction of cull, normal, and oversize seedlings some of which were pruned to different heights. Eight treatments were tested on four typical sites. Two cultural practices, clean cultivation and corona, were also compared.

Marked differences were found in the 1-year survival of seedlings planted in different localities within the climatic range of the species. Clean cultivation was superior to corona, particularly on very weedy locations. The 1-year survival of cull seedlings was not inferior to that of the other stock. Unpruned oversize stock was decidedly inferior to unpruned normal stock. Pruning did not increase the survival of normal stock, but in the case of oversize stock, a definite increase resulted. Oversize stock, pruned to 4 inches gave survival at the end of the first year equal to that of unpruned normal stock. Therefore, it is generally advisable to leave normal stock unpruned and to prune oversize stock to 4 inches.

Resumen

La caoba venezolana y de Honduras se han propagado extensamente en Puerto Rico debido a su fácil propagación, crecimiento rápido y al gran valor de su madera.

Estas especies crecen rápidamente y a menudo las plantas han alcanzado gran tamaño en la almáciga debido a dilaciones en la siembra. Se creía que plantas de tal tamaño no daban buenos resultados al sembrarse.

En el 1938 se llevó a cabo un estudio en la Unidad de Luquillo en el Bosque Nacional del Caribe para determinar la mejor manera de utilizar tales plantas crecidas y también sus méritos. Se estudió además la reacción de plantas endebles, de plantas normales, y de plantas muy crecidas, algunas de las cuales se podaron a diferentes alturas. Se probaron ocho tratamientos en cada una de cuatro localidades típicas y se compararon dos prácticas de cultivo, a saber: limpia total y corona.

Se llegó a las siguientes conclusiones:

(1) Al año de sembrada los resultados pueden variar considerablemente entre las diferentes localidades dentro de una misma zona.

(2) Responsables, en parte, de dicha variación son aparentemente las propiedades físicas del suelo, las que a su vez son consecuencia del uso pasado y actual del terreno.

(3) En sitios muy propensos al crecimiento de malas yerbas, las limpias totales son claramente superiores; mientras que en sitios de menos yerbas, como bajo sombra, se reduce tal superioridad.

(4) Al año de la siembra las plantas endebles no eran inferiores a las de tamaño corriente sin podar o a las plantas muy crecidas sin podar.

(5) Plantas muy crecidas sin podar son decididamente inferiores a las de tamaño corriente sin podar.

(6) La poda de plantas normales no mejora los resultados al año de la siembra. La poda de estas plantas a cuatro pulgadas es claramente perjudicial.

(7) La poda de plantas muy crecidas a uno y dos pies no es muy efectiva al final del primer año, pero la poda a cuatro pulgadas da tan buenos resultados como las plantas normales sin podar.

A PLANT NEW TO THE WESTERN HEMISPHERE

John H. Pierce
New York Botanical Garden

Trichodesma zeylanicum (L.) R. Br. has been collected by Mr. E. G. B. Gooding of Barbados, B. W. I. So far as I am able to ascertain this is the first record of this plant in the Western Hemisphere. It occurs naturally from Anglo-Egyptian Sudan and Tanganyika to Malasia, the East Indies and Australia. It is apparently a roadside weed and according to Mr. Gooding is frequent in an area of 2 to 3 miles on the northern end of Barbados, in the vicinity of an old estate. It seems probable that it was introduced with the exotic plants which Mr. Gooding says were imported for the gardens of this estate. It should be rather interesting to watch the spread of this weed in the West Indian area.

oOo

La Trichodesma zeylanicum (L.) R. Br., oriunda de la zona comprendida entre el Sudán angloegipcio y Tanganyika hasta la Malasia, las Indias Orientales y Australia, ha sido coleccionada por primera vez en el Hemisferio Occidental por el señor E. G. B. Gooding en una pequeña área al extremo norte de Barbados. Probablemente esta mala yerba fué introducida junto con otras plantas exóticas y será interesante ver como se desarrolla en las Antillas.

CELEBRACION DEL DIA DEL ARBOL[1]/

José Marrero
Tropical Forest Experiment Station

Espléndida oportunidad la que nos brinda el Departamento de Instrucción de dirigirnos a lo más preciado de nuestra isla: a sus niños. Ideas buenas se malogran si encuentran mentes endurecidas o indiferentes; pero fructifican si las reciben corazones juveniles y mentes ahitas de curiosidad. Dedicamos, pues, estas líneas a los niños de nuestras escuelas, especialmente los de las zonas rurales: al simpático "jibarito" de nuestros campos.

Hoy, como en años anteriores, vamos a dedicar el día a uno de los más abnegados mártires de todos los tiempos; vamos a rendirle tributo al árbol. En todas las naciones las florestas han sucumbido para dejarle paso al hombre y su progreso, y los campos que le han dado riquezas y prosperidad han sido abonados con las cenizas y los restos de los bosques.

Sus mentes inquietas se preguntarán si vale la pena entonar himnos en un día y destruir árboles cada uno de los muchos días del año. Hoy mismo, camino de la escuela, seguramente ustedes han presenciado árboles o arbustos quemados, cortados y desgajados; o toda una generación de arbolitos que forcejeaba por establecerse y serle útiles a ustedes mismos, talados y quemados para dar sitio a una siembra de habichuelas que las más de las veces no se cosecha debido a mucha lluvia, a mucho sol, a insectos o enfermedades. Ustedes se preguntarán en qué nos iban a beneficiar esos arbolitos. Sencillamente ellos al crecer protegen el suelo, lo enriquecen, y lo hacen más suelto; ya algo crecidos si se cosechan ordenadamente producen carbón y leña para combustible, espeques para cercas y alambradas, mangos y cabos de herramientas para labrar la tierra. El bosque al cerrarse da vida y sostén a las aguas, elemento esencial para nuestra existencia, sirve para levantar hogares y suplir material indispensable a las diversas fases de la vida moderna.

Nuestros padres y abuelos levantaron sembrados de caña, tabaco y vegetales y plantíos de café y frutas de los cuales dependemos todos. Ellos crearon riqueza y prosperidad pero nos legaron la indeseable herencia de mucho terreno despoblado, lavado, cansado y casi inútil. La misión de ustedes es mantener y mejorar siembras y plantíos de caña, café y tabaco pero además ustedes tendrán sobre sus hombros la dura tarea de reponer esos terrenos y de restablecer esas arboledas.

Esta es labor de generaciones. Creemos que su realización dependerá de la actitud y conceptos que ustedes niños de escuela adopten y formen hacia estas cosas. Nuestros padres crecieron con la noción de que el bosque era algo para destruirse. Algo que molestaba y que mientras más pronto se sustituyera por tabaco o caña de azúcar mucho mejor.

1/ Nota del Editor: Teniendo como objetivo utilizar la celebración del Día del Arbol el 28 de noviembre pasado, preparamos este artículo para leerse y discutirse en las escuelas de la isla. Se distribuyeron seis mil copias a través del Departamento de Instrucción Pública. Lo ofrecemos en nuestras páginas por creer que presenta ideas de interés para todos los países de la zona del Caribe.

Si ustedes heredan y practican esa teoría la campiña de Puerto Rico seguirá mostrando grandes áreas despobladas, la escasez de combustible, maderas para implementos agrícolas y para construcción será más aguda; los suelos depreciarán mucho más y las aguas serán cada día menos puras y menos consecuentes. Si por el contrario ustedes asimilan el concepto de que el bosque y el suelo se complementan y son necesarios el uno al otro; de que el crecimiento del monte es muchas veces el único medio al alcance del campesino para restablecer suelos agotados y que toda finca que produce cosechas agrícolas debe tener su monte o arboleda en los terrenos de menos valor entonces por lo menos se habría echado la base para dar y ganar esta gran batalla. ¿Qué finca en los valles y montañas de esta bella isla no tiene sus lomas y rincones donde el bosque sin tropezar con nadie rinda su labor útil y bienhechora?

Es éste esencialmente un problema de educación. La evolución de ideas hacia nuevas corrientes del pensamiento ha tenido su base en la escuela. Proponemos, pues, que aquellas Segundas Unidades y Escuelas Rurales que cuentan con malezas y terrenos propios levanten florestas y pequeñas parcelas de montes donde el estudiante aprenda y practique el cultivo de bosques que más tarde levantaría en su heredad. Las discusiones en clase irían moldeando y encaminando la mente juvenil por senderos de conservación. Clubs forestales 4-H servirían perfectamente a este propósito.

En esta labor tendrían ustedes el consejo y ayuda del Servicio de Divulgación y Fomento (Extensión) Agrícola, del Servicio Forestal y de la Estación Experimental de Bosques la cual gustosamente contribuyó estas líneas. Actualmente tenemos en preparación un panfleto que será excelente guía hacia el objetivo ya mencionado y que esperamos poner pronto a la disposición de sus maestros.

Cuando hayamos articulado un plan con los propósitos ya explicados, entonces El Día del Arbol será de dedicación a positiva y fecunda labor. No será día de remordimientos y de vanas promesas que muy pronto se olvidan. Entonces podríamos olvidar el pasado y mirar llenos de confianza al porvenir. ¡ESTUDIANTES Y MAESTROS, USTEDES TIENEN LA PALABRA!

Summary

In this Arbor Day celebration our organization wishes to dedicate this message to our school children especially to those of the rural communities. The rapidity with which agriculture on steep hill lands is replacing the forest stands with the consequent deterioration of a considerable portion of the land heritage is pointed out and at the same time the benefits derived from forests are briefly explained. Emphasis is placed on the fact that in addition to maintaining and improving such agricultural lands, the children will have the burdensome task of restoring the fertility of worn-out soils and of reestablishing forests.

The writeup is built around the concept that the attitude of our children will decide the fate of our farm woodlands in the future. Suggestions are offered to establish woodlots in the rural schools to serve as demonstration woodlots where the future farmers could be trained in the care of the woodlands and introduced to the philosophy of conservation. 4-H clubs are suggested as a very helpful means.

CONTENTS

SUMMARY OF SILVICULTURAL EXPERIENCE WITH CEDAR, CEDRELA MEXICANA ROEM. IN TRINIDAD

J. S. Beard
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Editor's foreword.--Ever since the days of the Spanish main the wood of Spanish cedar, Cedrela sp. has been highly prized and a ready market has been available. This together with its prolific seeding, ease of propagation in the nursery, and rapid growth has made the reproduction and management of this species almost invariably the first to receive attention by foresters in the tropics of the Western Hemisphere. As far as is known, no real success has attended these efforts and except for the small amount of natural reproduction which survives most foresters have abandoned the planting of cedar. The Tropical Forest Experiment Station hopes to carry on research in an attempt to solve this mystery but before embarking on this project is attempting to obtain all information on planting and research experience. The following information was kindly supplied by the Conservator of Forests in Trinidad which we found so interesting that we requested the privilege of publishing on the thesis that negative results may be extremely valuable. The Station would appreciate having the experience of others with this species and would be particularly interested in the details of any successful plantations either pure stands or in mixture.

Botany

Systematy

The Trinidad species was considered until 1922 to be Cedrela odorata L. In that year examination of Trinidad material showed it to be C. mexicana Roem. Three West Indian species had been confused under the name C. odorata, namely C. odorata L. (apparently confined in a wild state to Jamaica), C. sintenisii C. DC.[1] (Puerto Rico only) and C. mexicana Roem.[2]

Description[3]

Tree 27 to 40 m. high and up to 3 m. in diameter, heavily plank-buttressed. (A tree of 52 inches girth has been recorded in the Central Range Reserve.)

Leaves alternate, without stipules, pinnate 4 to 6 dm. long, with about 10 pairs of leaflets, paripinnate (juvenile form is imparipinnate.)

1/ Identified as C. odorata L. by Britton & Wilson.
2/ North American Flora. 25.293.
3/ Williams, R. O. Flora of Trinidad and Tobago, Vol. I, p. 159. Trinidad, 1929.

Leaflets entire, unequal-sided, lanceolate, ovate-lanceolate or oblong, acuminate at the apex, more or less rounded at the base, up to 16 cm. long and 6 cm. broad, glabrous, membranous.

Flowers monoecious in terminal panicles; panicles loosely branched, 2 to 3 dm. long; calyx 5-lobed, 1.5 to 2 mm. long, puberulous, shallowly lobed, the lobes mostly triangular; petals 5, erect, imbricate, more or less keeled inside, oblong 5 to 6 mm. long, 1.5 to 2 mm. broad, densely pubescent outside, puberulous with longer hairs inside; disk, thick or elevated, and columnar 4 to 6 lobed, stamens 4 to 6; filaments joined to the columnar disk below, free above, inserted on the edge of the disk, slender, glabrous; ovary 5-celled, sessile on top of the disk, glabrous; style united, 1 to 1.5 cm. long, glabrous; stigma disk-like; ovules pendulous in 2 series, 8 to 12 in each cell; fruit a capsule, leathery, 5-celled, septicidally 5-valved from the apex, oblong to elliptical-oblong, 4 cm long, 2 cm. broad; seeds pendulous, winged, samara like, 12 to 25 mm. long including wing.

Ecology

General Distribution

Recorded from Mexico, Central America, Venezuela, West Indies (Cuba, Antigua, Martinique, St. Lucia, Trinidad and Tobago.)

Local Distribution: Natural

The natural forests of the island may be divided, from the cedar standpoint, into three classes: those where cedar is absent, those where it is rare to occasional and those where it is frequent or abundant.

Cedar is absent from:

1. Montane forest. -(Lower Montane Evergreen Rain Forest, Montane Rain Forest and Elfin Woodland). High precipitation, exposure to wind, absence of actual drought but possible presence of physiological drought.

2. Swamp forest.--Inundated for all or part of the year and suffering physiological drought.

3. Marsh forest.--Alternately inundated and dried out - alternation of actual and physiological drought.

4. Littoral forest.--Windward seaboard, physiological drought set up by sea blast.

Cedar, therefore, avoids any habitat where there is physiological drought, and is found only on inland, lowland, well-drained sites.

Cedar is locally rare to occasional in:

Evergreen semi-monsoon forest.--Here the periodicity of the rainfall leads to a seasonal drought from January to April, with an average intensity measured as 3 months with under 4 inches of rain each but over

2 inches, the remaining months all having over 4 inches. The total annual precipitation varies from 70 to 120 inches. Cedar is not of uniform distribution throughout this type of forest. It avoids the higher rainfall areas and the sandy soils, but is found occasionally on the clay soils in the Central Range; that is to say, it is better developed on the driest sites, for the clay soils are stiff and impermeable and in dry weather tend to dry out, becoming hard with deep cracks. It shows further a marked site-preference for the tops of ridges. On 3,160 chains of enumeration survey lines (equivalent to 316 acres actually enumerated) on clay soils in the Central Range Reserve in more or less virgin forest the following stocking of cedar was found:

Girth class in inches										
1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10 +	Total
14	6	5	5	8	7	3	2	6	9	65

This gives an average stocking of one tree to about every 5 acres. The distribution of size classes is typical for large dominant trees in tropical forests, that is to say there is a certain apparent shortage of the smaller (younger) sizes, which appears to be due to very rapid growth in youth and great age of large trees, leading to accumulation in the larger (older) size-classes. There is no reason, from the enumeration records, to infer that cedar is not now regenerating itself and is dying out in this type of forest, though this has been concluded from observations that seedlings of the tree are apparently rare and that both they and saplings and young trees may often be observed in an unhealthy or dying condition. Cedar is a deciduous species and typical of the more xerophytic semi-evergreen forest, where it reaches its optimum development (see below). The contention that it is dying out today in evergreen forest, would postulate that it is a relic of drier conditions and that a climatic change has taken or is taking place. For this there is absolutely no evidence. It must be remembered that in evergreen forest, cedar is on the extreme edge of its natural range, as evidenced by its preference for the driest obtainable sites, and therefore may reasonably be expected to show symptoms of trouble in establishment of young individuals.

Cedar is of <u>frequent to abundant</u> occurrence in:

<u>Semi-evergreen semi-monsoon forest</u>.--Here, due to lowered rainfall, hard impermeable or too freely draining soil or steep topography, or a combination of some or all of these factors, the seasonal drought is of greater severity than in evergreen forest. Its intensity may be measured as the equivalent on fairly free-draining soil and gentle topography of 5 months with under 4 inches of rain each but over 1 inch, the remaining months all having over 4 inches. The drought is reflected in the forest growth, about one-third of the species and one-sixth of the individuals in the upper story being deciduous. The associations belonging to this formation may be arranged in two groups: the Southern

Range forests and the Limestone forests. The former occupy the low-rainfall areas along the southern and eastern coasts with annual precipitation of 50 to 70 inches, soils mainly hard clays and slopes moderately to very steep. The latter are found on limestone outcrops in the north of the island where the rainfall is high (90 to 120 in.), slopes are very steep, and the soil is thin over porous rock with excessive subsoil drainage. These forests are the natural home of cedar in Trinidad. In the southern range forests, cedar is occasional on sandy soils, at the rate of one tree to 5 acres, and frequent on clays at the rate of one tree to 1-1/2 acres. In the limestone forests there are four trees per acre. On 85 chains of enumeration survey lines (= 8.5 acres) at Mount Tamana and at Cumaca in the Northern Range, on limestones, the following distribution of cedar in girth classes was found:

Girth class in inches										Total
1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10 +	
-	4	2	5	6	4	1	5	1	5	33

The size class distribution is closely parallel to that recorded in evergreen forest and shows the same apparent deficiency in the smaller sizes. It cannot be claimed that cedar is dying out here. The development of individual trees is the same in evergreen as in semi-evergreen forest, the same gigantic old trees being encountered. The degree of abundance of the species shows a close relation with soil-moisture conditions, and definitely shows the optimum habitat to be the semi-evergreen forests. The tree's deciduous habit should therefore be regarded primarily as a physiological character, the leafless period having only a coincidental relation with the period of sexual reproduction.

Summary

Cedar is most abundant naturally in areas with a marked seasonal drought, on excessively drained limestone soils with high rainfall, or stiff clay soils with low rainfall. It extends its range to areas of less marked drought only in the drier locations such as ridge tops and heavy clay soils. It is absent from areas with much water in the soil and from the littoral tract.

Local Distribution: Secondary

The distribution of cedar in secondary vegetation (bush and plantations) is much harder to define than its natural distribution. Having a light, winged seed which is scattered by the wind, a very rapid early growth, and a "light-demanding" habit, it has the faculty of springing up "like a weed" in clearings and cultivations and by roadsides. Such areas clearly offer a more favorable medium for the dispersal and germination of the seed and survival of young trees of such a species than does natural forest, owing to the absence of competition and heavy shade. Further, the tree is favored by human selection:

a young cedar springing up weedlike will nearly always be spared by man clearing or brushing, whereas valueless weed trees are cut out. Cedar of this type is to be observed nearly always in a flourishing condition, almost anywhere in the island, without regard to its natural limits. It is most flourishing at the foot of the northern range from San Juan to Tacarigua and southwards into the Caroni Plain (rainfall 50 to 80 inches), in sheltered valley sides in the northern range between Toco and Grande Riviere (rainfall ?: possibly low, say 60 to 80 inches), and on marly and clay soils in the Princes Town district (rainfall 95 inches): but occasional healthy trees may be observed almost anywhere. The "most flourishing" distribution in secondary vegetation corresponds to a certain degree with the natural distribution. The tree avoids sandy soils, badly-drained sites, and high rainfall areas, preferring clay soils and dry sites and localities. None the less, its apparent readiness to come up almost anywhere even under swampy conditions led to early hopes of ease in its silvicultural treatment.

Silviculture

History of Regeneration Operations

Artificial regeneration of cedar in the forest was begun in 1908 at the Southern Watershed Reserve - a dry area with clay soil and rainfall of about 55 inches. Until 1912 ten acres were treated annually. The existing forest was felled and lopped (not burnt). Half of each coupe was planted with natural seedlings from the forest and half was sown, the spacing being 20 by 10 feet. Survival and growth were good. In 1912 all plantations were destroyed by fire. They were resown but were never satisfactory, probably due to soil degradation. Treatment of cedar was begun in the Arima Reserve in 1911 (high rainfall area, about 95 inches, little seasonal drought) and the Central Range Reserve in 1913 (high rainfall, 90 to 120 inches). These plantations were burnt before sowing or planting. From 1914 food crops were grown with the young cedar plants.

From 1914 on at the Southern Watershed open plantations were given up in favor of shelterwood. Forty to fifty acres annually were so treated. Undergrowth and small trees of inferior species were cut and large trees of inferior species were girdled and poisoned, leaving as a shelterwood such trees of valuable species as were available, and in places where these were insufficient the necessary number was made up of such less valuable trees as were in existence. The cut material was burnt. Cedar seeds were sown at 10 by 10 feet. Other species were also sown.

Operations for natural regeneration were conducted in the form of improvement fellings in the Southern Watershed Reserve from 1916. Altogether 7,090 acres were treated. The operations consisted of the cutting of creepers, the girdling or felling of trees of inferior species that would if left interfere with the healthy development of the already existing seedlings of cedar and other valuable species, the letting in of more light to the leeward of patches of natural regeneration for the purpose of inducing a further crop of the same, and the making of seeding fellings to the leeward of existing cedar trees of seed-bearing age.

In 1923 the regeneration program was suspended since, as the Conservator of Forests wrote, "it is unfortunate but true that to the best of my knowledge there are no cedar plantations in the Colony which can really be rated as first class". Results of the previous 15 years' work had in fact been disappointing and a series of comprehensive experiments were begun to get at the root of the trouble. These experiments are still in progress, without conclusive outcome, after 18 years.

It had proved quite easy to establish a young crop of cedar, either artificially or naturally, in the open or under shelterwood, and initial growth was usually rapid. This was followed, however, by a period of growth stagnation, unhealthiness and high mortality, so that promising young plantations suddenly died out altogether or became seriously depleted and unhealthy. This phenomenon is dealt with below.

Pests, Diseases and Pathological Symptoms

1. Pests.—Cedar has one major pest, the shoot-borer pyralid moth Hypsipyla grandella, which lays eggs in the young leaf axils. The larvae on hatching turn downwards in the pith of the shoot and eventually pupate there. The shoot dies and branching takes place below the dead part. The moth therefore has a very serious effect on the form of the trees, but does not appear to be connected with actual mortality.

Other pests are of quite minor importance. Freysuila cedrelae, the woolly psyllid of cedar, occasionally found forming white patches on the leaves and stems of young trees. In May, 1932, small sucking insects (Pachylis sp.) of the Hemiptera-Heteroptera were found on recently defoliated cedar at Tamana. Young seedlings are liable to destruction by mole crickets which cut the roots.

2. Diseases.—Elaborate attempts to detect the presence of disease have failed, except for a Rosellinia sp. recorded on young cedar roots at Tamana and this was not proved parasitic.

3. Pathological symptoms.—The dying off of plantation cedar is accompanied by the appearance of pathological symptoms which up to now cannot be related to anything save natural causes. These are:

Root rot.—Roots of seedlings which died have been almost entirely rotted off. Soil-acidity tests were made but failed to show any relation to the losses. Root-rot is usually associated with heavy rains and may indicate great sensitivity of the plant roots to too much soil moisture.

Weeping willow effect.—Young cedars which have grown well until 3 years old frequently develop a weeping willow appearance as a prelude to dying back. The shoots become long, thin and straggling and distorted into curls and loops. This is evidently due to some physiological trouble.

Unhealthy bark.—Healthy trees have a smooth clean bark for several years, but unhealthy looking bark with a blistered appearance

develops on sickly trees. Apparently it is due to enlarged lenticels

Irregular deciduousness.—Trees beginning to die back develop very small crowns and continually go in and out of leaf during the rainy season. This appears to indicate physiological drought.

Research

Silviculture

On the suspension of the planting program with cedar in 1923, detailed silvicultural experimental work was commenced. The following is a summary of the work and its results.

1924.—A number of 1-acre experimental plots were laid out in the Central Range (high rainfall) and Southern Watershed (low rainfall). The object was to discover the optimum spacing, light and soil requirements and mixtures in which cedar would thrive best. These plots all subsequently failed. The main losses of seedlings were observed to occur along with the heavy rains in July and August. Microscopical examinations failed to show any insect or fungus disease.

1925.—A number of young cedars were transplanted in the dry season (when out of leaf) with very satisfactory results, although later they all died back.

A very healthy nursery resulted from choosing a well-drained site on a hillside with full exposure and by forking the beds well.

A considerable number of seedlings were observed around a cedar tree in the Central Range under full shade. On a small area the overhead cover was lightened and finally removed. Here the cedar came on nicely (for the time being) while in the untouched area all died.

1926.—More attention was given to planting (as opposed to sowing), draining and weeding.

Successful results were obtained in planting in the dry season despite the most severe drought in 15 years.

The necessity of good drainage became clear. Much attention was paid to weeding, and sweet-potatoes and other food plants were tried as cover-crops.

A study was made of the geological formations on which cedar thrives best.

1927.—The tree factors: soil, topography and exposure were considered paramount. Cedar appeared to need a moderately rich soil, being essentially a tree of the ridges and intolerant of undue exposure.

Most of the original cedar plots had failed by this time.

Ecological survey work was started.

1928.—The problem was transferred from the obtaining of good results in the first year to the maintenance of these results during succeeding years. Successful establishment of a young crop had proved possible, given a fairly rich, well-drained soil, shelter from wind and sloping land with good natural drainage. Unfortunately, such plantations, though promising at the start, invariably began to die back after 1-1/2 to 3 years, and experiments were directed towards tiding them over this critical period.

A soil-protecting underwood was considered important and attention was directed to accessory species

1929 —Soil investigations were begun: these are dealt with separately below

Clean weeding was abolished in all plantation work and every effort was made to get the soil well covered. Silvicultural studies were made with accessory species

1930 —Effort was concentrated on accessory species, such as Pentaclethra macroloba, Brownea latifolia, Swartzia pinnata, Inga sp., Morisonia americana, and Pachira insignis Results were disappointing except with Pentaclethra It was hoped that the evergreen understory would maintain the humus status of the soil and so lead to proper conditions for survival of the cedar.

1931-32.—Cedar was planted with all conditions considered necessary secured and with a Pentaclethra understory in the Central Range. All the plots subsequently failed. Cedar planted without a definite understory at the Southern Watershed showed good progress after a poor start.

1933 —It now became apparent that the cedar problem had branched into two main divisions Regeneration in evergreen, and in semi-evergreen forest, yielding quite distinct results. In evergreen forest areas, with their relatively high rainfall and slight seasonal drought, cedar plantations were easily established and grew vigorously for 18 months, after which they invariably degenerated In semi-evergreen forest areas, with their relatively low rainfall and intense seasonal drought, germination of cedar seed was difficult to secure and early growth slow, but after about 3 years the trees seemed to go ahead without die-back.

1934 —The position was summarized by the Conservator of Forests as follows:

	Southern Watershed Reserve Low Rainfall	Central Range Reserve High Rainfall
Germination	Bad	Good
1st year's growth	Slow	Rapid
2nd year's growth	Slow	Rapid, but signs of deterioration at the end.
3rd year's growth	Improving rapidly: bark good: crowns good: sturdy trees.	Bark bad: crowns poor: whippy trees: weeping willow effect.

Since 1934 nothing new has eventuated. Every plantation in high rainfall areas has failed and the problem was considered silviculturally insoluble for the time being. Attention was shifted to soil and nutrition experiments (see below). Of the two plantations established in 1931 in the low rainfall area, one failed; the other, being on a south aspect and generally drier and airier, grew uniformly well until destroyed by fire in 1940. This was the only known successful cedar plantation, except for one in the limestone outcrop of Mt. Tamana in the Central Range Reserve.

Soils

Soil investigations were begun in 1929 in collaboration with the Imperial College of Tropical Agriculture. All results have been inconclusive.

Four lines of attack were tried.

1. Soil deterioration.—In 1930 the Conservator of Forests suggested that soil deterioration due to exposure of the soil to atmospheric influence might cause the failure of cedar plantations. Three pits were sampled, one in the 1930 cedar plantation at the Southern Watershed, one in natural forest, and one in the 1928 cedar plot which was dying back. On examination of the samples it was found that the older cedar area showed:

1. Great loss of organic matter.
2. Lower carbon/nitrogen ratio
3. Least amount of available nutrients.

Further samples were taken in the Central Range from the 1930 cedar experimental plot and natural forest control. Professor Hardy of the Imperial College of Tropical Agriculture wrote after the analysis: "There are no very distinct evidences of soil deterioration shown by these results, except the relatively low available nutrients and the relatively low rate of solution of the top soil of the cleared area as compared with the control area. This may imply leaching of nutrients from the uppermost layers."

It was not proved that soil deterioration was responsible for the cedar die-back.

2. Water-table studies.—In August 1932, the question of water (as opposed to deterioration) being the controlling factor in cedar regeneration, was taken up and studies were started at Tamana with a view to correlating the following:

1. Condition of cedar.
2. Rainfall.
3. Level of water-table.
4. Moisture content of soil.

The first samplings were begun in October 1932 when samples were taken from: (a) the 1930 cedar plot, (b) the 1931 cedar plot, and (c) natural forest - control.

Composite samples were taken from 20 spots on each area and were taken at three depths (0 to 6 in., 6 to 12 in., 12 to 24 in.). These samples were taken at fortnightly intervals from October 26, 1932 to October 12, 1933, and the Imperial College of Tropical Agriculture made laboratory determinations using the formula: free water equals G-0.6P where G is the gross soil moisture and P is the moisture at the point of stickiness.

In addition to this, perforated steel drainage tubes were put into the ground at 5 spots in each plot and the water level was read off weekly from September 16, 1932 to July 22, 1933.

The rainfall, moisture content and water level were then graphed.

The results indicated that there was no marked difference between the three plots studied, and therefore it was concluded that the water factor could not account for the failure of cedar. At the same time it must be borne in mind that there was no adequate control plot available, since the natural forest plot had practically no standing cedar and no natural regeneration of cedar could be observed in the area. Yet one important conclusion to be drawn from this work is that the system of silviculture adopted retained practically the same water relations as the natural forest, and consequently the following alternatives are possible:

(a) The water factor is not responsible for the failure of cedar.
(b) The available water supply in the natural forest is at present unsuited for the growth of cedar in plantations

There is no evidence to show that the area in general was ever suitable for plantations of cedar, since the occurrence of one flourishing cedar plot about 16 years old is counterbalanced by the fact that this was the only survivor of a number of plots of the same age.

3 Comparative analysis.—The object was to determine whether soil analysis of sites bearing good and bad cedar would give any indication of the reasons for the success or failure of the trees. The method therefore consisted of sampling "good" and "bad" cedar soils in the same vicinity. This was also inconclusive

4 Liming.—In 1934 it was decided to apply a heavy dressing of lime to a part of the 1932 cedar plot at Tamana where the trees were beginning to show unhealthy symptoms, to determine whether this would alter the soil sufficiently to prevent die-back of the trees. Six tons were applied to one-half acre. Results were inconclusive

Nutrient deficiency tests

Sand culture experiments to determine whether any nutrient deficiency was the cause of failure of young cedar were begun in 1937. Due to faulty technique no result was obtained and the tests were repeated at the Imperial College of Tropical Agriculture, beginning in 1938. Young cedars were grown in drums of sand and watered with various solutions to test reaction to deficiency of nitrogen, potassium, phosphorus, calcium and magnesium.

No result was obtained. Unfortunately rain water was not available for making up the solutions and tap-water was used. Plants fed with pure tap-water alone grew with great vigor, subsisting on the very small amounts of salts contained in the tap-water. Indications were that cedar does not suffer from nutrient deficiency.

Miscellaneous Research

1. Germination tests

Results of tests carried out by the Imperial College of Tropical Agriculture, 1929.—Seed received June 6. First trial started June 26 Seeds sown in soil. After 15 days 8%; after 29 days 12%; after 35 days 12%; after 51 days 16%; after which no further germination occurred In January 1930 they were examined and seemed quite healthy.

General notes on the germination of cedar seed.—Germination is normally very good within a week or two, provided that there is enough moisture. Broadcasting succeeds in areas with high rainfall.

Germination record to end of 1933.

Year	Locality	Germination %		Germination period		Remarks
		Open	Shade	Open	Shade	
1933	Arena	62	54	4 weeks	3 weeks	Covered
		60	62	4 weeks	4 weeks	Uncovered

2. Nursery research.—In 1938 it was found that burning brushwood on the nursery beds before sowing had a beneficial effect on germination, survival and growth of cedar.

3 Protection from the sun.—In 1935-36 it was found that sheltering unhealthy young cedar from the sun had no effect.

4 Moisture content.—In 1935 a healthy tree at St. Joseph (growing in the railway yard) and an unhealthy tree at Tamana (natural forest) were selected, described and cut down. Three inch sections at four foot intervals were cut out and their moisture contents determined. Except for the green growing point, the moisture content of the St. Joseph Cedar was substantially higher than that of the Tamana cedar. As only one tree of each was selected, conclusions could only be tentative; but they indicated that the St. Joseph cedar in spite of drier environment had more moisture in circulation than the Tamana cedar. This could not be due to lack of available moisture at Tamana and must be attributed to some physiological factor.

5. Leaf analyses.—Leaves from healthy and unhealthy trees were analyzed to determine their mineral content. Results were conflicting.

Summary

The cedar problem would appear to be one of soil moisture relative to a sensitive root system. The most marked symptom exhibited by unhealthy young cedar in plantations is the frequent intermittent loss of leaf during the rainy season when leaf-activity is normally at its fullest. This would seem to indicate physiological drought. A further feature of cedar is its numerous contradictions, e.g. healthy cedar occasionally flourishing under swampy conditions, young trees with long tap-roots sometimes found whereas normally they are surface rooted, and so on.

It has proved quite impossible to grow cedar as a crop in evergreen forest areas. Some success has resulted in semi-evergreen forest, but growth is so slow and danger of fire so great that it has not been thought worthwhile to proceed further. Every possible avenue appears to have been explored to attain success in evergreen forest and the solution is yet elusive.

Resumen

En Trinidad desde 1908 al 1923 se intentó regenerar artificialmente el cedro español, Cedrela mexicana Roem sin éxito alguno. Se demostró que era facil establecer plantaciones inicialmente por regeneración natural o artificial, a campo abierto o bajo techo. El crecimiento inicial por lo general era rápido. Sin embargo esta primera etapa seguía un período de estancamiento y de alta mortalidad, de manera que prometedoras plantaciones jóvenes decaían repentinamente, bajaban seriamente en número de árboles o se mostraban faltas de vigor.

Los síntomas que acompañan esta condición son peculiares y difíciles de explicar. Las raíces se pudren casi por completo, el árbol adquiere aspecto de sauce llorón, es irregularmente deciduo y la corteza se levanta en forma de verrugas. Búsquedas muy cuidadosas no mostraron ataques de insectos y enfermedades. Experimentos realizados entre 1923 y 1934 incluían estudios de cada factor que pudiera afectar la regeneración tales como prácticas del semillero, siembra, cantidad de luz, lluvia, suelos, humedad del suelo, topografía, y deficiencias de nutrición. Ninguna se encontró directamente relacionada con dicha condición.

El problema del cedro parece consistir en la relación entre la humedad del suelo y un sistema de raíces sensitivo. El síntoma más marcado que muestran los arbolitos en plantaciones afectadas es la intermitente y frecuente pérdida del follaje en la estación de lluvias cuando las hojas normalmente se hayan en su mayor actividad. Esto parece indicar sequía fisiológica. En el "semi-evergreen forest", se ha tenido algún éxito, pero el crecimiento es tan lento y el peligro de fuego tan grande que se ha creído no vale la pena seguir trabajando ahí. Parece que se han considerado todas las posibilidades que pudieran tener éxito en el "evergreen forest" y la solución es todavía elusiva.

A SYNOPSIS OF THE PALMS OF DOMINICA

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Native palms, although not numerous, are attractive features of Lesser Antillean vegetation. They are, however, but incompletely known and new entities are still to be expected from certain of the Caribbee isles. L. H. Bailey, who has contributed most recently to our knowledge of palms from this island arc, has kindly determined the members of this group represented in the writer's collections from the British island of Dominica.

The palm flora of Dominica is composed of only seven species representing five genera. Of these only Acrocomia aculeata has been previously recorded from the island. Of the remainder only one, ubiquitous Euterpe globosa, is widespread in the West Indies: one, Rhyticocos amara is localized on Guadeloupe, Dominica, and Martinique: three are novelties (Euterpe dominicana, Geonoma dominicana, G. Hodgeorum, the last-named described herewith); while the remaining species, Coccothrinax martinicensis, has until now only been recorded from Martinique. Thus the majority of the palms of Dominica can be seen to represent very localized species.

Dominica's palms are valuable as index species and as such delimit the chief vegetational zones of this small island. Acrocomia, Coccothrinax, and Rhyticocos inhabit the dry coastal hills or "mornes" and are good indicators of the extent of the low, scrubby, tropical forests which cover most slopes under the one thousand foot level. The latter genus is also prominent in the transition (the borderline of the mesophytic forest) where in certain localities it often forms extensive groves which are the largest known in the range of the local species. Mesophytic conditions are predominant on Dominica and above 1500 feet (1500 ft. to 2500 ft.) there exist magnificent tropical rain forests. Scattered sparingly throughout the latter is the commonest and tallest of the island's palms, Euterpe dominicana (palmiste or manicol), until recently undescribed. Associated with it in the same forest, but generally on steep shaded slopes or in sheltered wet ravines, is Geonoma dominicana (yanga)—another recent discovery—a slender, understory species with a cane-like trunk. Finally in the windswept, dripping, gnarled growth of the diminutive mossy-forest, characteristic of the higher mountain summits, there is to be found a similar Euterpe-Geonoma association, but here the species involved are common Euterpe globosa and rarer Geonoma Hodgeorum.

As elsewhere in the tropics, palms in Dominica serve the native population as a source of food and shelter. Both species of Euterpe supply an edible bud (mountain cabbage); the bud of Rhyticocos is also palatable but is apparently seldom used. All species (the spiny Acrocomia excepted) are a source of thatch. The leaves of the species of Geonoma are especially sought after and in former days the Carib aboriginals made even greater use of this roofing material. The same Indians fashioned the fan-shaped leaves of the now rare Coccothrinax into baskets, cassava squeezers, and tables, and their dwindling descendants still use the decorticated prop-roots of Euterpe dominicana in the manufacture of shoulder baskets.

The following key may be useful in identifying the native palms of Dominica:

a. Palms with pinnate leaves.... b.
 b. Prickly coastal palms with long spines on the stout fusiform trunk, also on the main ribs and petioles of the leaves..... 1. Acrocomia aculeata
 b. Non-prickly palms... c.
  c. Spathes long (0.5 m. or more in length), woody, pendant from the leaf axils; fruit large (ca. 5 cm. long, 3-4 cm. broad), oblong-ovoid, orange at maturity..... 2. Rhyticocos amara
  c. Spathes shorter, non-woody, horizontal or, if pendant, small (ca. 15 cm. long); fruit small (not over 10 mm. in diameter), globular, black at maturity.... d.
   d. Palms with stout trunks (never less than 8 cm. in diameter), these obscurely ringed and furnished at the top, underneath the leaves, with a crown-shaft of green leaf-bases; leaves completely and regularly pinnate; spathes and spadices horizontal, borne at the base of the crown-shaft; fruits 9-10 mm. in diameter.... e.
    e. Palms (15-25 m. tall) of high stem rain forests; crown-shaft 1.5-2 m. long; leaves 12-18 in number, 3-5 m. long, graceful, the pinnae lax (drooping from the rhachis); fruit globular, flattened at both ends, with persistent style centric; endosperm not ruminate..... 3. Euterpe dominicana
    e. Palms (3-10 m. tall) of the mossy-forest zone; crown-shaft almost wanting, leaves 8-12 in number, ca. 2 m. long, stubby, the pinnae stiff—(curving upwards from the rhachis)—; fruit globular, not flattened at the ends, with the persistent style acentric; endosperm deeply ruminate..... 4. Euterpe globosa
   d. Palms with slender, reed-like trunks or canes, these ringed and without a crown-shaft; leaves pinnately veined, irregularly divided; spadices pendant from the leaf axils; fruits 5-6 mm. in diameter..... f.
    f. Delicate palms of deep forests; trunk never over 5 cm. in diameter, and generally averaging 4 cm.; leaves not strongly nerved, blades 1-1.3 m. long, petioles elongated (30-60 cm. long); rhachillae very slender (2-3 mm. thick); fruits 5-6 mm. long, globular with obtuse or rounded tip, not apparently keeled..... 5. Geonoma dominicana
    f. Sturdier palms of mountain tops; trunk 8-15 cm. in diameter; leaves strongly nerved, blades 1 m. long, petioles not elongated (10-20 cm. long); rhachillae stout (5-6 mm. thick); fruits 7 mm. long, acute, 2-keeled..... 6. Geonoma Hodgeorum
a. Palms with palmate leaves..... 7. Coccothrinax martinicensis

FIG. 1.—ACROCOMIA ACULEATA (GROGRU); GROWING IN LOW XEROPHYTIC SCRUB FOREST ON THE COAST NEAR ST. JOSEPHS, DOMINICA.

FIG. 2.--RHYTICOCOS AMARA (YATTAHU), GROWING IN TRANSITIONAL FOREST EAST OF DUBLANC.

FIG. 3.—EUTERPE DOMINICANA (PALMISTE); THE TYPE SPECIMEN GROWING IN FORESTS IN THE VALLEY OF THE PEGOUA RIVER, VICINITY OF DEUX BRANCHES.

FIG. 4.--GEONOMA DOMINICANA (YANGA); A TYPICAL SPECIMEN CUT DOWN IN FORESTS ABOUT LAUDAT.

FIG. 5.--EUTERPE GLOBOSA (PALMISTE MONTAGNE); GROWING WITH CLUSIA VENOSA IN THE MOSSY-FOREST NEAR THE SUMMIT OF MORNE TROIS PITONS.

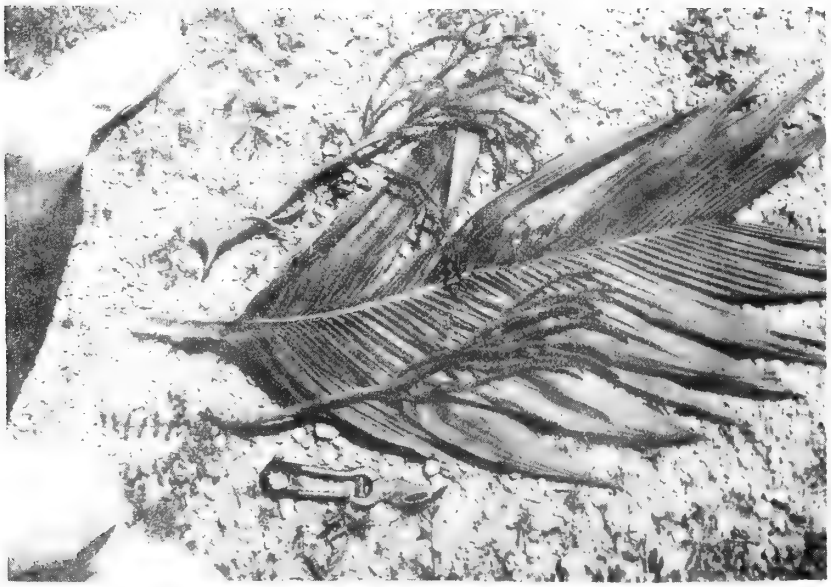

FIG. 6.--GEONOMA HODGEORUM (YANGA); THE TYPE MATERIAL SHOWING LEAF AND FLOWERING BRANCHES. SPECIMENS FROM MOSSY-FOREST ATOP MORNE TROIS PITONS.

1. ACROCOMIA ACULEATA (Jacq.) Lodd. (Grugru, Glouglou). See Figure 1.

In Mart. Hist. Nat. Palm. iii. 286 (1845); Bailey in Gent. Herb. iv. 469 (1941). Cocos aculeatus Jacq. Select. Stirp. Amer. 278, t. 169 (1763).

Type locality: Martinique

Distribution: Dominica and Martinique

Fairly common as scattered individual trees, throughout the scrub woodlands of both coasts. Specimens have been seen by me on the Imperial Road just beyond Canefield, at St. Josephs, and all along the windward coast from Blenheim to Hatton Garden.

2. RHYTICOCOS AMARA Becc. (Coconay, Yattahu). See Figure 2.

In Malphigia i. 353, t. 9, fig. 2 (1886); Bailey in Gent. Herb. iv. 368 (1940). Cocos amarus Jacq. Select. Stirp. Amer. Hist. i. 277 (1763). Syagrus amara Mart. Hist. Nat. Palm. iii. 291. t. 166, fig. ii (1845).

Type locality: Martinique.

Distribution: Dominica, Guadeloupe, Martinique.

A coastal species scattered throughout the xerophytic scrub woodlands of lower altitudes and running inland on the lower ridges as far as the zone transitional to the mesophytic woodland. In some localities (e.g. on the trail from Dublanc to Milton) this palm is very abundant forming small almost solid stands, the individuals 10-15 m. tall. I have seen this palm below Milton, on the Portsmouth road at Blenheim, on the bluffs near Calibishie, two miles up the Hampstead River at La Chaudière, and on all the coastal bluffs of the windward coast as far south as Salybia in the Carib Reserve.

3. EUTERPE DOMINICANA L. H. Bailey. (Palmiste, Manicol). See Figure 3.

In Gent. Herb. iv. 375 (1940).

Type locality: Dominica.

Distribution: Endemic.

Common in river valleys at moderate elevations and throughout the rain-forests at middle elevations. This palm has been seen on Morne Plat Pays, along the trail to Castle Bruce, at Sylvania, near La Chaudière, on the valley of the Pegoua River, and on wooded ridges west of Salybia.

4. EUTERPE GLOBOSA Gaertn. (Palmiste montagne). See Figure 5.

De Fruct. & Sem. Plant. i. 24 (1788).

Type locality: Unknown.

Distribution: West Indies.

This is a palm of the highest volcanic peaks, there constituting one of the chief elements of the mossy-forest. I have seen the species on Morne Plat Pays, Morne Trois Pitons, and Morne Diablotin.

5. GEONOMA DOMINICANA L. H. Bailey (Yanga). See Figure 4.

In Gent. Herb. iv. 232 (1939). G. pinnatifrons var. vaga Burret in Engl. Bot. Jahrb. lxiii. 213 (1930).

Type locality: Dominica

Distribution: Endemic

Infrequent on deeply forested slopes or in wet shaded ravines at middle and higher elevations. This palm has been collected at the following stations: Morne Colla Anglais, Sylvania, Morne Plat Pays, Laudat, Fon Pays, Morne Diablotin.

6. GEONOMA HODGEORUM L. H. Bailey, spec. nov. See Figure 6.

Affinis Geonomae dominicanae: differt foliis valdius nervatis et segmentis angustioribus, axis spadicis glaber et validior, margo foveolarum acutus, fructus longior et acutus, aliquid carinato-compressus, perianthus fructus major et acutissimus. Arbor, 5-7 m. alta, truncus 10-15 cm. diam.; folia 1 m. longa; segmenta multa, 3-6 cm. lata, longo-acuminata, valde nervata; spadix circa 15 dm. longa; axis rachillarum 5-6 mm. crassus; fructus 7 mm. longus, 5 mm. latus, acutus; perianthus 2-3 mm. longus.

Sturdy tree 15-20 feet tall, trunk 4-6 inches thick: leaves five or six to a tree, about 1 yard long, bright green and glabrous; segments many and close together, not constricted at base, very long-pointed, .5-2.5 inches broad, very prominently ribbed and the intermediate nerves strong on both surfaces but particularly underneath, petiole not elongated: spadix about 2 feet long, twice branched or forked, glabrous or nearly so, the rachillae stout: fruit oblong, two-edged and somewhat compressed, about 5/16 inch long and 3/16 inch broad, acute, surface glabrous; fruiting perianth large, about one-third length of fruit, the six parts acute; cavities or foveolae where the fruit was borne usually split on lower border and presenting two points.

Dominica, British West Indies: mossy-forests on summit of Morne Trois Pitons, alt. 1400 m., rainfall 762 cm., Feb. 23, 1940, Walter H. and Barbara T. Hodge, No. 1430, and Morne Diablotin, Hodges, No. 2835. Type No. 1430 and mature fruit (collected by Toulout Esprit and B. W. Pierre in Aug. 1941) in Herb. Bailey. (Isotypes in Herb. Gray, Herb. N. Y. Bot. Gard., Herb. Massachusetts State College). A sturdier plant than G. dominicana, Bailey, and at higher altitudes, distinguished particularly by the stronger nerving on the leaves, narrower leaf-segments, essentially glabrous rachillae, and longer acute (rather than obtuse or rounded) 2-keeled fruits, and the different fruiting foveolae and perianth.

This endemic species is associated with (but less frequent than) Euterpe globosa on the mountain tops of Dominica. Fruiting specimens are apparently rarely found.

7. COCCOTHRINAX MARTINICENSIS Becc. (Latanier, Alatani).

In Webbia xii. 324 (1907).

Type locality: Martinique.

Distribution: Dominica and Martinique.

This small species was probably once plentiful on the lower coastal mornes especially on the windward coast. It is said to occur on inaccessible bluffs near Vieille Case but I know it only from a single sterile plant growing near Salybia in the Carib Reserve.

Resumen

La flora palmífera de Dominica se compone de sólo siete especies representando cinco géneros. De éstas, solamente la Acrocomia aculeata ha sido previamente informada de la isla. De las restantes, la omnipresente Euterpe globosa está bien distribuída en las Antillas; la Rhyticocos amara se circunscribe a Guadalupe, Dominica y Martinica.

Tres especies son novedades (Euterpe dominicana, Geonoma dominicana y G. Hodgeorum, esta última descrita en el artículo) mientras que la restante, Coccothrinax martinicensis ha sido informada solamente de Martinica.

Las Acrocomia, Coccothrinax y Rhyticocos se encuentran en las áridas colinas costaneras llamadas "mornes". Rhyticocos es prominente también a lo largo de los límites de la floresta mesofita. Aquí la Euterpe dominicana está levemente esparcida siendo la palma más común y más alta de la isla. La Geonoma dominicana se encuentra en asociación con la última en declives escarpados bajo sombra o en las hondonadas protegidas y húmedas. La Geonoma es una especie delgada, de tronco en forma de caña que crece bajo el dosel del bosque. La muy común Euterpe globosa está asociada con la más rara Geonoma Hodgeorum en los bosques musgosos, de árboles retorcidos, barridos por el viento y chorreantes de húmedad, típicos de las cumbres de las montañas altas.

La población nativa usa las palmas de Dominica como fuente de alimento y abrigo. Ambas especies de Euterpe tienen un palmillo comestible. Todas las palmas con excepción de la espinosa Acrocomia proveen material para techar siendo el de las especies de Geonoma el mejor. Las raíces de la Euterpe dominicana se usan en la fabricación de canastos después de removerle la corteza.

THE QUESTION OF CROTON ELUTERIA AND CROTON CASCARILLA

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Some years ago, J. J. Bennett wrote a very interesting article about these two species of Croton in the Journal of the Proceedings of Linnaean Society 4: 26-30. 1860. In this article, he made a complete study of the nomenclatural question and made it of further value by using the original specimens in the Clifford's Herbarium and also other historical material in the British Museum. Mr. Bennett's paper furnished the nomenclatural problem of Croton eluteria (L., Sw. and C. cascarilla (L.) L. and also C. lineare Jacq. and C. Sloanei Benn. He concluded his paper with the following phrase: "These four species are so totally distinct, that, when once discriminated, they can never be again confused."

Unfortunately, Mr. Bennett's expectation did not come to pass because some years later Millspaugh in Field Mus. Bot. 2: 306. 1909, discussed the question and again caused confusion in the discrimination of these species. In attempting to clarify the question, however, I am not so optimistic as Mr. Bennett.

In these two species C. eluteria is first mentioned by Linné in Hortus Cliffortianus 486-487. 1737, as Elutheria and the description states among other things, Arbor ramis teretibus; foliis cordato-lanceolatis crenatis, obtuse acuminatis, petiolatis, glabris, subtus argenteis. The locality is given as Insula Providentiae, one of the islands of the Bahama near Eluthera from which the name is derived. The description given by Linné agrees perfectly with the plant that is known today as Croton eluteria. Since this plant is one of the most common species of Croton in the Bahama, we can not confuse its identity with any other species of this genus.

Here Linné mentions in the first place the following synonym: Elutheria provid. folio cordato subtus argenteo, Sweet-barck f. A Tree W[1]/ Petiv. Collectanea 4. n. 276 & 276[1]/ 1716. At the first glance this looked as if Linné was referring to Petiver's plant, and adding to it a full description, but as we will see later it is more probable that Linné may have had his own material which he believed to be the same as Petiver. Nevertheless, if we should refer to this description of Petiver, we must acknowledge the fact that this description agrees with the plant that we know today as Croton eluteria. We shall mention here also that the plant of Petiver seems to be from Providenciales too, as we can see in Musei Petiveriani 96 (or app.) n. 30. 1703.; here Petiver mentions the collection of plants sent to him by Captain Thomas Walker from Providentiae.

In Flora Zeylanica 174. 1747. Linné mentions Clutia foliis cordato-lanceolatis and to this description he adds a long list of synonyms, among them: Elutheria Hort. Cliff. 486. 1737; Elutheria providentia folio cordato subtus argenteo, Sweet-barck, cortes bene olens Pet. Coll. 4. n. 276. 1716;

1/ Thomas Walker

Ricinus dulcis arborescens americanus Plunk. 11: tab. 220. f. 5. 1541. These synonyms may be correct but we cannot undertake to discuss the remaining synonyms, as it is clear that Linné had different plants from various localities which he referred to his original Elutheria Hort. Cliff.

Again we find Clutia foliis cordato lanceolatis of Linné, in Materia Medica 166. 1749.; here he added only one synonym, Ricinoides elaeagni folio Catesby, which later became the source of confusion to some authors in the interpretation of these two different species. The common name given to the plant by Linné is "cacarillaea", which undoubtedly is taken from Catesby's "Chachrille". He referred this name to the Flora Zeylanica and gave the distribution of the plant as Peru, Florida, Providentia and Paraguay which proved to be incorrect for both of these species.

In Linné's Sp. Pl. 1042. 1753, the binomial Clutia eluteria L., was published for the first time, with the following synonym: Foliis cordato lanceolatis, Flora Zeylanica 174. 1747.; Materia Medica 166. 1749.; Elutheria Hort. Cliff. 486. 1737.; Ricinus dulcis arborescens americanus populnea fronde argentea Plunk. Alm. 11; tab. 220. f5. 1541. We have evidence that some of these synonyms are incorrect.

Some years later, in the Amoenitates Acad. 5: 411. 1760., this question was cleared up by Linné himself when he published two separate species of Clutia, one C. Elutheria in which part of the description is Arbor, Folio alterna, petiolata, ovata, integerrima, supre adspersa, squamis orbiculatis, subtus iisdem tecta. From this description we may with certainty identify this plant with the one which he published in Hort. Cliff. as Elutheria. The binomial Clutia Elutheria fortunately, stands alone without accompanying complicated synonyms and it acquires additional importance because of the simultaneous publication of the other species Clutia Cascarilla.

In conclusion the question may be easily settled by means of the original material upon which Linné based his Elutheria. According to Bennett this type specimen is to be found in Cliffort's Herbarium, now in the British Museum. On this sheet in Linné own handwriting is written Elutheria provid. folio cordato, subtus argenteo. This specimen matches the plant that was described and illustrated in Curtis Botanical Magazine 53: tab. 7515. 1897, and is the same plant that is known today as Croton eluteria (L.) Sw., from the Bahama, Cuba, Jamaica and Hispaniola. It is commonly known among the natives of the Bahama as "Sweet-barck" and from it the commercial "cascarilla" is obtained.

According to the Botanical Rules, we must begin to take this nomenclatural problem into consideration with Sp. Pl. 1042. 1753, but, of course, we cannot forget the history of the plant which was first published as Elutheria in Hort. Cliff., and to the type specimen mentioned. Therefore, we propose to accept this specimen in the Clifford Herbarium as the type of Clutia Elutheria L., Sp. Pl. 1042. 1753, excluding the synonyms.

The other species involved in this question is Croton cascarilla (L.) L., which was first mentioned by Catesby in his Natural History of Carolina, Florida and Bahama 2: tab. 46. 1743., under the name of Rici oides Aleagnia folio. Catesby applied to it the common English name "Ilatera Bark" and the French name "Charchrille". This is accompanied by a precise description from

which we shall quote "The leaves are long and narrow and sharp pointed and of a very pale light green color". This description concurs perfectly with the Catesby plate 46, in which we note the long petiole of the leaves that coincides accurately with another of the common and endemic crotons of the Bahama, which Millspaugh described as Croton bahamensis, Field Mus. Bot Publ. 2: 308. 1909.

The first time Linné mentioned the Catesby plant was in Materia Medica 166. 1749, listing it as a synonym of Clutia foliis cordato lanceolatis which has no connection at all with the Catesby plant which we have discussed in the preceding paragraph.

It is in Sp. Pl. 1042. 1753 that Linné first proposed the binomial Clutia Cascarilla with the description, Foliis lanceolatis acutis integerrimis petiolatis with only one synonym, Ricinus aeleaggni folio Catesby. This description agrees with the Catesby plate 46, and the synonym is correct. A plant that agrees with Linné's description and with the Catesby plate is often reported from Bahama and it was described as Croton bahamensis Millspaugh. As we have said before, it is here in Sp. Pl. 1042. 1753, where we shall take into consideration this binomial Clutia Cascarilla L., which fortunately in this case does not cause any confusion.

In Amoenitates Acad. 5: 411. 1760, Linné unfortunately confused the issue when he published again Clutia Cascarilla adding the following synonym: Croton fruticulosum, villosum foliis cordato acuminatis ramuramulis crassiouibus tomentosis P Browne, Civ. Nat. Hist. Jamaica 347. 1756; Ricino affinis odorifera Sloane, Jam. Nat Hist. 1: 133. tab. 86. f. 1. 1707; Croton foliis lineari-lanceolatis glabris subtus argenteis Mill Lex. Here he concludes with a description that in part states: Frutex Folia alterna, sed sparsa ad divaricationes ramorum facis Hippophaes, petiolata, glabra subtus albido tomentosa. In this case the Ricinoides elaeagni folio Catesby was not included in the synonym but the specific name Cascarilla is conserved, while the description agrees with the original Catesby plant, the synonym is obviously incorrect.

This question is further complicated in the second edition of Sp. Pl. 1424. 1763, where Linné transfers Clutia Cascarilla to Croton Cascarilla, adding a long list of synonyms. These we have discussed in part before.

Therefore, I recommend as the type of Clutia Cascarilla L., the plate 46 of Catesby in the Natural History of Carolina, Florida and Bahama, 1743.

CROTON ELUTERIA (L.) Sw. emend Carabia.- Clutia Eluteria L., Sp. Pl. 1042. 1753 (quoad Elutheria Host. Cliff. 486. 1737 nec quoad restat synonym).- Clutia Eluteria L., Amoen. Acad. 5: 411. 1760.- C. Eluteria L., Sp. Pl. ed. 2. 1476. 1763 (quoad Elutheria Hort. Cliff. 486. 1737, nec quoad restat synonym).- Croton Eluteria (L.) Sw., Prodr. 100 1788 - C. homolepidus Muell. Arg. in DC., Prodr. 15 (2): 518. 1862.- Clutia Cascarilla L. apud Millspaugh, Field Mus. Bot. Publ. 2: 152. 1906. (no C. Cascarilla L., Sp. Pl. 1042. 1753).- Croton Cascarilla Benn. apud Millspaugh, Field Mus. Bot. Publ. 2: 152. 1906. (no C. Cascarilla (L.) L. Sp Pl. ed. 2. 1424. 1763).- Clutia Cascarilla L. apud Britton & Millspaugh, The Bahama Flora 223. 1920 (no C. Cascarilla L., Sp. Pl 1042. 1753).- Croton Cascarilla Benn. apud

Britton & Millspaugh, The Bahama Flora 223. 1920 (no C. Cascarilla (L.) L. Sp. Pl. ed. 2. 1424. 1763).
Type locality: Providenciales Island, Bahama.
Distribution: Bahama, Cuba, Jamaica y Española.
Illustration: Curtis Botanical Mag. 53: tab. 7515. 1897.
Specimens: Bahama; Bahama, J. K. Brace 289.- Bahama, Eggers 4151.- Acklin's Island, Brace 4289.- Berry Island, Britton & Millspaugh 2339.- New Providence, Britton & Millspaugh 5354.- Eleuthera, Britton & Millspaugh 5425.- Atwood Cay, P. Wilson 7386 & 7411.- Mariguana, P. Wilson 7560.- New Providence, Britton 3143.- Great Exuma, Britton & Millspaugh 2985.- Nassau, Curtiss 185.- Cat Island, Britton & Millspaugh 5807.- New Providence, Cooker 3(a).- Hispaniola; Haiti, E. C. Leonard 11841.- Jamaica; Jamaica, Harris 8917.- Cuba; Oriente, C. Wright 1971.

CROTON CASCARILLA (L.) L. emend Carabia - Clutia Cascarilla L., Sp. Pl. 1042. 1753.- Croton Cascarilla (L.) L., Sp. Pl. ed. 2. 1424. 1763 (quoad descriptio nec quoad synonym).- Croton Cascarilla Lam. ex Jackson, Kew Ind. 1. 1893.- Croton Cascarilla Benn. ex Jackson, Kew Ind. 1. 1893.- Croton bahamensis Millspaugh, Field Mus. Bot. Publ. 2: 308. 1909.- Croton Lamarckianus Moldenke, Phytologia 1: 167. 1935
Type locality: Banama
Distribution: Bahama
Illustration: Catesby, Nat. Hist. Carol., Fl. & Bahama 2: tab. 46. 1743.
Specimens: Bahama; Eluthera, Britton & Millspaugh 5574 Conception Island, Britton & Millspaugh 6021 - Cat Island, Britton & Millspaugh 5954.- Rum Cay, Bruce 3979.- Acklin's Island, Brace 4064.- Long Cay, Brace 4165.- Long Island, Britton & Millspaugh 6246 & 6240 - Cat Island, Britton & Millspaugh 6176.- Cat Island, T. Rothrock 566.- Watling's Island, P. Wilson 7330.

All the specimens here mentioned are in the Britton Herbarium at the New York Botanical Garden.

Resumen

En este artículo el autor establece una aclaración sobre la nomenclatura de las dos especies de Croton. El llega a sus conclusiones después de revisar las referencias al respecto y los sinónimos de acuerdo con las reglas botánicas.

EL GENERO CROTON EN CUBA

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Conocido es de todos, las dificultades que el género Croton presenta al botánico sistemático, lo cual también sucede en otros muchos de las Euforbiáceas, razón por lo que no pretendo entrar en una discusión sobre la anatomía y morfología de los crotóns,[1] ni los motivos que pudieran influir en tal o cual tratamiento de este dificultoso género, comprendido por especies sumamente polimórficas y variables, las que son interpretadas de distintas formas por aquellos botánicos que estudian este grupo de plantas.

Sin embargo, desearía mencionar algunas de las pocas observaciones llevadas a cabo por mí en las distintas localidades donde estas plantas se encuentran. Estas son sin duda las razones que me hacen ser bastante conservador en el presente tratamiento ya que más de una vez he tenido la oportunidad de estudiar determinadas especies a todo lo largo de su distribución. Pasando de un grupo a otro, colonias aisladas se entrecruzan e intercambian en los más variables medios ecológicos. Se ocasiona de esta manera cambios notables en la morfología de aquellas plantas que posiblemente hubiera descrito como especies nuevas, de no haber tenido la oportunidad de observar distintos grupos con las formas intermedias.

Como ejemplo de lo anteriormente dicho, mencionaré el C. stenophyllus, especie endémica de la costa sur oriental de Cuba, con la excepción de dos grupos de plantas bastante aislados del centro de distribución. Un grupo se encuentra en la costa norte de Matanzas y el otro en la costa sur de Santa Clara. En la costa sur de Oriente esta especie es muy frecuente entre la vegetación xerofítica que predomina en esa costa rocosa.

Se puede reconocer en general, por sus hojas lineales u oblongas, estrechas de unos 4 cm. de largo y 3 a 4 mm. de ancho, agudas y la base rápidamente cónica con un pecíolo de 2 a 6 mm. de largo. Esto no acontece en las plantas de Guantánamo, descritas por Urban como C. litoralis y en el C. Rugelianus de Matanzas; en éstos las hojas son por reducción oblongas o elípticas y no tienen más de 2 cm. de largo: la base de las hojas es obtusa y el pecíolo muy corto. La pubescencia de las hojas en el C. stenophyllus es muy variable pero generalmente estelada y muy densa, cubriendo completamente las hojas; en el haz es siempre más comprimida y menos notable que en el envés. En la región de Santiago de Cuba y Guantánamo encontramos a veces colonias con hojas casi glabrescentes en la cara superior. Las plantas de Cienfuegos, aunque no siempre, son con frecuencia completamente glabrescentes en el haz, pero no en el envés, y a la vez aumentan en el ancho de la hoja; es decir que en las plantas con hojas glabrescentes el ancho aumenta hasta

1/ Este nombre es empleado en Cuba como nombre vulgar para distintas especies del género Codiaeum, especialmente el C. variegatum, que es cultivado y procede del Sur del Pacífico y del Archipiélago Malayo

unos 10 mm. y su forma es más bien lanceolada que lineal. La inflorescencia que es generalmente de unos 3 cm. de largo, y a veces mucho menos, es hasta de 10 cm. en las plantas del extremo este de la provincia oriental. En general las plantas del Cabo Cruz a Santiago de Cuba, las cuales Urban determinó como C. tenuiramis son pequeñas, de ramitas delgadas, las hojas muy finas y de color verdoso en el haz. Entre Guantánamo y Maisí encontramos plantas robustas de gruesas hojas densamente pubescentes y de color muy claro, con cuyos caracteres Urban describió el C. sabanensis.

Posiblemente un estudio más profundo que el que he realizado, permitiría separar en el futuro muchas de las plantas incluídas aquí, si no con el rango de especies, por lo menos algunas de ellas, como variedades de C. stenophyllus.

Otra especie digna de mención por la amplia variación de su morfología en general es el C. origanifolius, el cual parece tener su centro de distribución en las lomas no muy altas de la región oriental, pasando más tarde a las lomas de Trinidad, de donde fué descrita por Urban como C. siguaneanus y C. rectangularis. Es también frecuente en las sabanas serpentinosas de Camagüey y lomas de poca elevación de dicha región. Esta especie puede decirse que tiene un buen número de caracteres casi constantes, como son la forma de sus hojas lanceoladas y generalmente anchas y la pubescencia estelada, mínima y algo comprimida en la cara superior que da la sensación de rugosidad al tacto. En general las plantas son pequeñas y raramente casi postradas como en J. G. Jack 7252, N. Y. B. G. Las ramitas y las hojas tienen tendencia a extenderse o ser algo retroflexas, dándole un aspecto característico a esta especie. Otra cosa que pudiera tomarse como un carácter típico, es la variabilidad en el largo de los pecíolos, siendo frecuente ver en la misma rama, hojas con pecíolos de 1 a 2 cm. de largo y hojas casi sésiles.

Lo dicho anteriormente es algo inestable y mencionaremos como ejemplo las plantas descritas por Urban, como C. nephrophyllus y C. camagueyanus, basado en plantas propias de las sabanas serpentinosas de la provincia de Camagüey. En estas dos plantas la pubescencia del haz de las hojas es menos densa, pilosa y larga; las hojas en su mayoría son sésiles y cubren las ramitas lanceoladas muy anchas u ovado-agudas a elípticas. A primera vista esto parece separarlas del C. origanifolius pero es lo que precisamente las relaciona con esta especie, pues es una de las formas que frecuentemente ocurre entre las plantas típicas de C. origanifolius de las regiones montañosas de Santa Clara.

El C. siguaneanus de Urban no ofrece duda alguna al reducirlo a la sinonimia de C. origanifolius y se trata sólo de individuos de lugares rocosos de la región montañosa de Trinidad, Santa Clara, donde las plantas carecen posiblemente de nutrición, ocasionando que el desarrollo de éstas como el de sus hojas no sea completo. El caso de plantas como J. G. Jack 7252, N.Y.B.G., las cuales representan plantas semipostradas de inflorescencia muy corta y flores casi glabrescentes, es debido sin duda al hecho de que éstas se encuentran en montes bastante espesos y en un suelo muy húmedo. Un ejemplo más dificultoso de explicar es cuando las hojas cambian el modelo de su forma, como en el caso del C. rectangularis Urban y el ejemplar, H. León & H. Clement 6647, Loma del Tibisal, Sti. Spiritus. Estos sin duda deben ser

coespecíficos con el C. origanifolius, pero sus hojas oblongas más o menos largas parece separarlas mucho de dicha especie, y posiblemente es casi seguro que coleccionando más material de estas dos plantas, encontraríamos algunas que serían aún más difíciles de separar del C. origanifolius.

CROTON L., Gen. Pl. ed. 5. 436. 1754.

Arbustos o árboles pequeños generalmente cubiertos de pelos estelados de color claro o amarillos y carmelitosos y otras veces cubiertos de pequeñas escamas. Hojas generalmente alternas, a veces con dos o más glándulas en forma de discos o ciliares en la base y junto al pecíolo, enteras o aserradas y a veces con glándulas ciliares alrededor del limbo. Flores monoicas (raramente dioicas). Flor masculina con sépalos y pétalos, receptáculo generalmente muy piloso, pétalos 5 (4 a 6), del mismo largo, pubescentes, lepidotos o glabrescentes, pétalos 5 (4), iguales y casi del mismo largo de los sépalos, generalmente muy pilosos en los márgenes, disco representado por glándulas, estambres generalmente de 10 a 20. Flor femenina con sépalos pero no pétalos (raramente presentes o muy rudimentarios), sépalos pubescentes, lepidotos o glabrescentes, del mismo largo, ovario 3-locular, estilos generalmente divididos en dos y raramente en más; óvulos uno en cada carpelo. Semillas lisas y brillosas de color oscuro y generalmente punteadas o con ligeras manchas.

Claves para el género Croton en Cuba

Plantas espinosas, espinas de 1 a 3 cm. de largo.
  Hojas de 15 a 50 mm. de largo, pubescentes en el haz y envés..... 1. C. bispinosus
  Hojas de 5 a 15 mm. de largo, glabrescentes en el haz y lepidotas en el envés..... 2. C. Brittonianus
Plantas no espinosas.
  Limbo de las hojas rodeado de glándulas ciliares.
    Hojas lanceolado-obtusas o elípticas, estrechas..... 3. C. clavuliger
    Hojas acorazonadas..... 4. C. ciliato-glanduliferus
  Limbo de las hojas sin glándulas alrededor.
    Plantas postradas o de menos de 30 cm. de alto.
      Hojas de 2 a 5 mm. de ancho y 2 a 5 mm. de largo.
        Márgenes de las hojas dentados, hojas glabrescentes en el haz y lepidotas en el envés..... 5. C. prostratus
        Márgenes de las hojas enteros, hojas pubescentes en las dos caras o casi glabrescentes..... 6. C. nummulariaefolius
      Hojas de 2 a 10 mm. de ancho y 10 a 30 mm. de largo.
        Largo de las hojas 10 a 20 mm., elíptico-estrechas o lineales, estelado-comprimidas..... 7. C. procumbens
        Largo de las hojas 20 a 30 mm., elíptico-anchas o circulares, pubescentes, espinosas en el haz y muy pilosas en el envés..... 8. C. craspedotrichus
    Plantas no postradas, árboles o arbustos de más de 30 cm.
      Hojas completamente glabrescentes.

Márgenes de las hojas dentados, hojas de 1 a 3 cm. de largo..... 9. C. glandulosus
Márgenes de las hojas enteros, hojas de 3 a 8 cm. de largo, generalmente sólo de 5 a 6 cm. de largo..... 10. C. lucidus

Hojas lepidotas o pubescentes.
Hojas lepidotas por lo menos en el envés.
Haz de las hojas glabrescente.
Hojas lineales, oblongas u ovadas.
Haz de las hojas mate, hojas lineales de 8 a 25 mm. de largo..... 11. C. myricifolius
Haz de las hojas con brillo, hojas oblongas u ovadas de 20 a 40 mm. de largo..... 12. C. cristalensis
Hojas elíptico-estrechas o anchas.
Márgenes de las hojas convolutas, hojas de 4 a 10 cm. de largo y 15 a 25 mm. de ancho..... 13. C. trigonocarpus
Márgenes de las hojas extendidos, hojas de 9 a 14 cm. de largo y 25 a 45 mm. de ancho..... 14. C. Ekmanii
Haz de las hojas y envés lepidotos.
Hojas lineales, de 1 a 2 cm. de largo y 1 a 2 mm. de ancho..... 15. C. rosmarinifolius
Hojas ovado-elípticas u ovado-lanceoladas, de 3 a 4.5 cm. de largo y 2 a 5 cm. de ancho.
Largo de las hojas 3 a 6 cm., y 2 a 3 cm. de ancho, hojas ovado-lanceoladas y redondas en la base..... 16. C. eluteria
Largo de las hojas de 25 a 45 cm., y 2 a 5 cm. de ancho, hojas ovado-elípticas estrechas en la base..... 14. C. Ekmanii

Hojas pubescentes por lo menos en el envés.
Envés de las hojas pubescentes y glabrescentes en el haz.
Hojas lineales.
Pecíolo muy corto o hojas casi sésiles, hojas de 5 a 9 cm. de largo, haz de las hojas sin brillo generalmente, plantas poco ramificadas..... 17. C. Sagraeanus
Pecíolo de 2 a 3 mm. de largo, hojas de 2 a 5 cm. de largo y de 2 a 3 mm. de ancho, haz de las hojas generalmente con brillo, plantas muy ramificadas..... 18. C. hippophaeoides
Hojas elípticas, oblongas u obovadas.
Haz de las hojas liso, brilloso y suave al tacto.
Venas de la cara superior de las hojas algo marcadas o profundas y ligeramente notables en el envés, pubescencia herrumbrosa claro..... 19. C. viminalis
Venas de la cara superior de las hojas no marcadas y notables en el envés, pubescencia muy densa y de color pergamino claro..... 20. C. pervestitus

Haz de las hojas mate sin brillo alguno y poco suave al tacto.
Venas marcadamente impresas en la cara superior de las hojas.
Hojas elípticas u obovadas, con las venas muy marcadas en el haz de la hoja, haz de la hoja color obscuro..... 21. C. vaccinioides
Hojas obovadas y algo auriculadas, con las venas ligeramente menos impresas que la especie anterior, haz de las hojas color verde claro..... 22. C. panduraeformis
Venas no impresas en la cara superior de las hojas
Hojas de 15 a 25 mm. de largo y 5 a 8 mm. de ancho, con pubescencia muy incrustada en el envés que las hace duras al tacto..... 23 C. monogynus
Hojas de 25 a 50 mm. de largo y 15 a 20 mm. de ancho, densamente pubescentes en el envés pero no incrustada y suaves al tacto..... 24. C. leucophlebius
Envés de las hojas pubescente y también el haz.
Márgenes del limbo de las hojas dentados o aserrados.
Pubescencia de las hojas muy densa, hojas de 5 a 15 mm. de largo
Márgenes del limbo de las hojas marcadamente dentados, hojas y ramitas con una pubescencia clara..... 25. C. betulinus
Márgenes del limbo de las hojas ligeramente dentado, hojas y ramitas con pubescencia algo herrumbrosa..... 26 C. pachysepalus
Pubescencia de las hojas no muy densa o casi glabrescente, hojas de 20 a 50 mm. de largo.
Pubescencia estelada mínima y muy comprimida. 27. C. corylifolius
Pubescencia pilosa notable y larga
Glándulas de la base de las hojas ciliadas y pequeñas, hojas trilobadas..... 28. C. lobatus
Glándulas de la base de las hojas grandes y en forma de disco, hojas simples... 9. C. glandulosus
Márgenes del limbo de las hojas enteros.
Hojas muy tomentosas, suaves al tacto, pecíolos muy tomentosos también.
Pubescencia del haz y envés de las hojas muy denso, hojas ovado-lanceoladas, base cordiforme..... 29. C. flavens
Pubescencia del haz muy clara pero densa en el envés, hojas ovado-elípticas, base aguda o redonda.. 24. C. leucophlebius
Hojas de pubescencia estelada, densa y comprimida, más o menos papiráceas pero no suaves al tacto, pecíolo mínimo lepidoto comprimido.

Sépalos de las flores femeninas de 3 a 6 mm. de largo, pubescencia muy comprimida.
Sépalos de la flor femenina de 6 mm. de largo, foliforme..... 30. C. spiralis
Sépalos de la flor femenina de unos 3 mm. de largo, ovados..... 31. C. punctatus
Sépalos de las flores femeninas de 1 a 2 mm. de largo, pubescencia estelada, no comprimida.
Hojas lineales, raramente algo lanceoladas u oblongas, pecíolo de 1 a 6 mm. de largo..... 32. C. stenophyllus
Hojas ovado-agudas a casi esféricas, redondas en la base o cordiforme, pecíolo de 3 a 15 mm. de largo... 33. C. origanifolius

1. CROTON BISPINOSUS Wright en Sauvalle, Anal. Acad. Cienc. Habana 7: 152. 1870.- C. fulvus A. Rich. en Sagra, Hist. Cuba 11: 212. 1850 (no C. fulvus Mart. 1823).

Arbusto de unos 4 a 6 pies de alto, espinoso, las espinas gruesas de 2 a 3 cm. de largo, simples o divaricadas; hojas elípticas u ovadas, cordiformes en la base, de 3 a 6 cm. de largo, pubescencia estelada en las dos caras, comprimida en el haz y denso-herrumbrosa en el envés, pecíolo de 5 a 10 mm. de largo; inflorescencia numerosa a todo el largo de las ramas, de 5 a 10 cm. de largo y con muchas flores; flores femeninas y masculinas con pubescencia denso-obscura; pubescencia de la flor femenina estelada, algo herrumbrosa; estilos muy divididos lo cual hace la especie distinguible.
Localidad tipo: Cuba, Pinar del Río, Lomas de Rangel, San Cristóbal, Potrero de Balestan.
Cuba: Pinar del Río; Lomas de Rangel, C. Wright (s.n.).- Isla de Pinos; Loma La Daguilla, N. L. & E. Britton y P. Wilson 15169.- Oriente; Sierra de Nipe, Carabia 3785.- Holguín, J. Shafer 1407.- Puerto Padre, Roig y Curvelo 6192.- Sierra de Nipe, J. Shafer 1755.- Santiago de Cuba, J. Linden 2136.

Este Croton, como muchas otras plantas en Cuba, presenta una distribución muy interesante. Según la opinión general sobre la historia geológica de las Antillas, Cuba quedó casi completamente sumergida en el mar del Pleistoceno salvo en dos lugares, en Oriente y en Pinar del Río; razón por la cual encontramos en esas dos regiones montañosas grandes centros de reliquias y endemismos, constituyendo a la vez dos centros de distribución de donde partieron la mayoría de las plantas que ocupan los extensos llanos y sabanas tan frecuentes en esta isla. Esta opinión queda confirmada con el Croton bispinosus pues dicha especie se encuentra confinada precisamente a esas dos regiones; Oriente y Occidente. Es natural que comparando el material de Pinar del Río y el de Oriente encontremos algunas diferencias en el tamaño de las hojas, color de la pubescencia y otros caracteres morfológicos de más o menos importancia pero no suficientes para separar estas dos plantas como especies distintas.

2. CROTON BRITTONIANUS Carabia nom. nov.- C. spinosus Wright en Sauvalle, Anal. Acad. Cienc. Habana 7: 151. 1870, (no C. spinosus L., Syst. Pl. ed. 2. 1005. 1759).- C. spinosus var. heterolepis Urban en Fedde., Repert. 28: 220. 1930.

Arbusto de 2 a 4 pies de alto, espinoso; espinas delgadas de 1 a 2 cm. de largo; hojas de 1 a 2 cm. de largo, elípticas, glabrescentes en el haz y con escamas herrumbrosas y comprimidas en el envés; inflorescencia numerosa a lo largo de las ramas, de 1 cm. de largo o menos; flores masculinas y femeninas herrumbrosas y densamente lepidotas; los estilos divididos en tres y a veces vuelto a dividir.
Localidad tipo: Cuba, Pinar del Río, entre Guajaibón y Bahía Honda.
Cuba: Pinar del Río: Bahía Honda a Guajaibón, Wright 3690.- Oriente; Puerto Padre, Roig y Curvelo 6201 y 5035.- Jauco, Mesa de Prada, H. León 11773.- Camagüey.- Nuevitas, Ekman 19074.- Pastelillo, Ekman 15437.

Esta especie tiene una gran afinidad con la especie anterior como se puede demostrar por el estilo tan dividido, carácter que casi sólo se encuentra en estas dos especies entre los demás Croton de Cuba y las cuales son las únicas especies espinosas en Cuba. Ambas tienen la misma típica distribución, con la excepción de que el C. Brittonianus se halla también en las sabanas de Camagüey. No obstante esa interesante distribución no se altera con lo dicho pues es frecuente notar especies endémicas de las regiones montañosas de Oriente y Pinar del Río que aparecen también en las sabanas de Camagüey.

3. CROTON CLAVULIGER Mull. Arg. en DC., Prodr. 15(2): 644. 1866.

Arbusto pequeño; hojas de 4 a 6 cm. de largo y 1 cm. de ancho, lanceolado-obtusas, con glándulas ciliares alrededor del limbo, pubescencia de las hojas muy densa pero corta, más notable en el envés; pecíolo de 5 a 10 mm. de largo; inflorescencia y flores no vistas.
Localidad tipo: Cuba.

Esta especie nos es conocida sólo por fragmentos del tipo, C. Wright 1960. Grisebach refirió este material al C. ciliato-glanduliferus pero habiendo nosotros estudiado estas dos especies llegamos a la conclusión de que son afines pero no coespecíficas. El material de Wright parece haber sido coleccionado en las regiones montañosas de Oriente, pero hasta la fecha no ha sido coleccionado de nuevo.

4. CROTON CILIATO-GLANDULIFERUS Ortega, Hort. Matr. Dec. 51 1797.- C. penicillatus Vent., Choix Pl. Cels. 12. tab. 12. 1803.

Arbusto de 2 a 5 pies de alto, muy ramificado; hojas acorazonadas de 3 a 6 cm. de largo y unos 4 cm. de ancho, haz y envés cubierto de una pubescencia tomentosa fina y suave al tacto, margen del limbo completamente cubierto de glándulas ciliares que son más largas en la base junto al pecíolo; pecíolo de 2 a 4 cm. de largo, generalmente de 3 cm., cubierto también de una pubescencia fina; inflorescencia escasa, en la parte superior de las ramas axilar y terminal, de 2 a 4 cm. de largo; cáliz de las flores femeninas y masculinas muy pubescente; estilos algo divididos y muy finos.
Localidad tipo: Cuba (por error; posiblemente su patria es México).
Cuba. Según el autor de esta especie, el material tipo fué coleccionado en

Cuba por Martin Sessé, pero sin embargo es bastante dudoso, primero porque esta planta no se conoce en Cuba y segundo porque hoy día sabemos positivamente que muchas de las plantas coleccionadas por Sessé en Mexico, fueron despachadas de Cuba y la localidad dada por error a todo ese material fué el de nuestra isla. Como es lógico, encontramos que la mayoría de los autores posteriores a Ortega, refieren dicha especie a Cuba, pero la especie en realidad es sólo coleccionada en Mexico. En el "New York Botanical Garden" existe un ejemplar de herbario que perteneció al famoso "Herbarium Otto Kuntze", el cual procede de plantas cultivadas en el jardín de "Botanisches Museum und Garten," Berlin, y en la etiqueta se aclara que la planta fué cultivada de semillas procedentes de Cuba; de ser esto cierto, la planta es de semillas del tipo coleccionado en Mexico y si esto no fuera así, no nos quedaría entonces la menor duda de que la planta se encuentra en Cuba, pues sería mucha casualidad que se hubiera informado erróneamente dos veces.

5. CROTON PROSTRATUS Urban, Symb. Ant. 9: 195. 1924.

Plantas postradas de 20 a 40 cm. de largo; hojas de 2 a 5 mm. de largo, obovadas o circulares, glabrescentes en el haz y lepidotas, oscuras o negras en el envés, margen de la hoja dentado, menos en la base; inflorescencia terminal de unos 5 mm. de largo; flores femeninas y masculinas casi glabrescentes; estilos divididos sólo una vez.
Localidad tipo: Cuba, Oriente, Sierra de Nipe, Río Piloto.

Esta especie sólo la conocemos del material tipo, Ekman 2337 y Ekman 2521, no teniendo ninguna afinidad con otras especies conocidas en la isla, y a pesar de tener un aspecto muy parecido al C. nummulariaefolius, no tiene relación alguna con dicha especie.

6. CROTON NUMMULARIAEFOLIUS A. Rich. en Sagra, Hist. Cuba 11: 211. 1850.- C. Galeottianus Baill., Estud. Euph. 355. 1858.- C. sericoides Griseb., Mem. Acad. ii. 8: 159. 1860.

Plantas semipostradas con ramitas de 10 a 25 cm. de largo, muy ramificadas; hojas de 2 a 8 mm. de largo, elíptico-anchas o circulares, cubiertas de una pubescencia estelada corta, clara y a veces casi glabrescente, pecíolos de 1 a 3 mm. de largo; inflorescencia terminal de menos de 5 mm. de largo con una flor femenina en la base y de 2 a 3 flores masculinas arriba; flores femeninas y masculinas cubiertas de pelitos estelados; estilos divididos hasta la base en tres partes muy finas.
Localidad tipo: Cuba.
Cuba: Oriente; Wright 569.- U. S. N. Station, N. Britton 2152 y 1908.- El Cobre, J. Cowell, Baker & N. Britton 12885.- Holguín, J. Shafer 1265.- Camagüey; Cayo Ballenato Grande, J. Shafer 1030.- Camagüey, E. & N. Britton y J. Cowell 13234.- Cayo Romano, J. Shafer 2514.- Sta. Clara; Motembo, H. León 9350.- La Magdalena, Baker 2511.- Santa Clara, N. Britton y J. Cowell 13299 y 6098.- Motembo, H. León y P. Roca 8235.- Canasí, H. León 12999.- Manacas, H. León 9300.- Cieneguita, R. Combs 394.- Habana; Guanabacoa, J. Shafer y H. León 12052.- Guanabacoa, H. León (s. n.).- Guanabacoa, N. Britton, F. Earle y P. Wilson 6259.- Madruga, N. & E. Britton y J. Shafer 614.

Esta pequeña especie tiene una distribución bastante grande, razón por la cual es algo variable. En la región de Guantánamo sus hojas están a veces

completamente cubiertas de una pubescencia fina y estelada, mientras que en la Habana sus hojas son casi glabrescentes. Su identificación no ofrece duda alguna, pudiéndose distinguir fácilmente entre las demás especies del género.

7. CROTON PROCUMBENS Wright ex Griseb., Nachr. Ges. Wiss. Gött. 167. 1865.- C. cerinus Muell. Arg. en DC., Prodr. 15(2): 570. 1866.- C. linifolius Urban en Fedde., Repert. 28: 271. 1930.

Planta pequeña de 10 a 30 cm. de alto, ramas extendidas o casi postradas; hojas lineares o elípticas de 1 a 2 cm. de largo, lepidotas estelado-comprimidas en las dos caras o raramente glabrescentes, pecíolo de 2 a 4 mm. de largo; inflorescencia terminal de 1 cm. de largo con una sola flor femenina en la base (2) y 3 a 4 flores masculinas arriba; flor masculina lepidota estelado-comprimida y luego glabrescente; flor femenina con mucha pubescencia estelada y comprimida; estilos muy cortos y finamente divididos hasta la base.
Localidad tipo: Cuba occidental.
Cuba: Pinar del Río; Wright 1970.- Herradura, J. Baker 4866.- Mantua, Ekman 10996.- Guane, J. Shafer 10432.- Los Palacios, H. León y P. Roca 7392 y 7394.- Herradura, N. & E. Britton, C. Gager y F. Earle 6419.- Pinar del Río, N. & E. Britton y C. Gager 7097, 7069 y 7245.- Las Martinas, J. Shafer 11048.- Herradura, J. Shafer 11701.- Pinar del Río, J. Shafer 369.- Herradura, F. Earle 669.- Isla de Pinos; A. Curtis, 398.- San Pedro, N. Britton, P. Wilson y A. Selby 14284.- Los Indios, O. Jennings 373.

Esta pequeña especie endémica de Cuba, es frecuente en las sabanas arenosas de Pinar del Río e Isla de Pinos, siendo fácilmente reconocida por sus hojitas lineares o elípticas, gruesas y generalmente cubiertas de pelos estelados espinescentes muy comprimidos en las dos caras. A pesar de ser frecuente esta especie, no es muy variable, lo cual se debe sin duda a la uniformidad del "habitat"; no obstante Urban propuso un binomio nuevo, C. linifolius, basado en ejemplares de esta especie con hojas elípticas pero delgadas y bastante alargadas.

8. CROTON CRASPEDOTRICHUS Griseb., Nachr. Ges. Wiss. Gött. 173. 1865.- C. adpressus Wright ex Griseb., l. c.- C. scaberrimus Muell. Arg., Linnaea 34: 125. 1865.

Planta postrada con ramas de 30 cm. de largo o menos; hojas elípticas o circulares, el haz con una pubescencia corta y espinosa que las hace muy ásperas al tacto y a veces glabrescentes, envés densamente cubierto de suave y corta pubescencia, peciolo de 2 a 10 mm. de largo; inflorescencia terminal y raramente en las axilas de las hojas, de unos 2 cm. de largo con una o dos flores femeninas en la base y varias masculinas arriba; flores femeninas y masculinas densamente cubiertas de una pubescencia estelada color amarillo brillante; flor femenina con los pistilos divididos en dos y raramente en más.
Localidad tipo: Cuba.
Cuba: Pinar del Río; Herradura, N. & E. Britton, F. Earle y C. Gager 6425.- Guane, H. León y P. Roca 6991.- Laguna Jovero, J. Shafer 10729.- Pinar del Río, N. & E. Britton y C. Gager 7102.- Herradura, N. Britton y F. Earle 6595.- Pinar del Río, Wright 1963.- Guane, J. Shafer 10678.- Isla de Pinos; A. Curtiss 385.- Nueva Gerona, J. Roig y Cremata 1758.- San Pedro, N. & E. Britton y P. Wilson 14303.- Nueva Gerona, W. Palmer y J. H. Riley 890.- Isla de Pinos, A. Taylor 101.- Nueva Gerona, O. Jennings 24 y 21.

Esta especie como la anterior es endémica y muy frecuente en las sabanas arenosas de Pinar del Río e Isla de Pinos. Es fácil de reconocer por sus grandes hojas casi circulares de unos 2 cm. de ancho, con el envés cubierto de una densa pubescencia clara y el haz muy áspero al tacto por sus pelos espinosos y cortos. Este Croton como el anterior presentan una morfología bastante constante, debido a la uniformidad del "habitat" y nos hace suponer que se trata de verdaderas reliquias del género adaptadas a esas sabanas silíceas de Cuba.

9. CROTON GLANDULOSUS L., Syst. Nat. ed. 10. 2:1275. 1759.

Plantas bastante ramificadas, de 1 a 3 pies de alto o algo más, hojas ovado-agudas, aserradas profundamente, de 2 a 4 cm de largo, cubiertas en las dos caras con una pubescencia estelada larga y clara, raramente glabrescentes, con dos glándulas notables y en forma de disco en la base, pecíolo de 5-15 mm. de largo; inflorescencia terminal y a veces en las axilas de las ramas, de 2 a 4 cm. de largo, con varias flores femeninas en la base y unas cuantas masculinas arriba; flores masculinas y femeninas muy pubescentes, las femeninas con sépalos ligulados y largos, bastante pubescentes; estilos cortos y divididos en dos.
Localidad tipo: Jamaica.
Cuba: Oriente: Sevilla, N. Taylor 88 - Matanzas: Matanzas, N. Britton y P. Wilson 439.- Santa Clara: Cieneguita, R. Combs 139.- La Magdalena, Baker 2517.- Sti. Spiritus, H. León 1924.- Habana: Guanabacoa, H. León 596.- Madruga, N. & E. Britton y J. Shafer 729.- Rancho Boyeros, J. Shafer 256.- Santiago de las Vegas, P. Wilson 1033.- Guanajay, Van Hermann 206.- Pinar del Río: W. Palmer y J. Riley 29.- San Diego de las Baños, H. León 5089.- Sumidero, J. Shafer 13464.- Herradura, N. & E. Britton, F. Earle y C. Gager 6318.- Colóma, N. & E. Britton, F. Earle y C. Gager 6992.- Pinar del Río, J. Shafer 343.- Pinar del Río, Wright 568.- Guane, J. Shafer 10677.- Laguna Jovero, J. Shafer 10786. Isla de Pinos: Nueva Gerona, A. Curtiss (s.n.).- San Pedro, N. Britton y P. Wilson 14308.- Isla de Pinos, A. Taylor 103.

Esta especie, que parece estar representada en toda la América tropical, es frecuente también en Cuba donde a veces constituye una de las yerbas más frecuentes de los terrenos abiertos de esta isla. Su identidad es fácil de reconocer gracias a sus dos glándulas en forma de disco en la base de las hojas, como también por sus hojas profundamente dentadas y cubiertas de una pubescencia suave al tacto.

10. CROTON LUCIDUS L., Pl. Jam. Pugill 28. 1759.- C. campechianus Standley, Carnegie Inst. Wash. Publ. 461: 66. 1935.

Arbusto de 4 a 6 pies de alto, ramificado; hojas lanceolado-elípticas y generalmente algo cordiformes de 3 a 8 cm de largo y frecuentemente sólo de 4 a 5 cm, ligeramente pubescente-esteladas y muchas veces glabrescentes; pecíolo de 1 a 3 cm de largo, mayormente sólo 2 cm; inflorescencia de muchas flores en forma típica piramidal, 2 a 4 cm de largos; flores femeninas y masculinas cubiertas de pelos estelados; flor femenina con sepalos ligulados de unos 5 mm. de largo.
Localidad tipo: Jamaica.
Cuba: Oriente: Santiago de Cuba, V. Harvard 66, 70 y 103 - Imías, H. León

12265.- U. S. N. Station, N. Britton 2221.- Maisí, J. Shafer 7941.- Bahía de Nipe, N. & E. Britton y F. Cowell 12484.- Santiago de Cuba, Rugel 93.- Aserradero, S. Hamilton 160.- Santiago de Cuba, S. Hamilton 161.- Santiago de Cuba, C. Pollard, E. & W. Palmer 292.- Sevilla, N. Taylor 274.- Santiago de Cuba, L. Underwood y F. Earle 192, 147 y 166.- Holguín, J. Shafer 1350.- Bayamo, Shafer 12402.- Gibara, Punta Hicacos, J. Shafer 1504.- Santiago de Cuba, Linden 1732 y 1802.- Camagüey: Camagüey, J. Shafer 202.- Nuevitas, J. Shafer 779.- Cayo Guajaba, J. Shafer 645 y 644.- Tiffin, J. Shafer 1082.- Sta. Clara; Cieneguita, R. Combs 28.- La Magdalena, Baker 4929.- Soledad, Limones, C. Pringle 71.- Pitajones, J. Shafer 12277 y 12199.- Matanzas N. & E. Britton y J. Shafer 45.- Habana; Marianao, N. Britton y P. Wilson 4555.- Marianao, P. Wilson 9493.- Van Hermann 440.

Esta especie se encuentra en Cuba, Jamaica, Española, Bahamas, Gran Caimán, Islas Turcas y Honduras. En Cuba en particular se extiende por toda la isla, pero es en Oriente donde la encontramos más frecuentemente, formando colonias bajo montes claros y próximos a las costas. Es fácil de reconocer este Croton por ser una de las pocas especies casi glabrescentes, por sus hojas que se agrupan mucho en el ápice de las ramas y por su típica inflorescencia compacta y de forma piramidal; además es una de las pocas especies en que los sépalos de las flores femeninas son tan largos como los frutos.

11. CROTON MYRICIFOLIUS Griseb., Nachr. Ges. Wiss. Gött. 173. 1865.

Arbustos de unos 2 pies de alto, muy ramificados; hojas lineales u oblongas de 5 a 15 mm. de largo generalmente menos de 10 mm., glabrescentes en el haz y densamente lepidotas en el envés, color amarillo y punteado-herrumbrosas en el envés, vena central profundamente marcada en el haz, pecíolo de 1 a 2 mm. de largo; inflorescencia a lo largo de las ramitas en las axilas de las hojas y terminales, de menos de 5 mm. de largo y de muchas flores compactas; flores femeninas y masculinas densamente lepidoto-herrumbrosas mínimas. Localidad tipo: Cuba.
Cuba: Oriente, Wright 1969.- U. S. N. Station, H. Hioran & C. Ransden 2325.- Baracoa, Imías, H. León 12267.- Renté, H. Gioran 2029.- Santiago de Cuba, N. & E. Britton 7, J. Cowell 12636.- Santiago de Cuba, H. Clement 157.- Camagüey; Cayo Romano, J. Shafer 2520.- Cayo Romano, J. Roig y Ballon 1345.- Santa Clara; Casilda, N. Britton y P. Wilson 5592.- Cienfuego, Punta Colorada, N. Britton y P. Wilson 5630.- Ciénaga de Zapata, Bartolina, H. León 14628.

Esta especie endémica de Cuba es frecuente en Oriente pero no en las demás provincias. En Oriente la especie es bien conocida y poco variable, pero no así en otras localidades, por ejemplo el material H. León 14628 de la Ciénaga de Zapata, tiene hojas de 2 a 3 cm de largo muy anchas, mientras el material de Oriente es generalmente de 5 a 8 mm. de largo. Esta especie se parece mucho al C. rosmarinifolius del cual se puede distinguir porque el haz de las hojas de éste es lepidoto y en el C. myricifolius es glabrescente.

12. CROTON CRISTALENSIS Urban, Symb. Ant. 9: 197. 1924.

Arbusto (o árbol pequeño?); hojas obovadas, verde-oscuras, brillosas y glabrescentes en el haz, lepidotas oscuras en el envés, 3 a 5 cm. de largo y 1 a 3 cm de ancho, pecíolo de 5 a 7 mm. de largo; inflorescencia terminal con varias flores; flores masculinas y femeninas densamente lepidotas; flor

femenina de 5 a 6 mm. de largo; estilos divididos en dos.
Localidad tipo: Cuba, Oriente, Sierra de Cristal.

Esta especie endémica de Cuba, la conocemos sólo del material tipo y pertenece al grupo del C. Ekmanii y C. trigonocarpus, pudiéndose distinguir de éstos por sus hojas obovadas, más pequeñas que las de las anteriores especies y generalmente emarginadas.

13. CROTON TRIGONOCARPUS Griseb., Nachr. Ges. Wiss. Gött. 173. 1865.

Arbusto de 7 a 15 pies de alto, muy ramificado; hojas oblanceoladas o elípticas, agudas en la base y ápice, de 4 a 10 cm. de largo y 1 a 3 cm. de ancho, haz glabrescente liso y brilloso color verde, envés densamente lepidoto-oscuro, pecíolo de 1 cm. de largo o mucho menos; inflorescencia numerosa en el ápice de las ramas, de 3 a 5 cm. de largo, con varias flores masculinas y una o dos femeninas en la base; flores densamente lepidoto-herrumbrosas, flor femenina de unos 3 mm. de largo.
Localidad tipo: Cuba.
Cuba: Oriente; Wright 1972.- Sierra de Nipe, J. Shafer 3518, 3519 y 3176.- Matanzas; Cabonico, J. Roig 131.- Canasí, H. León 12965, 13136 y 13037.

Esta especie endémica de Cuba, se encuentra sólo en las sabanas serpentinosas de la Sierra de Nipe y en Sta. Clara; es muy variable en el tamaño de sus hojas, las cuales son siempre más grandes en las plantas de Oriente.

14. CROTON EKMANII Urban, Symb. Ant. 9: 194. 1924.

Arbusto muy grande o árbol pequeño; hojas elíptico-oblongas, de 5 a 10 cm. de Largo y 2 a 5 cm. de ancho, el haz es verde, brilloso y generalmente glabrescente o con una pubescencia espinosa mínima, casi imperceptible, envés densamente lepidoto oscuro, pecíolo de 7 a 12 mm. de largo; inflorescencia de 6 a 10 cm. de largo; flores femeninas y masculinas densamente lepidotas; flor femenina de unos 5 mm. de largo; estilos de menos de 2 mm. de largo, sin dividir.
Localidad tipo: Cuba, Oriente, Baracoa, Loma de Cuaba.

Esta especie pertenece al grupo del C. cristalensis y C. trigonocarpus, pero sin embargo Urban no la refirió a estas especies pero sí al C. corylifolius con el cual ésta no tiene relación alguna. Es curioso también que cuando Urban trata de dar la relación de esta interesante especie no la refiere a las otras ya mencionadas y vecinas, pero tampoco menciona el C. poecilanthus de este mismo autor y con la cual la especie cubana tiene una gran relación.

15. CROTON ROSMARINIFOLIUS Griseb., Nachr. Ges. Wiss. Gött. 174. 1865.

Arbusto de unos 2 a 4 pies de alto, muy ramificado; hojas lineales de 5 a 15 mm. de largo y unos 2 mm. de ancho, lepidoto-oliváceas en el haz y lepidoto-herrumbrosas en el envés, pecíolo de 1 a 2 mm. de largo; inflorescencia numerosa en el ápice de las ramitas, de 5 a 10 mm. de largo; flores femeninas y masculinas densamente lepidoto-herrumbrosas, claras; flor femenina de unos 2 a 3 mm. de largo; estilos divididos en dos.
Localidad tipo: Cuba.
Cuba: Oriente; U. S. N. Station, N. Britton 1926.- U. S. N. Station, H. Hioran y C. Randsden 2322.- Boca del Río Guantánamo, H. Hioran 4854.- Boca

de Jauco, H. León 11404 - Ensenada de Mora, N. Britton, F. Cowell y J. Shafer 13061.

Esta especie, que es muy frecuente en las Bahamas, es sin embargo bastante rara en Cuba, donde sólo se ha coleccionado en la costa sur oriental, pero pudiera ser que fuera abundante en la costa norte y cayos de Camagüey de donde hasta la fecha no ha sido informada. Las plantas de Cuba son en general muy parecidas a las de las Bahamas, pero sin embargo las de nuestra isla tienen hojas más largas y anchas. La especie mas vecina al C. rosmarinifolius en Cuba, es el C. myricifolius, del cual se puede distinguir porque las hojas de aquel son lepidotas en las dos caras y en el C. myricifolius el haz de las hojas es glabrescente.

16. CROTON ELUTERIA (L.) Sw. emend. Carabia, Caribbean Forester 3(3): 112. 1942 - Clutia Eluteria L., Sp. Pl. 1042. 1753 - Croton Eluteria (L.) Sw., Prodr. 100. 1788 - C. homolepidus Muell. Arg. in DC., Prodr. 15(2): 518. 1862.

Arbusto o arbolito de 5 a 10 pies de alto; hojas lanceoladas, anchas con la base cordiforme o redondeada, de 2 a 7 cm. de largo, lepidoto-punteado-obscuras en el haz y lepidoto-punteado argenteas en el enves, peciolo de 5 a 15 mm. de largo; inflorescencia numerosa en el ápice de las ramas, de 2 a 4 cm. de largo, con numerosas flores; flores masculinas y femeninas lepidoto-punteado algo herrumbrosas; flores femeninas de unos 2 mm. de largo; estilos divididos en dos en el ápice, aparentemente aplanado anchos.
Localidad tipo: Bahamas.
Cuba: Oriente: C. Wright 1971.

Esta especie que es muy frecuente en las Bahamas, se ha coleccionado también de Jamaica, Española y Cuba; en esta última isla sólo se conoce del material de C. Wright. Para más detalles sobre esta especie véase el artículo aparte.

17. CROTON SAGRAEANUS Muell. Arg. en DC., Prodr. 15(2): 616. 1866.- C. clarensis Urban en Fedde, Repert. 15: 408. 1919.

Arbusto de 2 a 4 pies de alto, no muy ramificado; hojas lineales de 5 a 10 cm. de largo y unos 5 mm. de ancho, glabrescentes en el haz y pubescente estelado muy fino en el enves; peciolo de unos 2 mm. de largo u hojas casi sesiles; inflorescencia en el apice de las ramas, de 3 a 10 cm. de largo con muchas flores; flores masculinas y femeninas pubescente-esteladas, color claro; flor femenina de unos 3 a 4 mm. de largo muy pubescente; estilos divididos en dos y casi todos cubiertos de una pubescencia estelada.
Localidad tipo: Cuba.
Cuba: Oriente: Alto Cedro, L. Underwood y F. Earle 1460.- Paso Estancia, J. Shafer 1767.- Santiago de Cuba, Linden 1851.- Camagüey: Camagüey, N. & E. Britton y J. Cowell 13141. Santa Clara, Manicas, L. Smith y A. Hodgdon 3091.- Sierras de Cubitas, J. Shafer 509. Manicaragua, N. Britton y J. Cowell 10258.- Santa Clara, N. & E. Britton y P. Wilson 6047.- Cieneguita, R. Combs 43.- Habana: Punta Braba, Baker y Van Hermann 4041.- Madruga, N. & E. Britton y H. León 659.- Madruga, H. León 3329. Pinar del Rio: Herradura, N. & E. Britton, C. Gager y F. Earle 6633. San Gabriel, J. Shafer 11864.- Guane, J. Shafer 11230.- San Diego de los Baños, W. Palmer y Riley 489.-

Consolación del Sur, Van Hermann (s.n.).- Punta Brava, Baker 4041.- Herradura, N. & E. Britton, F. Earle y C. Gager 6318 a.- Artemisa, P. Wilson y F. Earle 1542.- C. Wright 570 (n. prov.).- San Diego de los Baños, H. León y M. Hioran 4425.- Isla de Pinos; A. Taylor 99.- H. Curtiss 366.- Nueva Gerona, O. Jennings 200

Esta especie, endémica de Cuba, es bastante frecuente en toda la isla, encontrándose principalmente en las sabanas arenosas y de serpentina. Una de las especies más vecinas es el C. stenophyllus pero se puede distinguir de éste fácilmente porque el C. Sagraeanus tiene hojas glabrescentes en el haz lo que no ocurre en el C. stenophyllus. También se puede confundir con el C. hippophaeoides pero una serie de caracteres los diferencia (véanse los números 17 y 18 en la clave); además el C. Sagreanus es propio de las sabanas mientras que el C. hippophaeoides se encuentra sólo en las regiones montañosas de Oriente. Estas tres especies a la vez son muy afines al C. linearis, el cual es muy frecuente en Jamaica y posiblemente también en la Española.

18 CROTON HIPPOPHAEOIDES A. Rich en Sagra, Hist Cuba 11: 212. 1850 - C. Jaegerianus Muell Arg., Flora 55: 7. 1872 C. angustatus Urban, Symb. Ant. 3: 296. 1902.- C. nipensis Urban, Symb. Ant. 9: 196. 1924.

Arbusto de 2 a 5 pies de alto, muy distantemente ramificado; hojas lineales a veces algo agudas en el ápice, de 2 a 4 cm. de largo y unos 5 mm. de ancho, glabrescentes en el haz que es verde brilloso o algo oscuro y mate algunas veces, pubescente-claras en el envés, peciolo de 2 a 10 mm. de largo, pero generalmente sólo de 3 a 4 mm.; inflorescencia de 2 a 5 cm. de largo, con pocas flores; flores masculinas y femeninas pubescente-estelado-mínimas; flor femenina de unos 2 mm. de largo; estilos divididos en dos y cubiertos de pelos estelados como el resto de la flor.
Localidad tipo: Cuba.
Cuba: Oriente; Sierra de Nipe, Río Piloto, Ekman 9041 y 9539.- Pico Turquino, Arroyo Corojo, Ekman 14907.- Loma del Gato, H. León, H. Clemente y P. Roca 10465.- Loma del Gato, H. Edmond 110.

Esta especie, propia de las regiones montañosas de Oriente, parece encontrarse también en Jamaica y La Española. A pesar de no ser una especie de gran distribución es sin embargo muy polimórfica y ha dado origen a unas cuantas sinonimias, de las cuales el C. angustatus está basado en plantas de hojas muy anchas y de color muy oscuro; por otro lado el C. nipensis está basado en plantas de hojas muy finas y pequeñas. Nosotros hemos tenido la oportunidad de estudiar el material tipo, J. Linden 2103, gracias a la amabilidad del Dr. L. Croizat, y hemos encontrado que el material G. Nash 778 (Haití) y Ekman 14907 (Cuba) coinciden perfectamente con el material de Linden. Como es lógico entre esta forma típica y el C. angustatus y C. nipensis hemos encontrado muchas plantas con una buena cantidad de caracteres variables que a nuestro concepto representan todas en conjunto una especie muy variable.

19. CROTON VIMINALIS Griseb., Mem. Am. Acad. Sci. II. 8: 158. 1860.- C. yunquensis Griseb., Nachr. Gess Wiss Gött. 171 1865 - C. tropidophyllus Urban, Symb. Ant. 9: 196. 1924.

Arbusto de 4 a 8 pies de alto; hojas lineales oblongas, de 3 a 7 cm. de largo y 10 a 15 mm. de ancho, glabrescentes, verde-brillosas en el haz y

pubescente-herrumbrosas en el envés, pecíolo de 3 a 5 mm. de largo; inflorescencia en el ápice y axila de las ramas, de 2 a 4 cm. de largo; flores masculinas y femeninas densamente pubescente-herrumbrosas; flor femenina de 3 a 4 mm. de largo, densamente pubescente; estilos divididos en dos hasta la base, ligeramente pubescente-estelados en la base.
Localidad tipo: Cuba, Oriente, Guantánamo, Sta. Catalina.
Cuba: Oriente; Wright 565.- Nibujón y Tacotaco, Ekman 3738.- Guantánamo, Wright 559.- Baracoa, Ekman 3738 y 3627.- Sierra de Nipe, Carabia (s.n.).- Monteverde, J. Shafer 8848.- Toar, Río Navas, J. Shafer 4383.

Esta especie endémica de Cuba es bien distinguida entre los otros Croton por sus hojas coriáceas de un haz muy suave y brilloso y el envés muy pubescente-herrumbroso. Posiblemente la especie más vecina es el C. pervestitus, pero ésta tiene la pubescencia del envés de las hojas mucho más clara y las ramitas de esta misma están muy incrustadas con la pubescencia.

20. CROTON PERVESTITUS Wright ex Griseb., Nachr. Ges. Wiss. Gött. 172. 1865.- C. ellipticus A. Rich. en Sagra, Hist. Cuba 11: 212. 1850 (no C. ellipticus Ell., Bot. C. & Ga. 2: 648. 1821).- C. Francavillanus Muell. Arg. Linnaea 34: 111. 1865.

Arbusto de 4 a 5 pies de alto, ramas muy incrustadas en la pubescencia; hojas ovadas u ovado-elípticas, ligeramente cordiformes en la base, coriáceas, el haz glabrescente, liso, brilloso y de color verde claro, envés ligeramente incrustado en una pubescencia clara, pecíolo de 1 a 3 cm. de largo, incrustado como los tallos, de color claro; inflorescencia terminal de unos 6 cm. de largo y 15 a 20 flores, incrustadas en una pubescencia clara; flores masculinas y femeninas densamente cubiertas de una pubescencia corta y del mismo color que los pecíolos, ramas y envés de las hojas; flores femeninas de unos 2 mm. de largo.
Localidad tipo: Cuba.
Cuba: Oriente; Wright 1964 (parte izquierda en N.Y.B.G.).- Santiago de Cuba, Monte Líbano, Linden (n.z.).

Esta interesante especie endémica de Cuba sólo la conocemos del material de Wright 1964 y de un dibujo del material de Linden.

21. CROTON VACCINIOIDES A. Rich. en Sagra, Hist. Cuba 11: 211. 1850.

Arbusto de ramas extendidas y sólo 2 a 3 pies de alto, muy ramificado; hojas oblongas u obovadas de tamaño muy variable, de 15 a 45 mm. de largo y un poco más de 1 cm. de ancho, haz glabrescente pero con pequeños punticos verrugosos y de color oscuro, envés densamente pubescente color "Isabella", venas muy profundas en la cara superior y elevadas en el envés, pecíolo de 2 a 10 mm. de largo y generalmente de unos 3 mm.; inflorescencia terminal de 1 cm. de largo aproximadamente, pocas flores; flores masculinas y femeninas ligeramente pubescente-esteladas y luego glabrescentes.
Localidad tipo: Cuba, Oriente, Santiago de Cuba, Nimanima.
Cuba: Oriente; Santiago de Cuba, Nimanima, Linden 1722.- Sevilla, N. L. Taylor 423.- Loma del Gato, H. Clemente 666.

Esta especie, endémica de Cuba fué descrita como de sólo medio pie de alto, pero yo creo que las plantas alcanzan más altura. A primera vista se

parece al C. origanifolius, del cual se puede distinguir rápidamente porque éste tiene el haz de la hoja glabrescente-espinoso y en el C. vaccinioides el haz es glabrescente.

22. CROTON PANDURAEFORMIS Muell. Arg. en DC., Prodr. 15(2): 671. 1866.

Arbusto; hojas obovadas, ligeramente auriculadas, de 2 a 3 cm. de largo, haz verde claro mate y glabrescente, envés densamente cubierto de una pubescencia clara; pecíolo muy corto; inflorescencia corta y de pocas flores; flores masculinas y femeninas con pubescencia estelada, mínima y comprimida; estilos divididos en dos.
Localidad tipo: Cuba.
Cuba; Pinar del Río; Sierra de los Organos, La Palma, Wright 1957

Esta interesante especie endémica de Cuba la conocemos sólo del material de Wright, no habiendo sido coleccionada nunca más. De los fragmentos que hemos visto de esta especie, creemos que es algo vecina del C. vaccinioides, pudiéndose distinguir de ésta porque el C. panduraeformis tiene el haz de las hojas color verde claro y hojas ligeramente auriculadas.

23. CROTON MONOGYNUS Urban en Fedde., Repert. 13: 455. 1914.- C. incrustatus Urban, op. c. 454.- C. heteropleurus Urban, op. c. 453.- C. moanus Urban op. c. 28: 219. 1930.

Arbusto de 4 a 5 pies de alto, ramas incrustadas en una pubescencia muy densa; hojas ovado-elípticas a elípticas, de 1 a 2 cm. de largo y 5 a 10 mm. de ancho, casi sésiles o con pecíolo de 1 a 2 mm. de largo, haz de las hojas glabrescente-brilloso y suave o sin brillo y algo duro al tacto, envés muy incrustado en una pubescencia pilosa muy densa, dándole a las hojas un aspecto grueso y duro, en las hojas jóvenes la pubescencia es color amarillo claro y muy obscura luego; inflorescencia terminal o en las axilas de las ramas, de 1 a 2 cm. de largo; flores masculinas y femeninas densamente pubescente-pilosas, cortas e incrustadas; flores femeninas de 1 a 2 mm. de largo; estilos divididos en dos.
Localidad tipo: Cuba, Oriente, Sierra de Moa, Campo la Gloria.
Cuba; Oriente; Wright 565.- Sierra de Moa, La Gloria, J. Shafer 8230.- Sierra de Moa, La Barga, J. Shafer 4117.- Sierra de Moa, G. Bucher 120.- Sierra de Moa, La Barga, J. Shafer 4119.- Sierra de Moa, La Gloria, J. Shafer 8263.- Sierra de Nipe, Woodfred, J. Shafer 3187 - Santa Clara; Sta. Clara (palmares), N. Britton y F. Cowell 13326.- Sta. Clara (palm barren), N. Britton y J. Cowell 10192.- Sta Clara, N. & E. Britton y P. Wilson 8075 - Motembo, H. León 8581.

Lo problemático de este género queda bien demostrado con esta especie, basada en la cual botánicos de la talla de Urban han hecho varios binomios en la misma especie; pero en realidad esto nos sorprende porque los cuatro binomios propuestos por Urban están basados en plantas que a simple vista muestran una gran afinidad y un estudio más detallado confirma la imposibilidad de separarlos.

24 CROTON LEUCOPHLEBIUS Wright ex Griseb., Nachr Gess Wiss. Gött 172. 1865.

Arbusto distantemente ramificado; hojas elípticas u ovado-elípticas, finas y suaves al tacto, de 2 a 6 cm. de largo y 15 a 25 mm. de ancho, haz ligeramente piloso-pubescente y a veces casi glabrescente, envés muy piloso-pubescente, suave y de color claro, pecíolo de 1 a 2 mm. de largo, pubescente como el envés de las hojas; inflorescencia en el ápice de las ramitas, de 3 a 5 cm. de largo, con unas 5 a 8 flores solamente; flores masculinas y femeninas bastante pubescentes; flor femenina de poco más de 1 mm. de largo; estilos divididos en dos.
Localidad tipo: Cuba.
Cuba: Pinar del Río; Sierra de los Organos, La Palma Wright 1962.

Esta especie endémica de Cuba sólo la conocemos del material de Wright.

25. CROTON BETULINUS Vahl., Symb. Bot. 2: 98. 1791.

Arbusto de 2 a 3 pies de alto, muy ramificado; hojas ovadas, agudas o ligeramente acorazonadas, márgenes profundamente dentados, de 5 a 15 mm. de largo y 5 a 7 mm. de ancho, haz y envés densamente pubescente-estelados, pecíolo de 2 a 3 mm. de largo; inflorescencia terminal, numerosa y raramente axilar, de 1 cm o algo más de largo, con 10 a 12 flores masculinas y femeninas densamente lepidotas, las femeninas de 1 a 2 mm. de largo, sépalos notablemente largos en relación al resto de la flor; estilos divididos en dos.
Localidad tipo: St. Thomas.
Cuba: Oriente; Jauco, H. León 11661.- Cajobabo, H. León 12108.- Boca de Guantánamo, H. Hioran 4858.- U. S. N. Station, N. & E. Britton 2021.

Esta especie es panantillana, encontrándose en Cuba sólo en la costa sur oriental, donde en realidad no es muy frecuente. Sus hojitas dentadas y con una densa pubescencia estelada en ambas caras la separa de cualquiera otra especie antillana.

26. CROTON PACHYSEPALUS Griseb., Mem. Am. Acad. Sci. II. 8: 159. 1860.

Arbusto de 3 a 5 pies de alto, muy ramificado; hojas elípticas o elíptico-obovadas, de 10 a 15 mm de largo y 5 a 8 mm. de ancho, haz densamente estelado-pubescente, envés estelado pubescente-herrumbroso, pecíolo de 2 a 3 mm de largo; inflorescencia numerosa, terminal, de 5 a 10 mm. de largo; flores femeninas y masculinas densamente estelado-pubescentes; flor femenina de unos 4 cm de largo lo cual es el largo de los sépalos que cubren completamente el resto de la flor; estilos divididos en dos.
Localidad tipo: Cuba, Oriente.
Cuba: Oriente; Wright 539 - Boca de Guantánamo, H. Hioran 4855 y 4956.- U.S. N. Station, N. Britton 2023 y 2039.

Esta especie aparentemente está restringida a Española y Cuba, encontrándose en esta última isla, sólo en la costa sur oriental. Sin duda alguna ésta es muy afín al C. betulinus, según el aspecto general de la planta, y lo cual queda aún más confirmado por el tamaño de los sépalos en estas dos especies, los cuales cubren completamente el ovario y los estilos; sin embargo éstas se pueden separar facilmente porque el C. betulinus tiene los márgenes del limbo de las hojas profundamente dentados y en el C. pachysepalus éste es ligeramente ondulado o "crenate"; además la pubescencia del envés de la hoja

en el C. pachysepalus es de un color herrumbroso típico, mientras que en el C. betulinus es de un color claro o verdoso.

27. CROTON CORYLIFOLIUS Lam., Ency. 2: 205. 1788.= C. cubanus Muell. Arg. Linnaea 34: 94. 1865. C. microdon Urban en Fedde, Repert. 15: 406. 1919.

Arbusto o árbol pequeño; hojas acorazonadas, márgenes del limbo irregularmente aserrados, de 5 a 15 cm. de largo y 3 a 7 cm. de ancho, haz y envés cubiertos de una pubescencia estelada muy mínima, clara y dispersa, raramente glabrescente, generalmente con dos glándulas en la base de la hoja, pecíolo de 2 a 8 cm. de largo; inflorescencia terminal de 8 a 20 cm. de largo con numerosas flores; flores masculinas y femeninas densamente cubiertas de pelos estelados y cortos; flor femenina de unos 5 mm. de largo; estilos divididos en dos y pubescente-estelados en la base.
Localidad tipo: Antillas
Cuba: Oriente: Wright 566. Puerto Escondido, H. Hioran 4897.- Jauco, H. León 11860.- Sta. Clara: Lomas de Trinidad, J. Jack 5949 y 5944.- Lomas de Banao, H. León 8057.- Lomas de Banao, H. Hioran 1767. Cieneguita, R. Combs 120.- Habana: La Chorrera, H. Leon 474. Vedado, H. Leon 1585 y 6237. Cojimar, N. Britton, F. Earle y P. Wilson 6226.- Vento, Roig 3482.- Pinar del Río: Rangel, H. León 12619 y 12615.

Esta especie algo frecuente en Cuba, se encuentra también en Guadalupe, Jamaica, Martinica y Dominica. El material de Cuba se encuentra en los herbarios como C. cubanus, lo cual es simplemente una sinonimia del C. corylifolius.

28. CROTON LOBATUS L., Sp. Pl. 1005, 1753.

Arbusto de 1 a 3 pies de alto; hojas divididas en tres o cinco lóbulos, márgenes del limbo irregularmente aserrados, de 4 a 6 cm. de largo, el lóbulo central pubescente-piloso muy claro a glabrescente en las dos caras, pecíolo de 1 a 5 cm. de largo; inflorescencia terminal de unos 5 cm. de largo; flores masculinas pediceladas y muy pequeñas; flores femeninas generalmente dos o tres en la base de la inflorescencia, de unos 8 mm. de largo lo cual es el largo de los sépalos que cubren los estilos; estilos divididos muy finamente en cuatro o más ramas.
Localidad tipo: Mexico, Vera Cruz.
Cuba: Oriente: Holguin, J. Shafer 1357. Sta. Clara: Río San Juan, N. Britton, F. Earle y P. Wilson 5911. Cieneguita, R. Combs 0. Matanzas: N. & E. Britton y H. Leon 120. Habana: H. Leon 1338. Guanajay, W. Palmer y J. Riley 783.- Santiago de las Vegas, Baker y P. Wilson 528. Rincon, Van Hermann 664. Pinar del Rio: Mendoza, J. Shafer 1138. Herradura, F. Earle 659. Isla de Pinos: Van Hermann 664. A. Curtiss (s n.).

Esta especie es muy frecuente en todas las Antillas, México y norte de Sur America. En Cuba en particular esta planta se encuentra en los terrenos abiertos, zanjas y sabanas arenosas de toda la isla.

29. CROTON FLAVENS L. Syst. Pl. ed. 10. 1276. 1759.= C. albidus Muell. Arg. en DC., Prodr. 15(2): 645. 1866.

Arbusto de 4 a 10 pies de alto; hojas ovadas u ovado-lanceoladas, de 3 a 10 cm. de largo y 2 a 5 cm. de ancho, densamente cubiertas de una pubescencia

estelada y fina que hace las hojas suaves al tacto, pecíolo de 1 a 3 cm. de largo; inflorescencia terminal de 5 a 10 cm. de largo con numerosas flores; flores masculinas y femeninas muy pubescentes, del mismo color de las hojas; flor femenina de unos 3 mm. de largo; estilos divididos en dos con pubescencia estelada en la base.
Localidad tipo: Antillas.
Cuba: Esta especie panantillana y del sur de México ha sido coleccionada en Cuba sólo por Wright, material que fué descrito como una especie nueva, C. albidus. En realidad no podemos asegurar que el material de Cuba sea C. flavens, ya que sólo hemos visto fragmentos del tipo de C. albidus, pero todo parece indicar que nuestra decisión será correcta.

30. CROTON SPIRALIS Muell. Arg. Linneaea 34: 125. 1865.- C. cueroensis Britton y P. Wilson, Mem. Torrey Club 16: 75. 1920.

Arbusto de 6 a 8 pies de alto, ramas cortas de unos 15 cm. de largo; hojas acorazonadas o ovado-agudas u ovales y cordiformes, pubescente-mínimo-comprimidas en las dos caras, venas ligeramente marcadas en el haz y bastante sobresalientes en el envés, pecíolo de 1 a 2 cm. de largo, tomentosos; inflorescencia terminal de 2 a 4 cm. de largo con varias flores masculinas largamente pediceladas y unas pocas flores femeninas en la base, ambas densamente pubescente-mínimo-comprimidas; flor femenina de 1 cm. de largo o más, lo cual es el largo de los sépalos, sépalos foliformes con márgenes marcadamente aserrados cubriendo completamente el ovario y los estilos.
Localidad tipo: Cuba.
Cuba: Oriente; Wright 1670.- El Cuero, N. Britton y J. Cowell 12735.- Maisí, J. Acuña 5153.- Imías, H. León 12205.- Jauco, H. León 12396.- Maisí, H. León 18341 (A.A.).- Sierra de Imías, H. León 12205 (A.A.).

Esta especie se conocía solamente del material de Wright, pero recientemente otros botánicos la han recolectado y con este último material, N. L. Britton propuso el C. cueroensis, el que resulta ser una sinonimia del C. spiralis.

El C. spiralis es una especie endémica de Cuba, pero es muy vecino al C. astroites de todas las Antillas. Si no reducimos la especie cubana a la sinonimia de esta especie panantillana es simplemente porque los sépalos de las flores femeninas de las plantas cubanas son notablemente aserrados lo cual no ocurre en las plantas de las demás Antillas.

31. CROTON PUNCTATUS Jacq., Coll. 1: 166. 1786.- C. maritimus Walt., Fl. Car. 239. 1788.- Lasiocroton prunifolius Griseb., Nachr. Gess. Wiss. Gött. 175. 1865.

Arbusto de 3 a 5 pies de alto, ramas comprimidas con ángulos; hojas elípticas, oblongas u ovadas, de 2 a 5 cm. de largo y 1.5 a 3 cm. de ancho, haz y envés completamente cubiertos de una pubescencia estelada muy comprimida y algo herrumbrosa en el envés, pecíolo de 1.5 a 2.5 cm. de largo; inflorescencia terminal o en las axilas de las ramas más altas, de 2 a 3 cm. de largo, con pocas flores; flores masculinas y femeninas densamente cubiertas de una pubescencia estelada muy comprimida y de color herrumbroso claro; flor femenina de unos 5 mm. de largo; estilos divididos varias veces, muy cortos y cubiertos de pelos estelados y muy compactos.

Localidad tipo: Carolina.
Cuba: Matanzas: Cardenas, N. Britton y P. Wilson 14035.- Habana; Guanabacoa, H. León 4873.- Guanabacoa, Cazaña 310.- Cojimar, Baker y Van Hermann 4405.

Esta especie, bastante rara en Cuba, tiene sin embargo una gran distribución, pues se encuentra en el sureste de los Estados Unidos de América, Bermuda, Bahamas y al norte de Sur América. Sus ramas comprimidas con ángulos, la pubescencia estelada mínima que parece escamas lepidotas y los estilos cortos de la flor permite identificar esta especie rápidamente.

32. CROTON STENOPHYLLUS Griseb., Mem. Am. Acad. Sci. II. 8: 158. 1860 - C. stenophyllus var. acutifolius Muell. Arg., Linnaea 34: 123. 1864.- C. stenophyllus var. brevifolius Muell. Arg., l. c.- C. stenophyllus var. rosmarinifolius Muell. Arg. op. c. 124.- C. litoralis Urban, Symb. Ant. 3: 294. 1902 - C. litoralis var. Rugelianus Urban, l. c. - C. excisus Urban, Symb. Ant. 7: 257. 1912.- C. Rugelianus Urban, Symb. Ant. 13: 435. 1914.- C. micradeus Urban en Fedde, Repert. 13: 459. 1914.- C. sabanensis Urban, op. c. 458.- C. tenuiramis Urban, op. c. 457.

Arbusto de 3 a 6 pies de alto; hojas lineares, lineares-lanceoladas y raramente oblongo-estrechas, de 2 a 7 cm. de largo y 3 a 5 mm. de ancho, haz y envés densamente cubiertos de una pubescencia estelada y corta muy comprimida en el haz; inflorescencia de 2 a 4 cm. de largo con muchas flores; flores masculinas y femeninas densamente cubiertas de pelos estelados muy cortos; flor femenina de unos 3 mm. de largo con sépalos muy cortos; estilos divididos y cubiertos casi todos con pelos estelados y cortos.
Localidad tipo: Cuba, Oriente, El Cobre, Nueva Sofía.
Cuba: Oriente: Wright 560 - Ensenada de Mora, B. Cowell y J. Shafer 12950.- El Cobre, Wright 1669.- Guantánamo, N. Britton 1946.- Jauco, H. León 11660.- Santiago de Cuba, H. Clemente 105.- Renté, H. León 9785.- Ensenada de Mora, N. Britton, J. Cowell y J. Shafer 13062.- U.S.N. Station, N. Britton 1934.- El Cuero, N. Britton y J. Cowell 12729.- Jauco y Cajobabo, H. León 12077 y 12078.- U.S.N. Station, H. Hioran y C. Ransden 2319.- Santiago de Cuba, Linden 1851 y 2063 - Renté, H. Hioran 2037.- Maisí y Sabana, J. Shafer 7914.- Boca de Guantánamo, H. Hioran 4853 - U.S.N. Station, N. Britton 2117, 2043 y 1946 - Matanzas: Canasí, Rugel 160.- Boca de Canasí, H. León 13178, 13873 y 13283 Sta. Clara: Cienfuegos, N. Britton y P. Wilson 5634 - Milpa, E. Cuesta 1229

No creo haber resuelto el difícil problema que presenta esta especie tan variable; posiblemente algunas de las sinonimias incluídas en este binomio podrán ser separadas en el futuro, sino con el rango de especies por lo menos como variedades. Como ejemplo mencionaré C. Rugelianus y C. litoralis los que sin duda son coespecíficos del C. stenophyllus y del cual Urban los separó por las hojas oblongas de aquellas plantas, a lo cual podemos agregar que las representadas por los binomios de Urban, tienen una distribución muy especial, lo cual nos ha hecho dudar mucho al reducirlas al C. stenophyllus. Si reconociéramos estas plantas como especies, o por lo menos como variedades, tendríamos entonces que reconocer otras variedades y luego podríamos hacer sin dificultad algunas variedades más, pero en la opinión de este autor dicho tratamiento no resolvería el problema que esta especie tan polimórfica presenta. De acuerdo con el conocimiento actual que tenemos de nuestra flora creo que es más prudente ser algo conservadores en los momentos actuales.

Partiendo de la descripción original de Grisebach, encontramos que ésta es bastante dificultosa de adaptar al material tipo de Wright 560 y 1669 (de acuerdo con el material en el Britton Herbarium del N. Y. Botanical Garden y el material del Gray Herbarium). Estos números muy mezclados contienen posiblemente material de distintas localidades, pero todos sin duda son de la misma especie entre los cuales, como es natural, hay una parte que se puede adaptar mejor a la descripción de Grisebach que el resto. En la descripción original Grisebach dice que las hojas son "flavescenti-tomentosi" en el envés y "verruculoso-scabri" en el **haz**; del material de Wright que hemos visto no encontramos ninguno que sea "verruculoso-scabri" en el haz, no obstante el material de Guantánamo tiene una pubescencia estelada, sésil, comprimida y espinosa que pudiera interpretarse como "verruculoso-scabri" si no se observa detenidamente. Otro carácter mencionado por Grisebach es el de las glándulas en la base de las hojas; ésto **sólo lo hemos visto en** una planta de Wright 1669 y en otras de distintas localidades, especialmente en la Ensenada de Mora; pero puede decirse que generalmente esta especie carece de dichas glándulas.

Sobre la morfología en general de la especie, poco podríamos decir en una especie tan variable, pero sin embargo el modelo de hoja seguido por la especie es el lineal, con una ligera tendencia a lanceoladas y raramente oblongas; la inflorescencia, que es mas bien corta, tiene muchas flores masculinas y un gran número proporcional de flores femeninas que siempre están cubiertas de una pubescencia estelada muy densa que pasa hasta los estilos; los sépalos son muy reducidos y las semillas que son de color claro no pasan de 4 mm. de largo.

33. CROTON ORIGANIFOLIUS Lam., Enc. cl. 2: 205. 1786 - C. Lindenianus A. Rich. en Sagra, Hist. Cuba 11: 212. 1850 - C. origanifolius var. discolor Muell. Arg. en DC., Prodr. 15(2): 212. 1850.- C. nephrophyllus Urban & Ekman en Fedde, Repert. 28: 218. 1930.- C. camagueyanus Urban, l. c.- C. siguaneanus Urban, op. c. 219.- C. rectangularis Urban op. c. 220.

Arbusto de 3 a 7 pies de alto; hojas lanceolado-estrechas y lanceolado-anchas a casi esféricas, a veces con la base cordiforme, de 1 a 4 cm. de largo y 3 a 20 mm. de ancho, haz cubierto de una pubescencia muy fina, espinosa y comprimida que hace la hoja áspera, envés densamente piloso-estelado color claro; inflorescencia terminal o en las axilas de las ramas, de 2 a 15 cm. de largo, generalmente de unos 10 cm. de largo; muchas flores en grupos de dos o tres, generalmente las espigas de flores femeninas tienen pocas flores masculinas o viceversa; flores masculinas y femeninas cubiertas de una pubescencia estelada muy densa; flores femeninas de unos 4 mm. de largo lo cual es casi el largo de los sépalos; estilos divididos en dos y casi cubiertos de pelos estelados.
Localidad tipo: Las Antillas
Cuba: Oriente; Wright 564.- Holguín, Shafer 1191.- Paso Estancia, Shafer 1645.- Camagüey; entre Camagüey y Cubitas, León 18425.- Camagüey, J. Roig 730.- Nuevitas, Ekman 15112 y 15564.- Nuevitas, Shafer 799.- Sta. Clara; Lomas de Trinidad, Jack 6870.- Lomas de Banao, H. León y Luna 472.- Lomas de Banao, H. Hioran 1954.- Sti. Spiritus, H. León y P. Roca 7804.- Lomas de Trinidad, Ekman 14003 y 18923.- Lomas de Sti. Spiritus, H. León y H. Clement 6647.- Matanzas; Corral Nuevo, H. León 13104 y 13103.- Isla de Pinos; N. Britton y P. Wilson 15162 y 15120.- Eggers 4558.

Esta es otra de esas especies sumamente variables que ha dado origen a una buena lista de sinonimias. Sin embargo la especie posee una serie de caracteres muy típicos y más o menos constantes, como son la forma lanceolada de sus hojas, más o menos anchas y cordiformes, y la pubescencia estelada, mínima y comprimida que cubre el haz de las hojas, haciéndolas ásperas al tacto. El tamaño de los pecíolos es muy variable desde hojas casi sésiles a pecíolos de 3 cm. de largo, lo cual constituye a la vez un carácter típico de la especie; lo mismo sucede con las hojas, pues en una misma rama tenemos hojas de 1 cm. y hojas de 4 cm. de largo.

Algo muy raro en esta especie son las plantas con hojas oblongas como las descritas por Urban bajo el binomio C. rectangularis, la cual incluímos en esta sinonimia con bastantes dudas; pero estoy casi seguro que coleccionando más material mi actitud quedara confirmada.

Debo también mencionar el C. camagueyanus y el C. nephrophyllus, los cuales a primera vista parecen especies completamente distintas del C. origanifolius por el grueso de sus hojas, por la densa pubescencia en el envés y por ser éstas casi sésiles y cubrir casi completamente las ramas, pero todo esto sabemos que se trata más bien de variaciones típicas del C. origanifolius en terrenos muy áridos como las sabanas de Camagüey.

Todo el material aquí mencionado se encuentra en el Britton Herbarium del New York Botanical Garden.

Deseo expresar aquí mis más sinceros reconocimientos al Dr. L. Croizat, por su más desinteresada cooperación en este trabajo.

Resumen

Este artículo presenta las observaciones del Sr. Carabia con relación a las distintas especies del género Croton en Cuba.

En la introducción discute aquellas especies que adquieren cambios morfológicos respondiendo a diferencias en el medio ambiente a lo largo de su distribución. Esto ha dado lugar a que se hayan clasificado como especies distintas, grupos de plantas que exámenes más detenidos han demostrado ser variaciones de la misma especie. El autor describe el género y presenta una clave de las diferentes especies en Cuba. Gran parte del artículo consiste de la descripción botánica de treinta y tres especies de Croton.

Summary

This article presents Mr. Carabia's observations regarding the different species of the genus Croton in Cuba.

At the beginning he discusses those species that acquired morphological variations occasioned by their distribution in different habitats. This has brought about the classification, as different species, of plants which close study showed to be variations of the same one. The genus Croton is described. He offers a key to its different species in Cuba. A large part of the article consists of the botanical description of thirty three species of Croton.

CONTENTS

FOREST TYPES OF TROPICAL AMERICA

William R. Barbour
U. S. Forest Service

Introduction

Available information concerning the types of forests existing in tropical America is very limited. Botanists who have penetrated those regions have left accurate and valuable records of their discoveries, but their interest has been in taxonomy rather than in silviculture. The few foresters who have carried out researches in the forests of the New World tropics have been primarily engaged in timber appraisal of specific tracts of land, and their manuscript reports are as a rule not available for general perusal.

It seems worth while, therefore, to discuss briefly the primary forest types of tropical America, to attempt to clarify their nomenclature, and to indicate their distribution and economic importance.

Definitions of a Forest Type

In the United States, "forest type" has been defined[1] as "a descriptive term used to group stands of similar character as regards composition and development due to given physical and biological factors, by which they may be differentiated from other groups of stands. The term suggests repetition of the same characters under similar conditions." The term "site" is similarly defined as "an area, considered as to its physical factors with reference to forest producing power; the combination of climatic and soil conditions of an area. Syn.: locality, physical site." In other words, a "forest type" is the result of "site" (physical type) and phyto-geographical factors.[2]

While the prevailing practice in the United States is to separate types by factors of composition, European foresters rely more upon climatic and edaphic factors. Cajander[3] states:

"In a forest type, as a rule only those primary—climatic and edaphic—factors of the locality are reflected - which factors may be assumed to remain active, even when the locality is laid bare of all plants. ----- on a basis of forest types it is possible to work out a ----- basis of classification essentially independent of species of trees. ----- the nature of a forest

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1/ Forest Terminology (Report of Committee) Journal of Forestry, Vol. XV, No. 1. Washington, D. C. January 1917.

2/ In a Spanish English glossary of forestry terms in preparation by the Tropical Forest Experiment Station for general use throughout the American tropics the terms "forest type" and "forest site" are defined essentially as stated here. - Ed.

3/ Cajander, A. K. The Theory of Forest Types. Helsinki, Finland, 1926. (The underlining is the present writer's.)

type depends on the total value, biologically, of the locality, and originates as the final result of the combined action of all the primary climatic and edaphic factors on the vegetation ----"

For the purposes of this article the present writer prefers to use the European conception of a forest type rather than the American. The primary types herein described represent "forest regions" as the term is often applied in the United States, and are based primarily upon climate and soil. The term "sub-type" as used in this article more closely approximates the term "forest type" as used by American foresters

Primary Forest Types

In a consideration of the forest types of so vast a region as tropical America, only those types should be classed as primary which occur generally throughout the tropics Such primary types should not be differentiated by the composition of the stands, which can vary widely not only from one region to another but from one acre to another, but primarily by rainfall and soil conditions. They should be easily recognizable, both from the ground and by aerial reconnaissance The names assigned to them should be short, descriptive, applicable over wide regions, generally understandable, and easily translatable into Spanish, French, and Portuguese

These tropical forests, then, may be assigned to four primary types, which in succeeding paragraphs will be discussed in detail

(1) Dry forests --Synonyms -- "Thorn forests", "Xerophytic forests", "Arid forests", "Semi desert forests". Spanish: "Selvas secas". French: "Forêts sèches". Portuguese: "Selvas seccas"

These forests occupy regions where the precipitation is scanty, or sometimes either where physical soil conditions are such that only a fraction of the rainfall becomes available to the trees or the soil is impregnated with soluble saline substances which produce halophytic conditions The following table gives the rainfall in two typical dry forest regions

Table 1 -- Annual Rainfall of Dry Forest Regions

	Gonaives, Haiti[4/] Mean (17 years)		
January	.29	July	2 49
February	46	August	2 29
March	.62	September	3 69
April	.95	October	1 85
May	3 01	November	92
June	3 97	December	50
	Total 21 04		

4/ Woodring, Wendell P Brown, John S and Burbank, Wilbur S Geology of the Republic of Haiti. Department of Public Works, Port-au-Prince, Haiti 1924

Table 1.--Continued.

Guantánamo, Cuba5/

January	1.03	July	.12
February	.82	August	.58
March	1.06	September	1.91
April	2.93	October	2.27
May	1.28	November	2.62
June	1.76	December	.52

Total 16.90

Such regions are characterized by sudden, violent rains, which run off very rapidly, so that even the scanty annual rainfall is not all available for plant use. The soils of dry forest regions are usually porous, often thin and rocky. They are seldom if ever acid in reaction and often strongly alkaline. Though usually quite sterile, they sometimes are potentially fertile and productive and yield good crops under irrigation. Dry forest regions are scattered throughout large portions of tropical America, along coasts, on the leeward side of mountain ranges, on interior plateaus, and sometimes on steep rocky slopes even in regions of heavy rainfall.

Their forests may be characterized as follows: open, park-like stands, with occasional dense thickets of cactus and thorny shrubs. Little underbrush, and little or no ground cover except creeping cactus, agaves, etc. Litter and humus scanty or lacking. The trees are usually small, short-boled with rapid taper, with crowns flat or rounded. The roots are seldom exposed, and usually there is a long tap root. The bark is variable but usually not thick nor deeply furrowed. The twigs are stiff and sparse, often armed with thorns. The leaves are small, scattered, coriaceous with few pores or absent most of the year. The flowers are almost always small but brightly colored and conspicuous, the period of florescence being very short. Fruits are abundant; seeds have a high percentage of germination and retain their viability for long periods. The woods vary, but are much higher than average in weight, hardness, durability, and richness of color.

The composition of the stands naturally varies so greatly over the thousands of miles of latitude and longitude embraced in tropical America that specific enumeration is impossible. Generally speaking, Cactaceae; such Leguminosae as Prosopis, Acacia, Pithecolobium, Mimosa, Caesalpinia, and Haematoxylon; Zygophyllaceae (Guaiacum and Bulnesia); Burseraceae (Bursera) Rutaceae (Esenbeckia, Helietta, and Amyris); and genera of several other families are characteristics of the dry forests

These forests have for many years supplied certain important special purpose woods and minor forest products, such as lignum-vitae, logwood, dim-

5/ Bennett, Hugh H. and Allison, Robert V. The soils of Cuba Tropical Plant Research Foundation, Washington, D. C. 1928.

divi pods, amyris oil, etc. to the world markets. They yield excellent fence posts, cross ties, and firewood for local use and sometimes for export. Cattle and goats find a rather lean living within them. Little agriculture is attempted in their drier portions, but in some sections sisal, pineapples, and similar crops which do not demand much moisture are grown. With irrigation, large areas are being used for sugar cane and banana culture.

A large part of the accessible sections of the dry forests has been culled of its more valuable trees by a crude selection system. Silvicultural management is hindered by the aridity. The abundant supplies of viable seed always present make it unessential what system of cutting is used; in addition, many of the species sprout very readily. It is probable that the present area in dry forest will not be materially reduced, and that these forests, with or without technical management, will continue to supply the markets with certain products such as those previously listed.

The dry forests often grade imperceptibly into true deserts on the one hand and into deciduous forests on the other hand. More intensive studies of the dry forests of any one region would undoubtedly differentiate a number of sub-divisions, based on composition, site quality, and topography. Often one species is found gregariously over quite large areas (cactus, Prosopis, or Bursera, for example). Doctor Pittier[6/] separates the dry forests of Venezuela into three forms: los espinares (thorn forests), chapparal (which he states is the transition between the thorn forests and the savannas or the deciduous forests), and the matorrales andinos (the brushy transitory belt between the cloud forests and the páramos or treeless regions on the higher mountains). It is the present writer's opinion that designation of transition types should be avoided, since they are at best a makeshift. It is no more easy on the ground to draw a line between the thorn forest and the chapparal, or between the chapparal and the deciduous forest, than it would be between the two primary formations: dry forests and deciduous forests.

(2) Deciduous forests.—Synonyms: "Monsoon forests", "Trade wind forests", "Seasonal forests". Spanish: "Selvas de hojas deciduas". French: "Forêts à feuilles décidues". Portuguese: "Selvas de folhas deciduas".

There is less uniformity of nomenclature in this type of forest than in the preceding. The term "monsoon forest" is borrowed from India and the Philippines, and is easily understandable in those regions, where the coming of the rainy season brought by the monsoon winds is an annual weather event of primary importance. "Trade wind forests" would be a New World synonym. In this case, however, it is believed preferable to describe the type by the result instead of by the cause, and "deciduous forests" is suggested as a suitable descriptive term.

The deciduous forests occur in regions where the annual shift of the trade winds produced by the varying position of the sun in relation to the earth at different seasons, often aided or accentuated by the trend of mountain ranges, produces distinct annual wet and dry seasons. The total amount

6/ Pittier, H. Manual de las Plantas Usuales de Venezuela. Caracas, Venezuela. 1926.

of rainfall is not a modifying factor so much as the distribution of that rainfall. This total annual rainfall may be as little as 30 or 40 inches, or as much as 70 or 80 inches. The following table gives the annual rainfall for three regions typical of the deciduous forest type.

Table 2.—Annual Rainfall of Deciduous Forest Regions.

	Port-au-Prince, Haiti[7/] Mean, 44 years	Union de Reyes, Cuba[8/] Mean, 21 years	Rivas, Nicaragua[9/] Mean, 21 years
January	1.27	.97	.5
February	2.28	1.86	.2
March	3.69	3.07	.2
April	6.39	2.96	.3
May	9.83	10.17	8.2
June	3.65	12.21	11.8
July	2.74	8.35	7.2
August	5.49	8.82	8.1
September	7.27	10.48	10.2
October	6.68	8.16	17.4
November	3.37	2.16	4.6
December	1.38	1.42	1.3
Total	54.04	70.63	70.0

It must be remembered that a table of annual rainfall which gives the mean for many years such as those presented here, has a tendency to lessen contrasts, due to unseasonably rainy spells which sometimes occur, and that the rainfall during the ordinarily dry months comes in the form of sudden and violent storms, much of it therefore not becoming available for plant use.

The soils of the deciduous forest regions vary greatly, and do not as a rule affect the type of forest. They are seldom acid, usually neutral or mildly basic in reaction. As a rule they are deep, well drained, and fertile. Such forests occur over vast areas throughout tropical America. Most of the islands of the West Indies, the southwestern portion of Mexico, and the western slopes of Central America, lie within this type, which is also found in northern Venezuela and Colombia and over large areas in Brazil, Paraguay, Argentina, and other South American countries.

The character of the forests of this type varies greatly, especially with the total amount of available moisture. The forests range from open to moderately dense stands, one or at most two storied. Often there is a thick underbrush, which is sometimes thorny. Vines and creepers are not abundant.

7/ Geology of the Republic of Haiti. (Loc. cit.)
8/ The soils of Cuba. (Loc. cit.)
9/ Treadwell, John C.; Hill, C. Reed; and Bennett, H. H. Possibilities for Para Rubber Production in Northern Tropical America. Trade Promotion Series No. 40, U. S. Department of Commerce

There is usually a quite open horizontal view ten feet or so above the ground. The ground cover is usually sparse, but sometimes dense mats of wild pineapples, etc. are found. Grass is often abundant. The layers of litter and humus are usually fairly deep.

The trees vary in size with the site. They range from short to moderately tall, and often attain very large diameters. The root systems are well developed and often deep. Usually the boles are not heavily buttressed, and are of moderate taper and good timber form. The limbs are large, fairly wide spreading, and form rounded crowns. The twigs are usually unarmed, and often bear great quantities of epiphytic growths such as bromeliads. The bark is variable, but usually thick and deeply furrowed. The leaves of most of the trees are wholly or partially deciduous during the dry season. They vary in character, but are usually medium sized and abundant. Neither the flowers nor the fruits have especially distinguishing characteristics. The woods are extremely variable; many of them have concentric growth rings due to the complete or partial interruption of growth during the dry season.

A great portion of the population of tropical America lives within the zone of the deciduous forests, which as a result have been more affected by human interference than any other type. Much of the coffee and cacao, and most of the corn, cotton, tobacco, mandioca, sisal, pineapples, peanuts, citrus fruits, vegetables, and grasses, are grown within this type, which has suffered more from "conuco" agriculture than has any other type, and of which large areas have been permanently cleared for agriculture and grazing.

It is manifestly impossible to attempt to enumerate the varieties of trees which make up the deciduous forests. To do so would be to list a majority of the tree species of tropical America. Commercially important forest products include mahogany, Spanish cedar, rosewood, cocobolo, logwood, fustic, various "robles" (Tabebuia spp.), "quebracho" and other tanning materials, carnauba wax, and many gums, resins, and balsams.

As already noted, the deciduous forests often grade into the dry forests on one side. It is during the wet season that the greatest differences can be noted. On the other side they often merge into the rain forests, in which case they can best be delimited on the ground during the dry season.

The deciduous forests are more in need of technically directed supervision and conservation than are any others in the tropics. So many people are dependent on them for local supplies of fuel, farm materials, and lumber. A crude selection system has been practiced in the past; unfortunately in many cases only a few of the more valuable species have been cut, as a result of which the composition of the forest has deteriorated. The stands are so mixed, and for so many species no commercial use has yet been found, that modern logging is usually prohibitively costly. This fact reacts against the employment of proper silvicultural methods. Laboratory tests to determine the characteristics and possible uses of hundreds of species, protection against forest fires, the regulation of shifting agriculture, reforestation of denuded areas by seeding or planting, and provisions for natural regeneration, all must be included in any far-sighted policy for handling these deciduous forests. There must also be added studies to determine what lands within them are potentially better suited for agriculture, and, on the other hand, what

lands now cleared are inherently non-agricultural and should be allowed to revert to forest.

As in the other types of forest enumerated in this article, very many sub-types would be differentiated. Often one or a few predominant species are found over quite large areas. As examples: a "jobo", Spondias lutea, sub-type on the flatlands west of Lake Maracaibo in Venezuela, a "quebracho", Schinopsis spp., sub-type in the Chaco regions of northern Argentina, or a "logwood-mahogany" sub-type in parts of Haiti. Sub-types might also be distinguished by the relative amount of available water, as "moist deciduous" or "dry deciduous".

(3) Rain forests.—Synonyms: "Evergreen forests", "Tropical evergreen forests", "Tropical rain forests", "Evergreen rain forests", "Broadleaved evergreen forests", "Wet forests". Spanish: "Selvas pluviales". French: "Forêts pluvieuses". Portuguese: "Selvas chuvosas".

The rather long term "tropical broadleaved evergreen forests" would be the most descriptive. The term "evergreen" alone is not suitable because it would include coniferous forests. The title "rain forests", though descriptive of the cause of the type rather than of the type itself, has been chosen partly because it is short and partly because it is already used and understood in tropical America.

As indicated by the various names, the rain forests occupy regions which enjoy an abundant and all year round rainfall. As a consequence, growth is continuous and the trees are always in full leaf. The total rainfall may be as little as 60 to 80 inches, or may be several hundred inches. The following table gives the annual rainfall for two places typical of rain forest regions. The number of wet days for Bluefields is probably less than the average for such regions; there are places where it rains practically every day in the year.

Table 3.—Annual Rainfall of Rain Forest Regions.

	Bayeux, Haiti 10/ Mean, 35 years		
January	6.95	July	1.81
February	4.62	August	3.71
March	4.35	September	5.66
April	7.62	October	8.56
May	8.11	November	15.81
June	3.34	December	11.59
	Total 82.13		

10/ Geology of the Republic of Haiti. (Loc. cit.)

Table 3.—Continued.

	Bluefields, Nicaragua[11/] Mean, 5 years	No. of wet days
January	9.9	18
February	6.9	10
March	3.6	13
April	3.1	14
May	8.1	12
June	17.0	25
July	28.6	31
August	16.1	25
September	8.7	23
October	11.2	18
November	11.4	22
December	14.3	12
Total	138.9	223

The soils of the rain forest regions vary from sand or sandy loam to clays, but are apt to be heavy. In the flatter and lower lying sections large portions of them are poorly aerated, underlaid with an impervious hardpan, and sodden or even miry. Such soils are usually acid. Commonly thought of as being rich, much of it actually is quite poor soil.

Rain forests cover more area than any other forest region of tropical America. The coastal and foothill zones of eastern Mexico and Central America, a great part of the area of the Guianas and the more easterly of the West Indian islands, much of the drainage of the Orinoco and Magdalena Rivers, the regions south of Lake Maracaibo, the Pacific coastal zones of Colombia, Ecuador, and northern Peru, almost all the drainage of the Amazon, much of the Atlantic littoral of Brazil, and the more northeasterly tributaries of the Rio de la Plata, all are or have been covered with rain forests.

These forests may be characterized as follows:- dense to extremely dense, composed of several stories, only a very dim and diffused light over reaching the forest floor. The underbrush, usually not thorny, is so thick as to be almost impenetrable. The trees are shrouded in innumerable vines and creepers. Usually there is not much ground cover. Litter is usually not very abundant, but the humus is especially deep and springy. The trees vary from medium size to very large. They are often exceptionally tall, frequently over 150 feet, and reach diameters of ten feet or more. Their root systems are very strongly developed, but are usually shallow. The boles are characteristically very heavily buttressed, and are sometimes provided with supporting adventitious roots. The boles are usually long and clear above the buttresses, with little taper and good timber form. The limbs and twigs are seldom armed. Crowns of dominant trees are round or flat, of under-story

11/ Possibilities for Para Rubber Production in Northern Tropical America. (Loc. cit.)

trees attenuated. The leaves are persistent and evergreen. The bark, flowers, fruits, and woods are variable.

As in the case of the deciduous forests, it would be futile to attempt an enumeration of the species composing these forests. The number over all tropical America runs into the thousands; even on one small tract of land there may be scores or hundreds.

Some of the forest products derived from the rain forests are mahogany, Spanish cedar, greenheart, purpleheart, "Colombian mahogany", lapacho, and similar woods of the genus Tabebuia, satinwood, crabwood, balsa, rubber from the genera Hevea and Castilla, balata, chicle, and other gums and resins, Brazil nuts, medicinal herbs, etc. A great portion of the rain forest regions of the American tropics has never been explored, and is occupied only by scattered Indian tribes.

Rain forests are not bothered by fire, nor to any great extent by shifting agriculture. Large scale modern agriculture includes bananas and sugar cane; rubber plantations will be located almost wholly within this type.

Remarks made on lumbering in the deciduous forests are equally if not more applicable to the rain forests. In many regions (eastern Nicaragua for example) the more valuable species such as mahogany having been culled out, all lumbering has stopped, though the forests still contain heavy stands of trees most of which must surely be utilizable. There is a great need for more intensive studies of these forests, and especially for a systematic testing of their woods. They will probably always be handled under a selection system of forest management. Markets must be found for the woods of the poorer or lesser known species of trees, if a progressive lowering of the quality of the forests is to be avoided.

Intensive forest surveys will differentiate many sub-types within the rain forests. Some of these will be based on stand composition, others upon topographical data. Few of them will be recognizable by aerial reconnaissance.

(4) Cloud forests.—Synonyms: "Temperate rain forests", "Upland rain forests". Spanish: "Selvas nubladas". French: "Forêts nuageuses". Portuguese: "Selvas nubladas".

Doctor H. Pittier (loc. cit.) classes the cloud forests as a temperate sub-type of the rain forests. This is perfectly correct in so far as the amount and distribution of precipitation is concerned. He states: "the temperate rain forests, or cloud forests, occupy the median belt of the mountains, at a variable altitude which corresponds to the point where the humidity of the ascending aerial masses is condensed. In the daytime this belt is easily distinguishable from a distance, owing to a horizontally extending band of clouds whose well defined base rises or lowers with the temperature." Because the cloud forests are so absolutely distinct from the other types, because they lie entirely out of the zone of the true rain forests, because their moisture supply comes more from mists than from rains, because they occupy a separate climatic zone, and because the character of their stands is so different from that of the rain forests, the present writer prefers to give the cloud forests the status of a primary type

No rainfall records for this type are available. Its forests are dripping wet throughout the year, partly from misty rains and partly from direct condensation on the vegetation. Their lower limit is at 3000 up to 6000 feet above sea level, depending on latitude, and is usually sharp cut. The slopes below them are often grassy and even arid. Near their upper limit these cloud forests become low and scrubby, and sometimes merge into bleak and cold treeless regions. Their soils are usually thin and rocky but fertile. They occur sparingly in the mountains of Central America and on the higher peaks of the islands of the West Indies, and abundantly in the Andes of Venezuela, Colombia, and western South America, but are probably the least in area of the four primary types.

The cloud forests are easy to distinguish. Their spacing is always very dense. They are several storied, and are composed of fairly tolerant hygrophytic species There is a heavy, non-thorny undergrowth of heliconias, tree ferns, etc. Vines and creepers are not abundant. The dense ground cover is composed of ferns, cryptograms, and herbaceous plants. The trees range from medium size to fairly large, and are tall in proportion to diameter. Their root systems are not well developed and are often partially exposed. The boles are only slightly buttressed, are long and of good timber form. The limbs and twigs are seldom armed; the crowns are large and rounded. The bark is variable but is usually thin and smooth. Foliage is very abundant, with large, multi-pored leaves. The trees depend more upon their leaves than upon their roots for obtaining moisture. The forests are unusually rich in orchids and other epiphytic plants. Tree flowers and fruits are neither abundant nor conspicuous. The woods are variable, usually of good general utility, not especially heavy, hard, nor highly colored.

While the composition of these forests varies both with latitude and with altitude, certain species are characteristically present. The mountain cedro, Cedrela sp. and the mountain walnut, Juglans sp. yield high class cabinet woods. The many genera of the Lauraceae are quite often dominant. In Central America, oak, Quercus spp., and red gum Liquidambar styraciflua, are common. Species of Guarea are found in the cloud forests of the West Indies and northern South America. Other genera include Protium, Styrax, Sapium, and coniferous trees of the genera Podocarpus and Cupressus.

Man's influence upon these cloud forests has upon the whole been adverse. From them he has hewed large areas for coffee growing (the best coffee comes from these elevated sites) and for temperate zone vegetables and grains. As the soil is thin and easily eroded, fields are hard to maintain and often are soon abandoned. Little lumbering has been done except for local use. These forests located on the high mountains are especially valuable for protection purposes: conserving rainfall and preventing erosion. No further deforestation should be permitted, and lumbering should be limited to a light form of selection cutting. As the forests are never subject to fire damage, offer little inducement for grazing, and are too inaccessible, as a rule, for profitable exploitation, their protection offers few problems.

Special and Non-Forested Types

The four primary types already enumerated occupy the greater portion of the forested regions of tropical America. There are, however, a few

special types, two of the most important of which are:

(1) Mangrove forests.—These occupy shallow portions of the sea along much of the coast line of Central and South America and the West Indian islands. Often only a narrow strip, in the estuaries at the mouths of certain rivers they sometimes broaden out to many miles in width. They grow always in much (never in sandy or rocky soil) in shallow water or on mud flats which are covered at high tide. Most often they are pure stands of Rhizophora Mangle, but sometimes contain other mangroves such as species of Avicennia, Laguncularia, and Conocarpus. Usually the stands are scrubby and thickety, above a tangle of arching aerial roots, but sometimes attain good tree size. They have in the past yielded great quantities of mangrove bark for tanning purposes, firewood, and timbers for various local purposes. They are best handled on a short rotation, and offer no special silvicultural problems.

(2) Lowland pine type.—This is found within the rain forest regions of eastern Central America, notably in Nicaragua and Honduras, on sites whose soil is so sandy or gravelly, cold, acid, and sterile, that no other trees can exist than Pinus Caribaea or similar species. The type is distinct and clear cut, and is the result of edaphic rather than climatic factors. The forests are open and scattered, with little ground cover except grass. Lumbering has made heavy inroads, and creeping surface fires are gradually increasing the areas of open savanna at the expense of the forests. Silvicultural management of this type calls for protection against fire, and for some system of clear cutting, leaving seed trees. The type is absolutely non-agricultural, yields rather meager grazing, and is now and will remain best suited for growing timber.

(3) Non-forested types.—These may be classified as desert, savanna, and alpine. The desert type is not well developed in tropical America except in the Pacific coastal plain region of southern Peru and northern Chile. Areas of creeping sand dunes would be included in this type. The savannas, on the other hand, cover vast areas. Two notable examples are the Llanos of the Orinoco drainage and the more tropical portions of the Pampas of northern Argentina and Paraguay. Such regions receive sufficient rainfall and have fertile enough soil for forest growth. While it cannot be definitely proved that they were originally forest covered, it is certain that their area is constantly being extended by fire. The alpine treeless regions, variously called "páramos", "punos", etc. occur above the altitudinal limit of tree growth, throughout practically the full length of the Andes.

Conclusions

There is a great need for extended studies of the composition of the forest types of tropical America. Little is known of the silvicultural characteristics and requirements of the trees which make up these forests. Much botanical and wood technological work also remains to be done.

The forests of the New World tropics should first be broadly classified into primary types. This can most easily be done by aerial reconnaissance. As research progresses, these primary types should be divided into proper subtypes. The problem is much more complex than in the comparatively simple

forests of the temperate zones, where, even after generations of intensive study, the problems of proper type classification are not yet wholly solved.

In view of the fact that in the future an increasing dependence will be placed upon tropical forests, a greater knowledge of their characteristics should be gained with as little delay as possible.

Summary

A forest type as defined by foresters in the United States is based on composition. European foresters, on the other hand, base their type classification upon climatic and edaphic factors entirely independent of tree species. Using this latter broad basis of classification the forests of tropical America may be divided into the following primary types:

(1) Dry forests, where precipitation or available soil moisture is scanty. Rainfall is about 20 inches annually. They are open and the trees are small, as are their leaves which may be absent much of the year. Roots are long and penetrate to great depths. Fruits are abundant, the seeds retaining viability for a long period. The woods are generally hard and heavy. These forests have supplied many special purpose woods and other products to world markets.

(2) Deciduous forests, where there are distinct annual wet and dry seasons. The total amount of annual rainfall (50-75 inches) is less important than its distribution. The type is found throughout most of the West Indies, southwestern Mexico, the western slopes of Central America, and in many South American countries. The forests range from open to moderately dense, one or at most two storied. The trees range from short to moderately tall. Root systems are well developed. The leaves of most of the trees are wholly or partly deciduous during the dry season. The woods have concentric growth rings in response to the wet and dry seasons. A great proportion of the population of tropical America lives within the zone of deciduous forests, which have been more affected by human interference than any other type.

(3) Rain forests, where rainfall is abundant (60 to several hundred inches annually) throughout the year. The soils are apt to be heavy and poorly aerated. These forests cover more area than any other type and are or were originally found throughout large areas in the West Indies, Mexico, Central, and northern South America. They are dense, and composed of several stories, the underbrush being almost impenetrable. The trees vary from medium to very large, tall, and heavily buttressed, and have strongly developed root systems. The leaves are persistent and evergreen. Because of the inaccessibility of parts of these forests and lack of

information regarding the uses of their products great areas have remained virgin.

(4) Cloud forests, where the trees are dripping wet throughout the year. These are confined to altitudes of more than 3,000 feet. These forests occur sparingly in the mountains throughout tropical America. They are always very dense and several-storied. The trees are medium to fairly large. Root systems are poorly developed, sometimes exposed. Foliage is abundant, as are epiphytes. Cutting where practical, should be very light to protect the thin soil.

Two other forest types are distinct, the mangrove and lowland pine. The mangrove forests, confined to the muck soils along coasts and lagoons, are scrubby and often contain a tangle of aerial roots. The bark of the trees yields tannic acid. The lowland pine type is found on sandy cold soils within rain forest regions in eastern Central America. Lumbering has been extensive. Cutting should be selective to permit reproduction of the pine forest because the land is not suited to agriculture.

Three extensive non-forested vegetation types also exist; the desert along the pacific coastal plain of southern Peru and northern Chile; the savanna in various parts of South America such as the Pampas of norther Argentina and Paraguay, a type which may result from fire; and the alpine treeless regions above the altitudinal limit of tree growth throughout the Andes.

Resumen

El tipo forestal según la definición de los dasónomos de los Estados Unidos se basa en la composición del bosque mientras que según los europeos, está basado enteramente en los factores climáticos y edáficos, independiente por completo de las especies forestales. Usando esta última base de clasificación tan extensa, los bosques de la América tropical pueden dividirse en los siguientes tipos primarios.

(1) Selvas secas, donde la precipitación o la humedad disponible en el suelo es escasa. La precipitación pluvial es alrededor de 20 pulgadas anuales. Este tipo de selva es claro y los árboles son de poca altura con hojas pequeñas que pueden faltar durante la mayor parte del año. Las raíces son largas y muy profundas. El fruto es abundante; la semilla retiene su viabilidad por mucho tiempo. La madera es generalmente dura y pesada. Estos bosques han suministrado maderas de usos especiales y además otros productos forestales al mercado mundial

(2) Selvas de hojas deciduas, donde los períodos anuales de sequía y de lluvia están bien definidos La precipitación anual total (50-75 pulgadas) no es tan importante como la distribución de las

lluvias. Este tipo forestal se encuentra a través de casi todas las Antillas, el sudoeste de México, las cordilleras al oeste de la América Central y en muchos de los países sudamericanos. Los bosques varían entre claros a moderadamente densos y sus doseles forman uno o no más de dos pisos. Los árboles varían desde pequeños hasta moderadamente altos. Las raíces están bien desarrolladas. Durante la sequía los árboles pierden la hoja parcialmente o por completo. La madera tiene anillos de crecimiento concéntricos como resultado de las dos estaciones seca y lluviosa. Una gran proporción de la población de la América tropical vive en esta zona de selvas de árboles deciduos y por lo tanto ha sufrido ésta más que ninguna otra la intervención del hombre.

(3) Selvas pluviales, donde las lluvias son abundantes a través del año (de 60 a varios cientos de pulgadas anuales). El suelo tiende a ser pesado y poco aireado. Estos bosques cubren más área que ningún otro tipo forestal y se encontraron primitivamente a través de grandes áreas en las Antillas, México y al norte de Sur América. Son densos, su dosel forma varias capas sucesivas y la maleza es casi impenetrable. Los árboles varían desde medianos hasta gigantescos con muchas raíces fulcro. El sistema de raíces es fuerte y muy desarrollado. Las hojas son persistentes y siempre verdes. Debido a la inaccesibilidad de algunas de sus partes y también a la falta de información sobre el uso de sus productos, grandes áreas de estas selvas se han conservado vírgenes.

(4) Selvas nubladas, donde los árboles escurren agua durante todo el año. Están confinadas a altitudes de más de 3,000 pies. Estos bosques se encuentran aquí y allá en las montañas de la América tropical. Son siempre muy densos, formando varios pisos. Los árboles varían desde medianos hasta bastante grandes. Las raíces están poco desarrolladas y a veces expuestas. El follaje y las epífitas abundan. El corte del bosque donde sea práctico debe ser ligero para así proteger el suelo en las pendientes.

Otros dos tipos forestales son bien definidos, los mánglares y los pinares de la bajura. El mangle, que está confinado a suelos de turba a lo largo de las costas y lagunas, es achaparrado y sus raíces aéreas a menudo forman marañas. De la corteza de estos árboles se obtiene el ácido tánico. Los pinares de la bajura se encuentran en los suelos arenosos fríos dentro de los bosques pluviales al este de la América Central. Debido a que han sido extensamente explotados el corte debe hacerse por selección para que así permita la reproducción natural ya que estos terrenos no son laborables.

Existen otros tres tipos extensos de vegetación caracterizados por la ausencia de árboles: el desierto, en los llanos a lo largo del litoral Pacífico al sur del Perú y al norte de Chile; la sabana, en varias regiones de la América del Sur tales como la Pampa del norte de Argentina y Paraguay, tipo que puede originarse como resultado de incendios forestales y por último, la zona andina, desprovista por completo de árboles por encontrarse más arriba del límite a que éstos crecen.

THE FOREST POLICY OF TRINIDAD AND TOBAGO

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The importance of a sound forest policy, to which continuity is ensured, cannot be over emphasized. In this connection it is well worth while quoting Resolution No. 1 of the British Empire Forestry Conference of 1920, which has been reaffirmed at all subsequent Conferences:

> "In view of the great importance to the Empire as a whole, as well as to each of its component parts of producing a sustained yield of all classes of timber, of encouraging the most economical utilisation of timber and other forest products, and of maintaining and improving climatic conditions in the interests of agriculture and water supply, each of the Governments of the Empire should lay down a definite forest policy to be administered by a properly constituted and adequate forest service."

Forestry deals with a long range crop and fluctuation of policy may well result in the breakdown of the scientific progress of the crops forming the forests, and the waste of money spent in previous years. The Forest Authority must have a definite program of work and must be secure in its finance so that it does not have to lead a hand to mouth existence. Past experience in most countries, however, has repeatedly shown that in times of financial depression the allocation for forestry is one of the first to undergo severe retrenchment, with inevitable rupture of the continuity of the forest policy.

In Trinidad a Forest Policy has been enunciated and formally accepted by the Government, thus ensuring continuity. The writer feels that the reproduction of this Policy here may be of interest to foresters in other countries for comparison, favorable or unfavorable, with their own. He feels also that it may act as a spur to those foresters who have not as yet drawn up their own Forest Policy.

The main bases on which the Forest Policy of Trinidad and Tobago must rest are as follows:

1. The necessity for the preservation of protective forest vegetation and the desirability of the protection of the natural flora and fauna.

2. The necessity for the production of considerable quantities of major and minor forest products to meet the needs of the community.

3. The low volume production of timber per acre of marketable species in the natural mixed forests with consequent high cost of exploitation; the past serious overcutting of certain of the more

valuable species with consequent scarcity of present supplies; the lack of any market at all for the majority of the species; and the insufficient exploitation and utilization of certain species of utility.

4. The destruction of forest capital on an increasing scale, even in areas permanently dedicated to forests, caused by the exploitation of petroleum.

5. The dependence on a large importation of softwoods to meet mainly the requirements of the building market.

6. The prevalence of areas of poor soil, coupled with the existence of large areas of non-productive land and the denudation and exposure of hilly land due to mistakes in alienation to agriculture in the past, leading to the necessity for a sound land policy conducive to the optimum usage of land.

7. The major importance of agriculture as a basic industry of the Colony.

8. The prevailing lack of knowledge and understanding of the benefits and potentialities of forests and forestry.

In view of the foregoing major considerations the Forest Policy has been enunciated in the following form:

General Policy

Forest reservation.—To effect the permanent reservation by the Crown of suitably situated areas of forest of a total acreage sufficient to supply the benefits necessary for the welfare of the community - indirect benefits in the form of the maintenance of climatic conditions for agricultural crops, preservation of water supply, prevention of erosion and flooding, etc., and direct benefits in the form of the supply of forest produce.

Forest management.—To manage the forests in such a way as to place the utilization of their products on the basis of a sustained yield and to effect such improvement of their growing stock as will enable the Colony eventually to become self-supporting in lumber.

Utilization.—To effect the fullest possible utilization of the products of the forests, subject to the requirements of Forest Management, and to encourage the most economic utilization of imported lumber.

Research.—To carry out organized research on all branches and aspects of tropical forestry and eventually to establish a Research Branch of the Forest Department.

Education.—To educate and train the subordinate forest staff, and to educate all classes of the community to an understanding of the benefits and value to the community of scientific forestry.

Private forestry.—To encourage and assist in every possible way owners of private forests and plantations.

Land usage.—To cooperate with all other land interests in the evolution of a sound land policy leading to optimum land allocation and usage, and in all projects for soil conservation and prevention of erosion, and in reclamation work on deteriorated lands.

Detailed considerations of policy involved in the execution of the general policy

Forest reservation.—The total area of reservation to be aimed at should not be less than 25 per cent of the total land area.

In the selection of areas for reservation cooperation must be effected with other land interests and due consideration must be given to the following factors:

(a) Topography.—In view of the quantity and violence of the rainfall and the dangers of erosion, landslips, flooding, and loss of water supply, special attention must be given to hilly country.

(b) Water supply.—Adequate protection must be given to the catchment areas of rivers and streams.

(c) Wind.—Suitable reservation on the eastern side of Trinidad must be made to provide shelter belts for the protection of agricultural cultivation from the prevailing wind.

(d) Soil.—Except when protective benefits form the primary consideration, areas of poorer soil unsuitable for permanent agriculture should be selected for reservation. Pockets or strips of good soil within the Reserves should not be alienated to agriculture.

(e) Natural flora.—It is desirable to prevent the destruction and disappearance of types of natural vegetation of scientific interest and aesthetic value.

(f) Natural fauna.—It is desirable to provide shelter and breeding places for the fauna of the Colony.

The survey, demarcation and proclamation of the selected Forest Reserves should be effected under a sustained annual program.

Forest management.—A survey of the forest resources of the Colony must first be carried out by a 1 to 2 per cent enumeration in order to provide a sound basis for management.

The yield of the Forest Reserves must then be controlled so as to prevent overcutting and to provide a sustained yield. Simple forms of yield control, such as girth limits, should be introduced at first, but the intensity of management should be increased as staff and silvicultural knowledge permit.

Special attention must be paid to controlling the cuttings on oil-fields situated in Forest Reserves, particularly Reserves of a protective nature, and clearings must be limited to the minimum essential for oil exploitation.

Improvement of the growing stock must be effected by silvicultural operations at suitably selected centres. Such operations may take the form of plantations of indigenous and exotic species, and of improvement fellings to obtain natural regeneration supplemented if necessary by artificial regeneration. The aim must be to build up crops of high volume production per acre with consequent low cost of exploitation.

The regeneration program should be gradually extended to cover 800 to 900 acres per annum, the rate of progress depending on staff, funds and the development of silvicultural technique.

In order to effect continuity of management on the foregoing lines, Working Plans must be prepared for all Forest Reserves.

Utilization.—The measures adopted should include:

(a) The encouragement of the use of local timbers and the improvement of the methods of their exploitation, handling and treatment.

(b) The search for substitutes for the valuable species which have become scarce owing to past over-cutting.

(c) The provision of markets for species at present unsaleable.

(d) Efforts to effect the exploitation of the mora forests on a commercial scale by competent private timber interests

(e) The encouragement of the use of anti-termite and anti-fungus construction methods and of the introduction of antiseptic treatment of timber, both local and imported, subject to any necessary preliminary research.

Research.—Organized research must be carried out under the following main heads:

(a) Production

1. Botany.—The collection and identification of all plants, but particularly of woody species forming the forest flora

2. Ecology.—The study of individual species, of the habitat, structure and floristic composition of the forest types, and of vegetational succession, retrogression and deflection.

3. Silviculture.—The study of the silvicultural characteristics of individual species: nursery work: regeneration both natural and artificial: improvement felling: measurement of the rate of growth and outturn of plantations: introduction of likely exotics.

4. Soil.—The study of soils in relation to the forest vegetation; preparation of soils maps; soil deterioration.

5. Diseases and pests.—The study of harmful insect and fungus diseases and pests and methods of control.

Utilization

The study of the wood structure and technical properties of local woods; of seasoning; of the utility of species at present unmarketable; of timber pests; of the antiseptic treatment of local timbers; of the possibilities of paper pulp; and of minor forest products such as gums, tans, resins, fibers, etc.

Education.—The training of the forest staff should take the form of the study of a course in elementary forestry, combined with practical work in the field and followed by examinations.

Educational propaganda by Forest Department Leaflets and pamphlets, lectures, articles in the local press, visits to silvicultural centers, etc should be conducted with energy as time permits.

Private forestry.—Executive measures should take the form of technical advice, assistance in marking of thinnings, preparation of simple working plans and so on.

Land usage.—Especially close cooperation must be effected with the Crown Lands and Agricultural Departments. Special attention must be paid to the prevention of the alienation of further Crown Land to steep hillsides, particularly in the Northern Range, and of Crown Land generally to persons other than bona fide agriculturists e.g. charcoal burners, in order to prevent an increase of the already large area of deteriorated non-productive land.

To ascertain how far the Forest Policy has been put into effect the reader is referred to the Annual Administration Reports of the Forestry Department of Trinidad and Tobago

Resumen

Nunca se le daría énfasis de más a la importancia de una política forestal sabia cuya continuidad estuviese asegurada. Esto se ha logrado en la isla de Trinidad ya que el gobierno ha enunciado y aceptado formalmente una política forestal de tales condiciones.

Las bases primordiales sobre las que descansa la Política Forestal en las islas de Trinidad y Tobago son las que siguen:

(1) La necesidad de preservar la vegetación protectora de bosques y la conveniencia de proteger la flora y fauna naturales.

(2) La necesidad de producir cantidades considerables de productos forestales principales y secundarios para cubrir las necesidades de la comunidad.

(3) La baja producción volumétrica de madera por acre de aquellas especies comerciables en los bosques mixtos naturales, con el consiguiente aumento en el costo de la explotación; el corte desmedido hecho en el pasado de algunas de las especies más valiosas dando como consecuencia la escasez actual de estas provisiones; la carencia absoluta de mercado para la mayoría de las especies y la explotación y uso insuficiente de ciertas especies de utilidad.

(4) La destrucción en escala ascendente de las riquezas forestales debido a la explotación del petróleo, aún en aquellas áreas que se habían dedicado al bosque con carácter de permanencia.

(5) La dependencia que tiene el mercado de construcción de la importación en gran escala de la madera de los coníferos.

(6) La preponderancia de áreas de suelos pobres y de tierras baldías y también la denudación y exposición de los terrenos montañosos debido a la conversión errónea de los terrenos forestales en terrenos agrícolas crea la necesidad de una política sabia precursora del uso óptimo del terreno.

(7) La importancia primordial de la agricultura como industria básica en esta colonia.

(8) La escasez prevaleciente de conocimientos y de comprensión de los beneficios y potencialidades de los bosques y de la Dasonomía.

En vista de las consideraciones principales arriba expresadas la Política Forestal ha sido enunciada de la siguiente forma:

Política General

Reserva forestal.—La Corona debe efectuar la reserva permanente de áreas forestales adecuadamente situadas, con un número de acres suficiente para suplir los beneficios necesarios para el bienestar de la comunidad beneficios indirectos en forma del mantenimiento de condiciones climáticas satisfactorias a los cultivos agrícolas, conservación del agua, prevención contra la erosión e inundaciones, etc., y los beneficios directos en forma de recursos forestales.

Manejo forestal.—Manejar el bosque de manera que la utilización de los productos forestales se efectúe a base del rendimiento en proporción a su incremento. Llevar a cabo una mejora tal que la producción de la colonia satisfaga con el tiempo sus demandas locales de madera.

Utilización.—Lograr la utilización máxima de los productos forestales sujeta a los requerimientos dasocráticos y fomentar el uso más económico posible de la madera importada.

Investigación.—Desarrollar la investigación organizada en todos los ramos y aspectos de la Dasonomía tropical y establecer en el futuro una División de Investigación del Departamento Forestal.

Educación.—Educar y entrenar el personal subordinado y darle a comprender a todas las clases sociales de la comunidad el valor local y los beneficios que ofrece el estudio científico del bosque.

Bosques y plantaciones privadas.—Estimular y ayudar en todo lo posible a los dueños de bosques y plantaciones privadas.

Uso del terreno.—Cooperar en todo lo posible con el progreso de una política consciente que conduzca al uso y distribución óptimos del terreno y también con todos los proyectos cuyo fin sea la conservación del suelo, prevención de la erosión y los trabajos de restauración de los terrenos deteriorados.

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CENTRAL AND SOUTH AMERICAN PLANT SCIENTISTS LISTED

In the May issue (Vol. VII, No. 3) of "Chronica Botanica" a list of Central and South American plant scientists was published. The list contains about 2,000 names, and is the result of extensive correspondence with scientists and institutions in all of the countries concerned. Wherever possible the position, scientific interest, and current and planned projects for each worker are included. The editors emphasize the fact that the list is incomplete, and they solicit corrections and additions. However, as the first compilation of its kind for this region it should be a very valuable contribution.

Among others the list includes the names of men working in forestry. The number working full-time or primarily on forestry presented for the countries in the Caribbean area follows. In addition there appear to be many who are spending part of their time in this field, especially in the countries where a separate forestry department has not been established by the government.

Country	Number	Country	Number
British Guiana	1	Haiti	4
British Honduras	3	Jamaica	1
Colombia	3	Mexico	16
Costa Rica	1	Nicaragua	1
Cuba	1	Puerto Rico	5
Dominican Republic	4	Trinidad and Tobago	4
Guadeloupe	2	Venezuela	2

The total of 48 includes forest administrators, men in experiment stations, and forestry professors.

PLANTING WITH TAR-PAPER POTS ON DIFFICULT SITES IN PUERTO RICO

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The establishment of forest plantations on difficult sites, particularly in areas of low rainfall, using seedlings with bare roots has in general proved a total failure in Puerto Rico. Despite extreme care in lifting and planting and the degree of defoliation practised to balance up for the loss of roots resulting from lifting, survival has been uniformly so low as to preclude the use of such methods.

Ball of earth planting being clearly indicated, various methods of lifting such as square-pointed shovels, trowels, conical spades, and similar devices were tested. Because of the nature of the soil in the nursery and the high cost, such methods while increasing survival materially, were still not considered adequate or satisfactory. The use of pots was considered but pots of most types such as clay, bamboo, etc. were unobtainable or expensive in Puerto Rico.

A method of planting with tar paper pots was then developed which has proved not only inexpensive but has given satisfactory survival on the most difficult planting sites. The method and procedure is described in extensive plantings carried out by the Forestry Division of the Puerto Rico Reconstruction Administration on dry sites on forest lands situated on the south and southwestern portion of the island of Puerto Rico. The species planted was West Indian mahogany, Swietenia mahagoni, although pot planting of a number of other species has recently been tried.

The Pots

The material used for the pots is 15 lb. "tarred felt". It is obtainable in rolls 36 inches wide weighing 65 pounds each, and containing 432 square feet. The pots used have been 4 inches in diameter and 6 inches deep, large enough to permit adequate root growth yet weighing only 2-1/2 pounds when ready to transport to the field. Further study is contemplated to determine the most satisfactory size of pot.

The tar paper is cut into rectangular pieces 6 x 14 inches. Cutting can be done with a sharp knife or a cross-cut hand saw. One roll contains sufficient paper for 720 to 740 pieces.

The pots are made by fastening the ends of the pieces together with four thin wire staples using a common office stapling machine.

The cost of construction of 1000 pots is as follows:

Tarred Felt	Cutting	Stapling	Total
$2.70	$0.67	$0.83	$4.20

Nursery Practice

Two nursery practices were tried: (1) raising 1-month seedlings in beds and transplanting them to the pots, and (2) raising the seedlings directly in the pots.

It is very desirable to have the nursery as close to the planting area as possible in order to minimize the cost of transporting the potted plants, heavier and more bulky than bare-rooted stock, to the field. As with all nurseries the site should be level and a reliable source of water should be at hand.

Transplant stock production.—When the seedlings are sown in nursery beds and later transplanted to the pots the beds used are 4 feet wide and 100 feet long. The seeds are sown in drills 6 inches apart. The number of seeds sown is such that six to eight seedlings will be produced per square foot. The seeds are covered with 1/2 inch of sifted soil. Germination starts after 18 to 20 days. Subsequent care consists of frequent watering, weeding, and partial shading with lath screens. When the seedlings are about 1 month old (3 inches tall) they are pricked off, culled, and set in the pots. The pots are then set in the same area as that used for the seed beds.

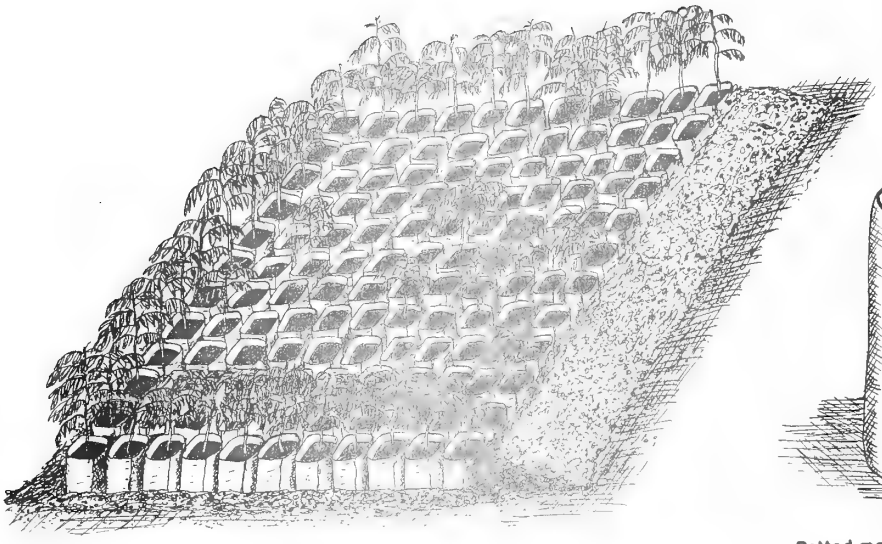
Seedling stock production.—When the seeds are to be sown directly in the pots, beds are prepared as in the first method. The pots are placed side by side on the bed and filled with soil with a trowel. They are filled to the top so that after the soil settles the surface will be 1 inch from the top. A bed 4 feet by 100 feet will accommodate approximately 3,600 pots.

One or more seeds are sown per pot at a depth of about 1/2 inch. After sowing the soil in the pots is watered sufficiently to soak the soil well.

In a hot dry climate, such as that of southern and southwestern Puerto Rico it is necessary to provide partial shade over young mahogany seedlings for at least 2 or 3 months. The shade can best be furnished by lath frames but palm leaves laid across a wooden frame supported by 3- to 4-foot stakes or posts will also serve the purpose.

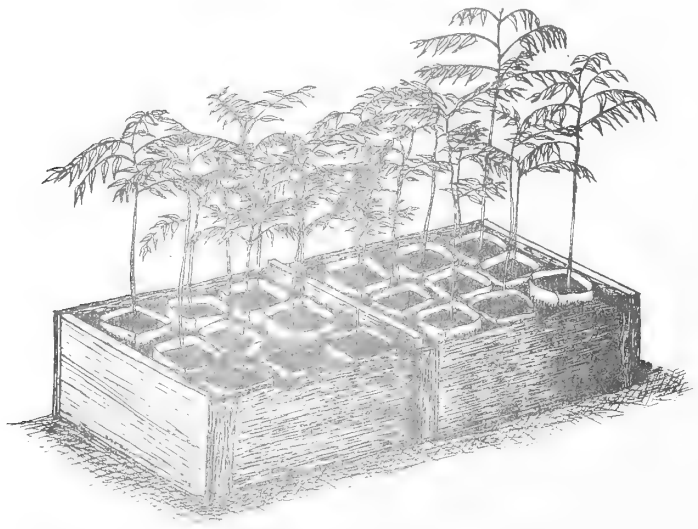
Care consists of frequent watering, preferably in the morning hours to minimize danger of attack by the mahogany blight fungus and a small amount of weeding.

The seedlings are ordinarily left in the nursery for a period of 6 to 8 months. At the end of this period the stock is 8 to 10 inches tall, the lateral roots have penetrated to the sides of the pots, and the tap root has penetrated 3 or 4 inches of soil below the bottom of the pot.



Pots in nursery bed.

Potted mahogany seedling.



Pots in crate used for transportation.

Costs.—The cost of seedling stock production on the basis of 1000 seedlings 8 months old is as follows:

Construction of Pots	Establishment			Maintenance (Watering, weeding, etc.)	Total Cost
	Ground Preparation	Preparing beds and pots	Sowing pots		
$4.20	$0.03	$2.00	$1.00	$2.60	$8.83

Field Planting

Sites.—The plantations established are in locations ranging in elevation from 500 to 1,500 feet above sea-level. Annual precipitation varies from 20 to 35 inches, distributed in two seasons; one from the latter part of March to about the middle of June and the other from the latter part of July to about the last week in November.

The soils in the area planted are of the San Anton, Rosario, and Descalabrado series. The first two cover most of the area.

(1) The San Anton loam is the type representative of this series, and appears as small pockets of alluvial soil along rivers and creeks. It is derived from tuffaceous rock and is friable and well drained. These alluvial soils are frequently flooded and covered with clay, silt, and sand, a circumstance which prevents the use of their great potential capacity for agricultural production.

(2) The Rosario series is represented by two types: the Rosario silty clay, which lies above the San Anton loam, along the slopes on both sides of the rivers and ravines; and a level phase occupying the more or less level ridges. These soils are lateritic, shallow, friable, and usually reddish brown or red.

(3) The Descalabrado silty clay represents the third series and occupies a very limited area. This soil is derived from tuffaceous rocks and is brown to red in color. It is very shallow, friable or plastic, and very easily eroded.

The entire area is covered with a mixed stand of deciduous species. Many of them are armed, a factor affecting ground preparation and maintenance work. The arborescent species are about 4 inches in diameter and 15 feet tall. The more common ones are:

West Indian Birch, Elaphrium simaruba
Aquilón, Laugeria resinosa
Ausú, Myrcia pagani
Yellow Torch, Exostema caribaeum
Canela, Acrodiclidium salicifolium
Poison Ash, Comocladia dodonaea

Site preparation. Essentially site preparation consists of removal of sufficient existing vegetation (brush and vines) to provide space for the

young trees. All arborescent species are left uncut. Strips 3 feet wide are opened up with machetes. The strips follow the contour of the land, the distance between strips being 6 feet. The material cut is windrowed along the lower side of each strip.

Transportation of the potted plants.—If the nursery is located close to the planting site the potted plants are transported in wooden boxes with manpower. Pack-horses are used for greater distances.

The pots are carefully lifted by passing a sharp machete under them to cut the tap roots. Then the pots are placed in wooden boxes resembling field pineapple crates (See Figure 1). The boxes are about 11 inches wide, 27 inches long, and 5 inches deep, and they weigh about 5-1/2 pounds empty and 40 pounds when filled with 14 potted trees.

Transportation by horse is resorted to when distances greater than 1/4 mile are involved. Each horse carries two kerosene boxes which hold 20 potted trees each.

Planting technique.—The holes are dug with a pick mattock. Stones are removed and the soil in the bottom of the hole is carefully tilled. The potted tree is placed in the hole with the root collar level with, or slightly below the surrounding soil level. In the absence of definite information regarding the effects of leaving the more or less durable pots around the roots the pots have been removed at the time of planting. The pot is slit down the side and removed and loose soil is packed firmly against the ball of earth. When the former soil level has been reached the surface is mulched with a litter of dead leaves or trash and the job is done.

Survival

Replanting costs following pot planting have been very low and records indicate that 70 per cent survival is readily obtained with this method as compared with extremely low survival on similar sites with bare-rooted stock.

Conclusions

Experience with tar-paper pot planting of West Indian mahogany in Puerto Rico in the reforestation of dry sites points to the following advantages over the bare-rooted planting technique:

(1) Tar-paper pots are cheaper than other types of pots available in Puerto Rico.

(2) The additional cost of raising seedlings in tar-paper pots is offset by the increase in survival.

(3) Better planting with a local or other partially trained crew is possible.

Resumen

El establecimiento de plantaciones forestales en localidades desventajosas, particularmente en áreas de baja precipitación pluvial, usando posturas con raíces desnudas, ha fracasado totalmente en Puerto Rico. Por lo tanto se ha desarrollado un método para plantar usando envases hechos de papel embreado que ha resultado barato y además con una supervivencia que asciende a 70 por ciento en los sitios más desventajosos.

Se usan rollos de 15 libras de papel embreado que se cortan en piezas rectangulares de 6 por 14 pulgadas. Los envases se hacen uniendo estas piezas a máquina por sus extremos más angostos. El costo es de $4.20 por millar.

En el vivero tanto las semillas como las plantitas de un mes se siembran directamente en los envases de papel. Luego se colocan éstos en las eras convenientemente rodeados de tierra.

Debido al peso de las posturas junto con los envases los viveros deben hacerse lo más cerca posible del sitio donde se vaya a plantar. Se pueden llevar allí en cajas de madera, a mano si es cerca, o a caballo si es lejos.

En la plantación se hacen hoyos con zapapicos en los cuales se colocan los envases de papel con las posturas. Se corta el papel a lo largo y se saca dejando así la postura en una bola de tierra. Luego se le echa tierra y se pisa bien.

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UN PLAN NACIONAL FORESTAL VENEZOLANO

Manuel A. González Vale
Ingeniero Civil y Técnico Forestal
Venezuela, 1942

El señor González Vale cortésmente nos ha remitido esta publicación que comprende un bosquejo del problema forestal venezolano el cual ha elevado de este modo a la atención del gobierno de su país. Describe el autor el progreso alcanzado hasta la fecha como "eminentemente precario" y dentro del límite de la publicación analiza los siguientes problemas: tierras forestales de propiedad privada, tierras agrícolas disponibles para usos forestales, tierras forestales del dominio público, producción forestal, protección de las vertientes, pastoreo de montes, vida animal silvestre, recreación y conocimiento forestal.

Para lograr sus objetivos el autor propone el establecimiento de bosques y parques nacionales, estadales y municipales de manera que sea el gobierno quien lleve la iniciativa y el peso de las actividades propuestas aunque sin eliminar otras formas de propiedad forestal. Recomienda además la creación del Instituto Forestal Nacional cuyo objetivo final sería la preparación de personal técnico idóneo para la realización del vasto y necesariamente complejo programa forestal.

FOREST ASSOCIATIONS OF BRITISH HONDURAS

N. S. Stevenson
Conservator of Forests
British Honduras

No. I

ORBIGNYA-DIALIUM-VIROLA ASSOCIATION

The Orbignya-Dialium-Virola association of British Honduras is the typical high forest of the valley bottoms in the granite, schist and quartzite zones in the central portion of the Colony and in the higher rainfall limestone and Toledo bed areas of the southwestern portion, and it occurs also as levee forest along the rivers draining those areas. It contains a scattered stock of mahogany but apart from this species and in some areas banak, the timbers are not at present utilized. Considerable areas of this type of forest have been destroyed in the making of banana plantations. No attempt has yet been made to estimate the extent of this association.

Name and location

This association is dominated by ironwood, Dialium guianense; and banak, Virola koschnyi, with scattered tall individuals and abundant medium and small individuals of cohune, Orbignya cohune. It is generally referred to as "high forest with cohune."

The sample plot described (B.H. No. 9) lies along the southern boundary of the Silkgrass Forest Reserve in the Stann Creek District, between Silkgrass and Dog Creeks in Block II Compartment 13.

Size and nature of samples studied

The chief species were enumerated in a 1-chain wide transect on the boundary, section, and cruising lines and hunting picadoes. The sample plot of 2 chains by 1/2 chain was then taken in what appeared to be typical high forest without apparent biotic modification. The observations were made in December 1939

Editor's note: This is the first of a series of descriptions of tropical forest associations. It is hoped that this beginning to a large task which confronts tropical foresters will encourage others to add to our understanding of tropical forests by contributing similar descriptions of other forest associations. The pages of "The Caribbean Forester" will always be open for publication of such material. The system here used is that outlined in Institute Paper No. 19 of the Imperial Forestry Institute. Standardization of procedure is essential to the ultimate classification of associations into formations. It is hoped that the information suggested in the outline in Paper No. 19 will eventually be compiled for all of the important tropical forest associations within the Western Hemisphere.

The plot was located on a flat-topped ridge at about 200 feet above sea-level. The area had a slope of about 1.5 per cent with a generally easterly aspect.

Structure and Composition

Structure

The canopy is closed, the crowns of the constituent species being "wind sway" distance apart only. The spacing of the large trees is apparently uniform, varying between 1 and 1-1/2 chains on the average.

In the sample plot (see figure 1) the ironwood was 27 inches and the banak was 26 inches in diameter above the spurs. In the supplementary tract enumeration, diameter measurements were not taken. There is, however, a general appearance of uniformity in the size of mature trees which in this area do not commonly exceed 30 inches in diameter.

Stratification can be recognized in the field and is obvious in figure 1. There are four more or less definite strata. The canopy of the largest individuals is closed between 75 and 100 feet. Below this main crown spread is a stratum of smaller trees with occasional large individuals of cohune at a general foliage height of 30 to 50 feet. Below this is a layer of shrubs and small trees ranging between 10 and 25 feet in height. There is a dense ground cover below 16 feet.

Physiognomy and life-form

Lianas and other epiphytes were common in the plot. They are here listed by host species.

On ironwood.

A. Indeterminate. Top of canopy, large lianas dependent from branch to roots in ground, not on trunk. This species appears to be terrestrial and is now sending up shoots from the base, scandent in habit.
B. Indeterminate. Liana, trunk up to branches, 40-50 feet.
C. Bellyfull tietie 1/2 way up trunk and first branches.
D. Jimmy Palmer (arum-like plant with pedate leaves) about crotch.
E. Basket making tietie, large, simple, but perforated leaves 2/3 up main stem.
F. Arum-like epiphyte, Anthurium concinnatum ?.
G. Small bellyfull tietie with large parted leaf.
H. Apparently ordinary ferns on top of branches.
I. Wild pine, Aechmea sp.? on trunk just above crotch.
J. Orchids on upper branches.

On banak

K. Young mata palo growing on top at 75 to 90 feet, roots have not yet reached the ground. Ficus sp.

SILKGRASS FOREST RESERVE-DOG CREEK
PLOT NO. 2

SPECIES	SYMBOL	SPECIES	SYMBOL
IRONWOOD, Dialium guignense	1	CACAO, Theobroma cacao	11
BANAK, Virola koschnyi	2	TIMBERSWEET, (Lauraceae)	12
COHUNE, Orbignya cohune	3	MAYA, Miconia sp.	13
WHITE COPAL, (indeterminate)	4	CACHO VENADO, Eugenia capuli	14
WILD COFFEE, Rinorea sp.	5	MATA PALO, Ficus sp.	15
WAIKA PLUM, Rheidia edulis	6	MONKEY TAIL, Chamaedorea sp.	16
MAMMEE CIRUELA, Lucuma sp.	7	HONE, Bactris sp.	17
NEGRITO, Simaruba glauca	8	TREE FERN, Alsophila	18
RED COPAL, Cupania sp.	9	PACUCA, Genoma sp.	19
MOUNTAIN TRUMPET, Pourouma aspera	10	KEROSENE WOOD, (indeterminate)	20

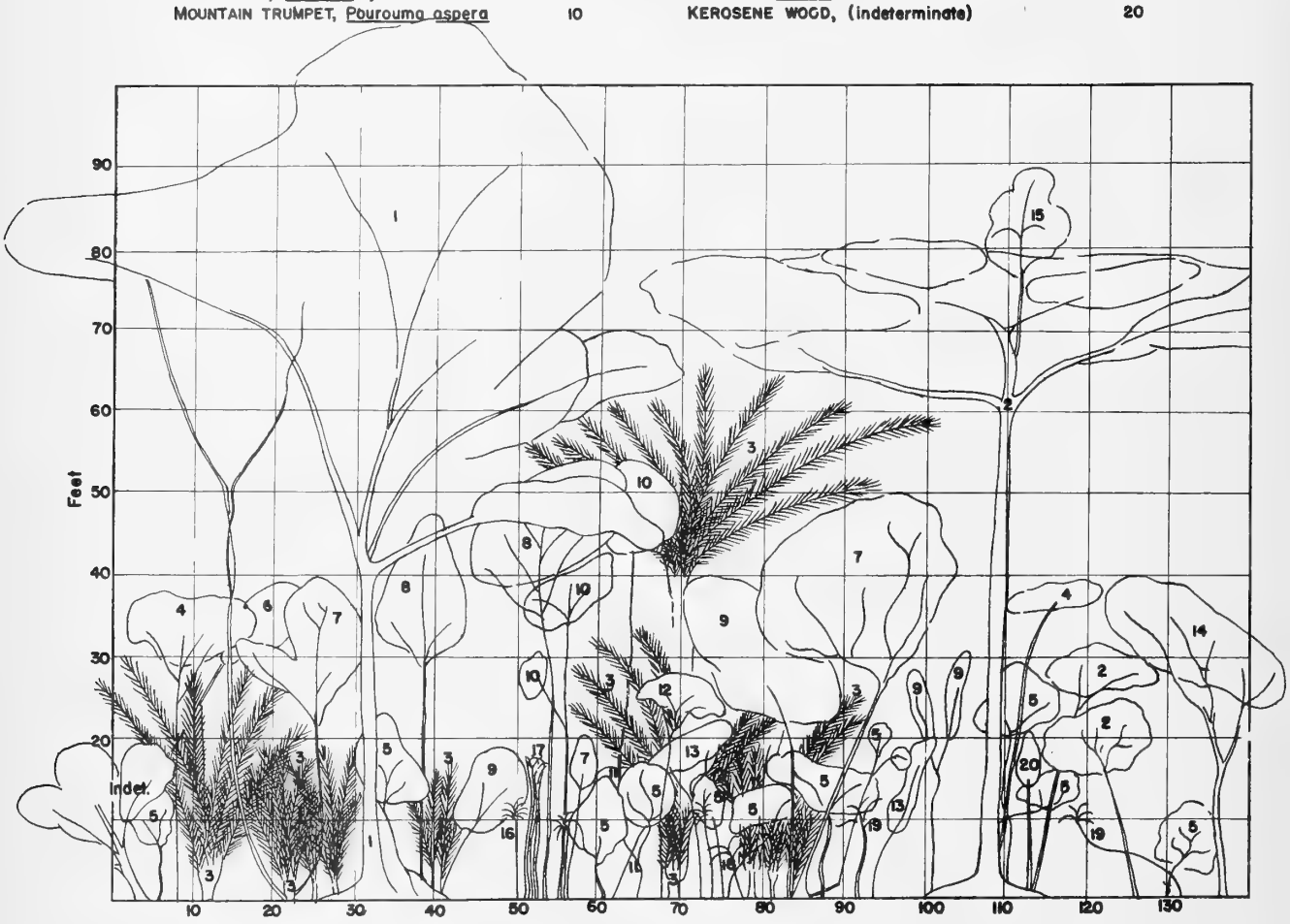

Fig. 1 PROFILE OF ORBIGNYA-DIALUM-VIROLA ASSOCIATION

On small wild coffee trees

L. Six climbing ferns
M. Four climbing palms
N. Basket tietie, Desmoncus, over other trees.

Both banak and ironwood have plank buttresses. Red copal, Cupania sp. and mountain trumpet, Pourouma aspera, have stilt roots. Pneumatophores, and thorny trunks and branches were absent in the plot although waika chewstick, an associated species, has stilt-like breathing roots. Cauliflory is present in cacao, Theobroma cacao, and one of the maya species has corky bark. Succulent leaves and stems are absent.

Special life forms present in the plot include very numerous palms, a tree fern, Alsophila; and a rattan, Desmoncus.

Ironwood and mahogany, Swietenia macrophylla, are deciduous in their adult form. In the canopy evergreen and deciduous species have equal representation, but 92 per cent of all the woody species in the association are evergreen. The leaves of ironwood and mahogany develop in March and fall in January or February.

The type and size of leaves by species are shown in the following table:

Tree Species	Type of leaves	Number of leaflets	Size 1/	
			Leaves	Leaflets
Dialium	pinnate	7	mesophyll	microphyll
Virola	simple		macrophyll	
Swietenia	pinnate	8	macrophyll	mesophyll
Lucuma	simple		mesophyll	
Simaruba	pinnate	up to 21	mesophyll	microphyll
Cupania	pinnate	9	macrophyll	mesophyll
Rheedia	simple		mesophyll	
Eugenia	simple		microphyll	
Pourouma	simple		macrophyll	
Rinorea	simple		mesophyll	
Miconia	simple			
Drypetes	simple		mesophyll	
Theobroma	simple		macrophyll	
All palms	pinnate	numerous		

1/ Raunker's leaf size classes.

Selaginella is particularly abundant in the ground layer, the count of individuals in an average plot of 6 feet by 3 feet being 102, or at the rate of nearly one-quarter million per acre.

Tall herbs and ferns were absent on the ground but small scattered mosses and ferns were present on the buttresses of the large trees.

Annual plants were not noted, and it is not believed that there is any seasonal dying down of the ground layer.

Reproduction

Ironwood produces abundant seed in small (2 cm. long) one seeded, globose fruits which do not open and are said to be a favorite food of animals. Dispersal by animals is not known, and no ironwood seedlings were found underneath the tree on the plot.

Banak produces abundant seed in small (2.5 cm. long) one-seeded fruits which open to release the nutmeg-like seed. Animal dispersal is not known. Thirteen small banak seedlings were found in the plot, but there were no saplings. Therefore, although the seed germinates freely under shade it is believed that light is required for its subsequent development.

Some negrito, Simaruba; and santa maría, Calophyllum, seedlings were noted, and one sapodilla macho, Achras, seedling was found. All have rather large seeds which fall directly from the tree, and those of santa maría and sapodilla presumably are borne by mammals or birds.

Two small mahogany saplings of 5 and 7 feet in height were noted. Production of seed appears to be irregular, but the periodicity is not known. The seed is winged, and dispersal is by wind before foliation. The seedlings require light for development.

Sucker shoots were developing from the base of the large canopy tietie on the ironwood. No other vegetative propagation was observed.

Floristic composition

The canopy of the largest individuals includes in the plot ironwood and banak on the top of which is growing an epiphytic Ficus.

In the second stratum in addition to cohune the following species are found: mammee ciruela, Lucuma sp.; negrito, Simaruba glauca; red copal, Cupania sp.; waika gum, Rheedia edulis; cacho venado, Eugenia capuli; mountain trumpet, Pourouma aspera; and white copal, (indeterminate).

The shrub and small tree layer includes numerous individuals of wild coffee, Rinorea sp.; small cohunes; monkey tails, Chamaedorea sp.; immature individuals of the canopy species, and the following others: maya, Miconia sp.; bullhoof, Drypetes sp.; red copal, Cupania sp.; mammee ciruela, Lucuma sp.; mahogany Swietenia macrophylla; cacao, Theobroma cacao, criollo type; pacuca, Geonoma sp.; bone, Bactris sp.; kerosine wood, (indeterminate); and timbersweet, (Lauraceae).

Below 6 feet in height, the species in the following table are found:

Species	Number per acre
cohune, Orbignya	130
monkey tails, Chamaedorea sp.	590
hone, Bactris	20
basket tietie, Desmoncus	10
wild plantain, Heliconia aurantiaca	1,020
silkgrass, Aechmea	710
waha (indeterminate)	100
Selaginella umbrosa	246,880

Very definite aggregations are noticeable in the above table. With the exception of Selaginella which was counted in a plot 3 feet by 3 feet in extent, the counts were taken for the whole plot of 1 chain square.

Wild coffee is a common undergrowth species and occurs in the plot at the rate of 100 per acre.

Habitat

Climate

Climatic data are taken from the records of the Stann Creek Agricultural Station, approximately 5 miles to the north.

The 4-year average mean temperature for the hottest month (June) is 80.9° F; for the coldest month (December) it is 74.0° F. The absolute maximum, recorded on October 14, 1934, was 105° F. The absolute minimum, recorded on January 29, 1935, was 46° F.

The 7-year average monthly precipitation means are as follows:

January	5.89"	July	13.75"
February	2.73"	August	9.96"
March	1.93"	September	13.14"
April	3.61"	October	13.73"
May	9.57"	November	7.38"
June	9.19"	December	6.64"

There is no regularity in the rains, which may vary considerably from year to year. There is a comparatively dry season in February, March, and April. The mean number of days without rain (6-year average) is 179.

A comparison of the 1939 Silkgrass monthly precipitation record and that at the Agricultural Station follows:

	Silkgrass	Agr. Sta.		Silkgrass	Agr. Sta.
	Inches	Inches		Inches	Inches
January	?	11.64	July	9.26	7.03
February	?	3.52	August	9.04	7.89
March	?	1.63	September	14.48	15.10
April	1.06[1/]	1.14	October	12.56	12.38
May	4.46	4.34	November	1.93	1.37
June	12.64	10.84	December	3.64	4.14

1/ Silkgrass Station established March 1939.

Wind records have not been kept near the plot. The prevailing wind is generally considered to be from the east. The prevailing wind in Belize is from the east except during November, December, and January, when it is northwest, and April, when it is southeast. The average velocity of these winds varies between 9 and 14 miles per hour, with maximum velocities up to 60 miles per hour. The mean is 12.1 miles per hour.

Soil and subsoil

The underlying rock is not known, but the site lies on the edge of the coastal alluvial plain, and the rock is probably mixed metamorphic, including ironstone, sandstone, and quartzite.

The soil is a clay loam. The surface litter is sparse and consists of a thin layer of dry leaves and small twigs. The rate of disappearance is presumably rapid and a definite humus layer is not distinguishable.

The first 13 inches of soil is a loam to clay loam, deep sienna in color. The next 6 inches is similar but with angular stones. It is not water worn and is possibly concretionary. At the bottom of this layer the stones appear to be breaking up. Below this layer the soil is red micaceous-clay to a considerable depth. Soil reactions determined colorimetrically were uniformly pH 6 5

Detailed information on the soil water is not available. Erosion is probably negligible The depth of the water table is not known. Within 3 chains of the west end of the plot Dog Creek runs about 15 feet below the plot level. To the east of the plot 4-1/2 chains runs Silkgrass Creek, about 25 feet below the plot level.

History of the area

The finding of Amerindian household artifacts led Mr. I. T. Sanderson of the British Museum to the belief that shifting cultivation had "passed through" in the last couple of hundred years This view is supported by the report of an ancient house mound in the locality

Enumeration of the mahogany growing stock in the reserve suggests that the present very uneven stocking may have been due to good regeneration following some catastrophe which damaged the bush badly about 1865. A local tornado in 1928 crossed the mouth of Stann Creek Valley, a few miles to the north, and the fact that the Colony lies within the hurricane zone support the possibility of considerable wind damage, but no records have been found to check this belief.[1]

Biotic factors

Recent records of mahogany extraction show that trees were obtained along Silkgrass Creek from the Reserve in 1911, 1918, 1920, 1926, and 1936. Of these operations those of 1926 and 1936 constitute the only record of the definite removal of mahogany in the vicinity of the plot.

In 1923-4 the Forest Department maintained a camp on Dog Creek in this area, and tree improvements which included the cutting of tieties or lianas and the removal of trees interfering with mahogany were carried out. Seedling improvements which involved the removal of undergrowth and the opening of the canopy were made in 1923, 1926 and 1927-8. In the last operation 41 seedlings per acre were treated, indicating the degree of interference.

There has been no shifting cultivation or grazing of this area within living memory. The effects of grazing or trampling by wild animals were not noted. Termites of an unknown species were present in a wild coffee trunk, but there was no observable effect in the vegetation. There were no signs of burning.

Succession

The association is predominantly Orbignya-Dialium-Virola, a tall mixed levee forest which may attain 100-130 feet in height. It contains species from the previous association, Calophyllum, Terminalia, Symphonia, and Vochysia, but it is apparently now stable. It is suspected that cohune is increasing and nargusta, Terminalia, and yemeri, Vochysia are disappearing in a change of composition probably due to better drainage.

Resumen

Esta es la primera de una serie de descripciones de asociaciones forestales tropicales. Esperamos que esta iniciación de la labor enorme con que se confrontan los dasónomos tropicales sirva de estímulo para que otros contribuyan con descripciones similares de otras asociaciones forestales. Las páginas del "Caribbean Forester" están siempre a la disposición de aquellos que quieran publicar sobre esa materia. El sistema que usamos es aquel bosquejado en la publicación No. 19 del Instituto Imperial Forestal. El establecimiento de una norma a seguir es esencial a la clasificación posterior de las asociaciones en las diversas formaciones. Esperamos que en el futuro la información que

1/ The Silkgrass Forest Reserve was badly damaged during a hurricane in September 1941.

sugiere dicho bosquejo se compile para todas las asociaciones importantes del Hemisferio Occidental.

La asociación Orbignya-Dialium-Virola que existe en la Honduras Británica es el monte alto típico del fondo de los valles en la zona de granito, esquisto y cuarcita del centro de la colonia, de las áreas calizas de precipitación pluvial alta en la parte sudoeste y también de los bosques a lo largo de los ríos que bañan esas áreas. Contiene árboles de caoba aquí y allá pero aparte de esta especie y de banak en algunos sitios, las demás maderas no se utilizan en el presente. Areas considerables de este tipo de bosque han sido destruídas para substituirlas por bananos. Todavía no se ha tratado de estimar la extensión de esta asociación.

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FOREIGN WOODS USED IN MANUFACTURING IN THE UNITED STATES DURING 1940

A canvass conducted by the Forest Survey in cooperation with the Bureau of the Census has made possible a tabulation of the domestic and foreign wood consumption during 1940 by the so-called secondary wood-using industries - industries such as box and furniture manufacture. The report, prepared by R. W. Marquis, sums up consumption by species, by types of forest products used (lumber, veneer, logs, or bolts), by products manufactured, and by states. A tabulation of the foreign woods consumed, in thousands of feet, board measure follows:

Wood	Consumption[1] M feet, B.M.	Wood	Consumption[1] M feet, B.M.
American Woods			
Mahogany	40,820	Prima vera	842
Balsa	2,261	Rosewood	579
Spanish cedar	1,418	Degame	134
Cocobolo	1,019	Lignum vitae	36
		Satinwood	5
Non-American Woods		**Total Woods**	
All Philippine	20,686		
Oriental Wood (Teak)	1,196	American	47,114
African (Khaya)	1,142	Non-American	23,512
European (Brier)	408	Other[2]	2,842
Australian (Eucalyptus)	61		
Indian (Jarrah)	19	Grand Total	73,468

1/ Figures in this column do not include reports in which the species were grouped because of their minor importance.
2/ "Other" includes the volume omitted as noted in 1/. All species in the tables are included in this item plus avodire, oak, zebra wood, West Indian boxwood, Turkish boxwood, ebony, snake wood, grenadillo, and Circassian walnut.

A SEED STORAGE STUDY OF MAGA[1/]

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It is common knowledge that the seed of numerous plant species cannot be kept for long periods under ordinary storage conditions in humid tropical climates without losing viability within a very short period of time. Farmers repeatedly have had losses due to the very rapid deterioration of the seeds of vegetables such as lettuce and onions. Plant breeders are often concerned over the loss of many a promising line of beans or corn from total loss of seed viability after a relatively short period of storage. Similar difficulty is encountered when the forester stores tree seeds.

Related Seed Storage Studies

A considerable amount of work has been done on seed storage in temperate climates, some of it with forest tree seeds. Duvel (3) found that moisture plays an important part in bringing about the early loss of seed viability and that the detrimental effect of moisture is more marked as the temperature increases.

San Pedro (4), studying storage of vegetable seeds in the Philippines found that moisture seems to exert more influence on seed viability than temperature.

Barton (1), working with dandelion seeds, showed that the effects of storage temperature were less marked when the moisture content of the seed has been reduced. With 3.9 per cent moisture seeds showed little difference in viability after three years at room temperature, 5°C, or -5°C. When room temperature or 5°C was used, sealed storage proved superior to open storage regardless of moisture content (up to 7.9 per cent). However, seeds kept in perfect condition for three years at -5°C regardless of sealing or moisture content.

The same authority (2) stored Pinus taeda for seven years, sealed in low temperature storage, without loss in viability, whereas a low seedling producing power was shown by seeds stored open for one year at room temperature. Only a few seedlings were produced thereafter. The same beneficial effects of sealing at low temperatures were found for seeds of P. caribaea, P. echinata, and P. resinosa. Summarizing, Barton states: "results indicate that seed storage at a low temperature is effective for the maintenance of vitality of these coniferous seeds for considerable periods."

1/ Studies in 1938 and 1939 were made under the direction of L. R. Holdridge. The writer had direct responsibility for the 1940 study.

Simpson (5) stored cottonseed of two upland varieties ranging in moisture from 7 to 14 per cent at constant temperatures of 90°, 70°, and 33° F. The seeds stored at 90° deteriorated rapidly, those containing 14 per cent moisture were all dead after 4 months, and after 36 months' storage only seeds with seven per cent moisture content were viable. Those stored at 33° , even with 14 per cent moisture, retained good viability for 36 months. Simpson concluded that "the longevity of cottonseed is definitely dependent upon the moisture content of the seeds and the temperature conditions under which the seeds are stored. If the moisture content is low, cottonseeds can withstand high temperatures without rapid deterioration, and if the temperature is kept low they are tolerant of high moisture, but both temperature and moisture cannot be high if rapid deterioration is to be prevented."

Unpublished data (1938-39) from the Tropical Forest Experiment Station shows the beneficial effect of cold storage in conserving the viability of seeds of Cedrela mexicana Roem. and Swietenia macrophylla King for eight months. In the case of Hymenaea courbaril the type of container or storage temperature did not make much difference during the first year. At the end of two years low temperature storage was clearly superior Recent tests show that seed of Tabebuia pallida Miers, of very good viability at the time of collection deteriorates very rapidly. At the end of the first month only a small percentage of seedlings is produced in nursery beds.

Regardless of unfavorable conditions for storage (these are most favorable in sub-humid or dry climates) some tropical species of trees and shrubs with hard shelled seeds expose their indehiscent pods to the weather for several months, after which the seeds are usually in perfect condition. Albizzia lebbeck and Hymenaea courbaril are good examples in Puerto Rico On the other hand considerable difficulty has been experienced by agriculturists in establishing South and Central American species of Ingas due in part to the rapid deterioration of the seed. Among others, some forest tree species with seed of short viability under our conditions are: Casuarina equisetifolia, Dacryodes excelsa, Cerdana alliodora, Guarea guara, and Vitex divaricata.

The Problem

Maga, Montezuma speciosissima Sessé & Moc., the species used in the present study, is a medium to large malvaceous tree endemic to the island. It yields a strong and durable construction and furniture wood that compares well with mahogany in appearance and termite resistance. It has received considerable attention in reforestation work.

Maga seeds consist of a large embryo folded inside the seed coat. Having no endosperm the embryo lacks a large food reserve and must germinate and become established soon after dropping from the capsule In fact, seeds often start germination before the fall of the capsule. Frequently a large proportion of the seeds received in the nursery have been already in the process of germination. Thus, sowings had to be made soon afterwards. When the planting schedule called for large amounts of seedlings large sowings were made at one time. As a result a great amount of stock became ready for

planting within a short period resulting in overgrown planting material if planting schedules were delayed. Difficulty was experienced in distributing seeds from the central to the local field nurseries when sowing had to be delayed in the field. Usually low germination resulted from this circumstance.

The 1938-39 Study

Procedure

A series of studies were started in May 1938 with maga and four other hardwood species. The following results are for maga storage only.

Seeds were stored four days after collection. No effort was made to dry them and therefore all treatments had an equal initial moisture content. Two temperatures were used: room temperature in a wooden office building in Rio Piedras[2/], and cold storage in a commercial storage plant in San Juan, where the temperature remained between 35° and 40° F. (1.7° to 4.4° C.) Two containers were used, small cotton bags and quart size fruit jars sealed with a rubber ring. Each container had 100 seeds or 25 seeds per row in each of four randomized blocks in the nursery. Seven storage periods were used ranging from 2 weeks to 1 year. Germination was taken in open nursery seedbeds subjected to the usual nursery conditions.

Results and Discussion

Table 1.—Germination Percentages for 1938-39 Study.

Storage Periods[1/]	Room Temperature		Cold Storage	
	Sack	Qt. Fruit Jar	Sack	Qt Fruit Jar
2 weeks	51	31	31	70
1 month	40	0	34	62
2 months	0	0	34	10
4 months	0	0	25	0
6 months	0	0	8	0
8 months	0	0	0	0
1 year	0	0	0	0

1/ Germination of seed lot previous to storage averaged 53.5 per cent.

No statistical analysis of the data was made in view of the obvious wide variation of the results which show that some treatments resulted in almost complete loss soon after storage.

2/ The 10 year temperature average at Rio Piedras is 76.7°F; lowest 54°F; and highest 98°F. Relative humidity in San Juan, 7 miles from Rio Piedras, is 81

As is shown in Table 1 no great differences were obtained during the first two weeks of storage except that the cold storage jar was better than any other one. From that time on cold storage is shown to be more effective than ordinary temperature. Seeds in the sack in cold storage kept viable longer than those under any other treatment.

Seeds kept at room temperature in a fruit jar were dead after one month storage while those under the same temperature but stored in a sack retained good viability after the same period. It was evident that seeds in the sack lost moisture while those in the sealed jar were surrounded by a humid atmosphere. In the sacks, although the temperature was high, drying of the seeds reduced respiration to such an extent that viability was prolonged to one month in spite of the high temperature. In the sealed jar a high humidity combined with a high temperature brought about early loss. Under the conditions of this study one month seems to be the limit of seed viability in ordinary temperature.

The viability of the seeds in cold storage in the sealed jar dropped suddenly between the one- and two-month storage periods. This is attributed to the effect of the humid atmosphere in the sealed container. This relation is verified once more in the case of the cold stored seed in the sack which after 4 months showed 25 per cent as compared with the original germination percentage (53.5%). These seeds apparently had lost part of their moisture, and thus were under more favorable storage conditions. Accordingly there seems to be a close interrelation of moisture and temperature affecting the results in this study.

The 1940 Study

Procedure

Realizing from the previous studies that moisture was an important factor the experiment was repeated in 1940 using maga as the only species and drying the seeds to four different moisture contents. One more container was introduced, sealed bottles which were opened once every week. It was hoped that the effect of the high humidity in the sealed bottles and also a possible lack of oxygen due to respiratory activities of the seed could thus be avoided. Two ounce sample bottles were used instead of the quart fruit jars. One hundred seeds were stored in each bottle, 25 for every nursery row in each of four replications. The sealed treatment consisted in screwing the bakelite caps tightly on the bottles and coating them well with melted paraffin. The sacks were the same small white muslin bags as used in the previous study.

Percentage of moisture loss was calculated by dividing weight following drying by original weight and multiplying by 100. In this way four different moisture contents were used: 100, 87.5, 75, and 62.5 per cent of the original weight. Drying was done with an electric fan taking from 4 hours for the 87.5 per cent to 16 hours for the 62.5 per cent sample.

Ordinary or room temperature was that of the interior of an office building. Cold storage was obtained in a 10 cu. ft. electric refrigerator in

which the temperature ranged from 35° to 40° F. (1.7° to 4.4° C.) Five periods of storage from 2 weeks to 6 months were used. The refrigerator was kept closed except once a week when half of the bottles were taken out and opened. Seed bed germination was again taken as the index of seed viability. Sowing was done in nursery seed beds in the open under ordinary field conditions.

The location of the sections in the nursery, corresponding to the storage periods and of the treatments within each period were obtained by randomization. Seed was fresh and of very high quality, being extracted from the capsule the day previous to storage. The germination obtained with fresh seed and with the various treatments after the different storage periods is shown in Tables 2 and 4.

Results and Discussion

The difference in initial germination between the seeds of different moisture contents as shown in Table 2 was not great. Table 3 shows that it was not statistically significant, and therefore, the drying alone did not have any effect on germination under the conditions of the study.

Table 2.—Germination of Fresh Seeds.

Moisture Percentage	Germination Percentage
62.5	73.67
75	70.17
87.5	70.83
100	78.00

Table 3.—Analysis of Variance—Germination of Fresh Seeds.

Source of Variance	D F	S S	M S	F	F at 5%	F at 1%
Block	3	169.8719	56.6240	2.2647	3.86	6.99
Moisture	3	852.8419	284.2806	2.2169 1/	3.86	6.99
Error	9	1,154.1056	128.2340			
Total	15	2,176.8194				

1/ Not significant.

Table 4.—Germination per cent by storage treatments and periods.

Storage Period	Sack				Sealed Jar				Opened Jar			
	62.5	75	87.5	100	62.5	75	87.5	100	62.5	75	87.5	100
	%	%	%	%	%	%	%	%	%	%	%	%
					Room Temperature							
2 weeks	47	40	47	54	7	0	1	1	20	0	0	3
1 month	23	16	7	7	0	0	0	0	0	0	0	0
2 months	1	1	1	0	0	0	0	1	0	0	0	0
4 months	0	0	0	0	0	0	0	0	0	0	0	0
6 months	0	0	0	0	0	0	0	0	0	0	0	0
					Cold Storage							
2 weeks	14	5	4	2	74	62	62	65	83	75	65	79
1 month	19	8	0	1	78	76	59	29	60	52	50	23
2 months	8	2	0	0	50	8	3	14	64	70	32	0
4 months	0	0	0	0	8	0	0	0	0	0	0	0
6 months	0	0	0	0	0	0	0	0	0	0	0	0

Because of the obvious wide variation in the results and low survival with some treatments as shown in Table 2 it was unnecessary to pool all the data for statistical analysis. The analysis for only fresh seeds and for some periods of the cold storage (2 wks. to 2 mos.) is presented in Table 5.

Table 5.—Analysis of Variance—Two Weeks to Two Months Cold Storage Data.

Source of Variance	D.F.	S.S.	M.S.	F	F at 5%	F at 1%
Block	3	285.784	95.261	1.457	8.94	27.91
Storage	2	13,860.064	6,930.032	49.918	5.14	10.92 1/
Error (1)	6	832.966	138.828			
Total	11	14,978.814				
Moisture	3	7,369.974	2,456.658	67.052	2.75	4.11 1/
Container	1	497.770	497.770	13.586	3.99	7.06 1/
Moist. x Cont.	3	1,183.345	394.448	10.766	2.75	4.11 1/
Storage x Moist.	6	3,735.293	622.549	16.992	2.24	3.10 1/
Storage x Cont.	2	2,022.121	1,011.060	27.596	3.14	4.96 1/
Stor. x Moist. x Cont.	6	3,745.109	624.185	17.037	2.24	3.10 1/
Error (2)	63	2,308.190	36.638			
Total	95	35,840.616				

1/ Highly significant.

Table 5 shows a very high statistical significance in the differences between the various moisture contents, storage periods, and containers, especially in the first two factors. It was natural to expect differences between storage periods, as seed of this species loses viability rapidly in storage. The great differences between the different moisture contents have practical as well as high statistical significance. There is no doubt that a comparison of both temperatures in the analysis would have shown still greater statistical significance. All the interactions between storage, moisture and containers also show very high statistical significance. This is of great importance in the application of the results since it is the interrelated effect of these storage factors that is directly responsible for the success of storage. This is in accord with the findings of others as has been pointed out, especially in reference to the interaction of moisture and temperature.

Figure 1 illustrates the combined influence of the two most important factors affecting maga seed storage.

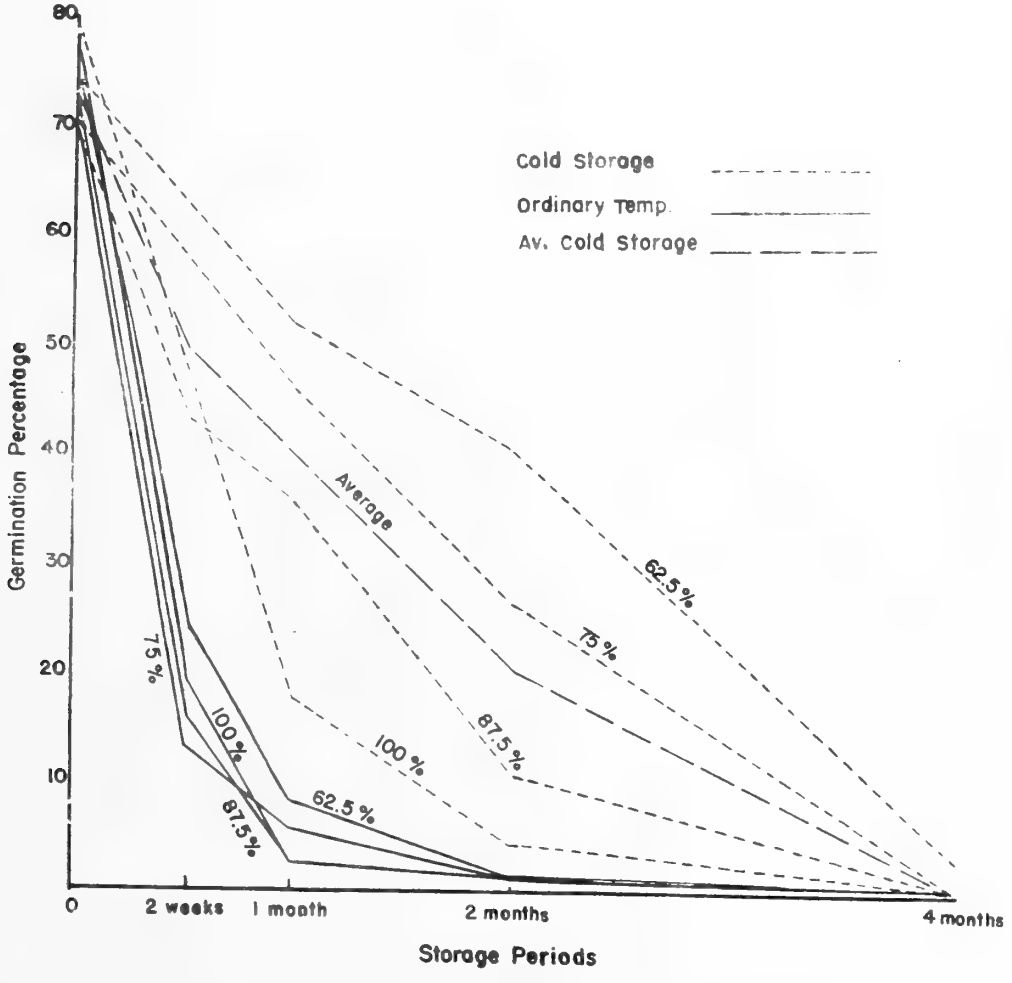

Figure 1.—THE COMBINED EFFECT OF ORIGINAL MOISTURE CONTENT AND STORAGE TEMPERATURE ON THE VIABILITY OF MAGA SEED.

The relations shown are:

1. Loss of viability in maga seed proceeds rapidly in storage. Eight weeks was the limit for satisfactory storage under the conditions of the study.

2. An obvious superiority of cold over room temperature storage is shown. However, loss in viability of cold stored seed was very rapid between the 2- and 4-month periods.

3. A very pronounced reduction in loss of germination was obtained by drying the seed to 62.5 per cent of its original weight when using cold storage. Little was gained by drying seed when stored at ordinary temperature.

4. The best storage conditions were obtained by drying seed to 62.5 per cent of its original weight and storing at a low temperature. Wide divergence between 62.5 per cent and 75, the next highest moisture percentage, suggests reduction in moisture beyond 62.5 per cent in future studies.

Barton (1) expressed a common criterion obtained by working with other species in cooler climates: "For safe storage of seeds with high moisture contents, low temperatures are required and the higher the moisture content, the lower the required temperature." Simpson (5) working with cotton stated: "If the moisture content is low, cottonseeds can withstand high temperatures without rapid deterioration, and if the temperature is kept low they are tolerant to high moisture. . . . ."

Maga seeds under the conditions of this study have shown very exacting requirements for optimum storage conditions, for combinations of high moisture-low temperature and high temperature-low moisture produced similar low germination. (Note in Fig. 1 how close the curves for both combinations come together). With ordinary temperature, the slight differences between 62.5 and the higher moisture contents do not give much hope that a further reduction in moisture might be a help in high temperature storage. With cold storage further reduction in moisture seems to offer the best possibility for lengthening the safe storage period.

Figure 2 shows the effect of the different containers:

1. Except for the relative position of the sack container best results were obtained by cold storage.

2. Strangely enough cold storage in sacks proved inferior to storage at room temperature.

3. The relation between the germination of seed from opened and sealed jars was not uniform after each period of storage, the relative position of the two treatments alternating between two weeks and to months.

Results of the two studies seem contradictory regarding the viability in the sack in cold storage since in 1938-39 this treatment was more successful than any other. In 1940 germination was very low even after two weeks storage. One interpretation of this inconsistency is that seeds in the small refrigerator could have been dehydrated beyond the optimum percentage of moisture and in addition were subjected to fluctuations in moisture content since the refrigerator was opened once a week.

In the sack under ordinary temperature, seeds lost moisture so that the very injurious combination of high humidity and high temperature, which soon killed most of the seeds in the bottles after 2 weeks, was avoided. In the sacks stored in the cold storage plant there was some drying of the seeds which was beneficial, in contrast to those in the sealed fruit jars which were stored without drying. (Compare with previous study on page 175).

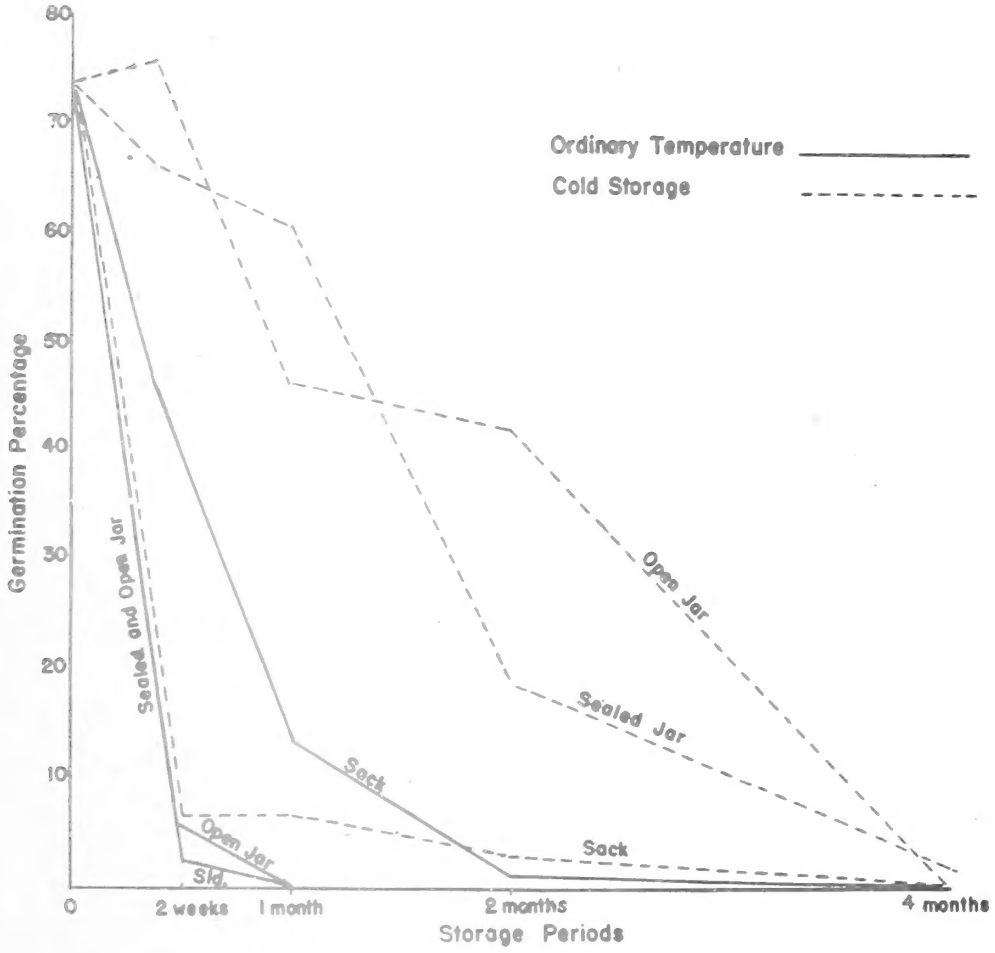

Figure 2.—THE COMBINED EFFECT OF TYPE OF CONTAINER AND STORAGE TEMPERATURE ON THE VIABILITY OF MAGA SEED.

The sudden drop in viability in the sealed jar-cold temperature between one and two months is the most conspicuous feature of the graph. Seeds in the previous study behaved exactly alike under the same condition. This drop is attributed to the high moisture content in the sealed bottles.

That such a theory seems justified is proved by the fact that the seeds dried to 62.5 per cent and sealed, germinated well after two months and were the only ones to germinate at four months. Those seeds dried to the same percentage but stored in the opened bottles were not significantly superior at the end of two months. On the other hand viability in opened jars showed higher germination than in sealed jars with 75 and 87.5 per cent moisture. Apparently the difference at two months between sealed and opened jars in cold storage is due to greater moisture retention in the sealed jars since some moisture escapes when the other jars are opened. With 100 per cent moisture content there was no significant difference between sealed and opened jars, both being very low because of the high moisture content.

From the evidence presented it appears that the higher humidity in the sealed bottles and its effects upon respiration are the cause of the drop in germination between one and two months. The alternative fluctuations of germination of seed from both types of containers between two weeks and one months is not understood.

Conclusions

(1) Storage of maga seed for any relatively long period is a difficult problem. Even under the favorable conditions of this study seed devitalization was rapid after two months.

(2) Evidently cold storage is essential for satisfactory results. Room temperature failed to satisfactorily preserve seed viability for even 1 month.

(3) Under cold storage germination varies inversely with the moisture content of the seed, a relation especially apparent at the end of the period of satisfactory storage. Reduction in moisture content did not have much effect at room temperature.

(4) Relative effectiveness of different types of containers depends to a great extent on the temperature and moisture conditions under which the seed is stored.

(5) Moisture seems to be the factor directly or indirectly responsible for the drop in germination percentage of seed stored in sealed jars between one and two months.

Literature Cited

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Resumen

Es un hecho comprobado que las semillas de diversas especies no se conservan bien en el trópico, donde la temperatura y la humedad relativa son altas. En los climas templados este problema de conservación de semillas ha sido investigado intensamente con diversas especies, algunas de ellas especies forestales.

Durante el 1938-39 y 1940 y como parte de una serie de investigaciones con varias especies de árboles, se llevaron a cabo estudios sobre la conservación de la semilla de maga, Montezuma speciosissima, especie endémica de Puerto Rico y cuya madera es de gran utilidad. En el primer año el estudio consistió en almacenar semillas en dos envases diferentes: frascos de cristal herméticamente cerrados y saquitos de tela; y también a dos temperaturas diferentes: temperatura corriente (promedio de 25°C.), y a la temperatura del frigorífero disponible o sea de 1.7° a 4.4° C. El grado de humedad de la semilla fué uniforme ya que no se le alteró antes de almacenarse en ninguno de los tratamientos.

En el 1940 se repitió el experimento con las siguientes diferencias: en vez de usar frascos grandes se usaron frascos pequeños la mitad de los cuales se cerró herméticamente hasta el tiempo de sembrar la semilla y la otra mitad se abría semanalmente para el intercambio de gases y para evitar la falta de oxígeno. Se usaron saquitos de tela igual que el año anterior. Además de las semillas sin secar se usaron semillas que se secaron hasta pesar 62.5%, 75% y 87.5% respectivamente del peso original; de manera que además de dos temperaturas y tres envases había también cuatro grados diferentes de humedad.

Las semillas, sujetas a estas diversas condiciones se dividieron respectivamente en 5 períodos de almacenaje, desde dos semanas hasta 6 meses.

Los resultados fueron los siguientes:

(a) La refrigeración demostró ser indispensable para conservar las semillas.

(b) La reducción del grado de humedad dió buen resultado bajo refrigeración pero no así a temperaturas más altas.

(c) La utilidad de los recipientes dependió en gran parte de las condiciones de humedad y temperatura a que se guardó la semilla: los frasquitos conservaron la semilla bien solamente bajo refrigeración, especialmente si el grado de humedad era bajo; los saquitos la conservaron un poco mejor que los frasquitos a la temperatura más alta; los frasquitos cerrados conservaron bien la semilla con 62.5 por ciento del peso original hasta los dos meses pero con mayor contenido de humedad los que se abrieron semanalmente la conservaron mejor.

(d) En los frasquitos que se mantuvieron cerrados continuamente, cuando el grado de humedad era alto, la acumulación de humedad más bien que la falta de oxígeno, perjudicó la viabilidad de las semillas.

(e) Aun bajo las condiciones más favorables, la semilla de maga perdió rápidamente su viabilidad, conservándose en buenas condiciones solamente hasta los dos meses. En condiciones poco favorables, a las dos semanas ya se había depreciado considerablemente.

La combinación de factores que mejor conservó la semilla de maga fué un contenido de humedad bajo y envase en frasquitos bajo refrigeración.

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FOREST PLANTING IN JAMAICA DURING 1940

During the fiscal year April 1, 1940-March 31, 1941, the total area in forest reserve in Jamaica was increased 8,210 acres to 209,209 acres or nearly half of the forest land of the island.

Twelve nurseries were maintained by the Forest Department from which 57,000 plants were removed. Progress was made in afforestation of grassy and bracken-covered hillsides in the Blue Mountain Forest Reserve, the principal species used being mahoe, Hibiscus elatus; cedar, Cedrela odorata; mahogany, Swietenia mahagoni; cape yacca, Podocarpus elongatus; and juniper cedar, Juniperus lucayana. Activities were continued at Green Hills, Hermitage, and Shooters Hill and 47,000 trees were planted. Direct sowing of seed of Pinus massoniana failed due to bad seed. Soil analyses of Hollywell, where practically all species failed, revealed a nearly complete absence of phosphates, and it is proposed to plant only pine with a low nutrient demand. The cedar shoot-borer, Hypsipyla grandella, was observed in the plantations for the first time.——From the Annual Report of the Conservator of Forests.